



Electrical Specifications

Issued for Tender and Permit

Project Name

SHN Dialysis Care Units
Centenary Hospital

Project Number

MRK-22001516-A0

Date Submitted

April 17th, 2024

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PART 1 - GENERAL

1.1 References

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

1.2 Application

- 1.2.1 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 01, conditions of Division 01 to take precedence.
- 1.2.2 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Electrical Sections. It is intended as a supplement to each Electrical Section and is to be read accordingly.
- 1.2.3 Be responsible for advising product vendors of requirements of this Section.

1.3 SUBMITTALS

- 1.3.1 Submit shop drawings for products of this Section.

1.4 Product Requirements in Special Areas

- 1.4.1 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.
- 1.4.2 Products in public areas such as exterior areas and in parking areas are to also be vandal-proof and impact resistant.

1.5 Definitions

- 1.5.1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- 1.5.2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- 1.5.3 "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.
- 1.5.4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- 1.5.5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.

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- 1.5.6 "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.
- 1.5.7 "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 Consultant.
- 1.5.8 "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.
- 1.5.9 "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.
- 1.5.10 "Mechanical Divisions" - refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- 1.5.11 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- 1.5.12 "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.
- 1.5.13 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.
- 1.5.14 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.
- 1.6 Documents**
- 1.6.1 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.
- 1.6.2 Review Drawings and Specification in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
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- 1.6.3 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Electrical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- 1.6.4 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.
- 1.6.5 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.
- 1.6.6 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.
- 1.6.7 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.
- 1.6.8 Starter/ 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, VFD, and motor specification requirements of Mechanical Divisions specifications and drawings. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- 1.6.9 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.
- 1.6.10 In case of discrepancies or conflicts between Drawings and Specifications, Documents will govern in order specified in "General Conditions", however, when scale and date of Drawings are same, or when discrepancy exists within Documents, include most costly arrangement.
- 1.7 Work Standards**
- 1.7.1 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 obtaining building permit and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- 1.7.2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Consultant.
- 1.7.3 Supplementary mandatory Specifications and requirements to be used in conjunction with project include but are not limited to following:
- 1.7.3.1 Canadian Standards Association (CSA);
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- 1.7.3.2 Long-Term Care Home Design Manual 2015 by MOHLTC;
- 1.7.3.3 Ontario Fire Code Ontario Long Term Care Homes Act (LTCHA);
- 1.7.3.4 UL 2560 Standard for Emergency Call Systems for Assisted Living and Independent Living Facilities;
- 1.7.3.5 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- 1.7.3.6 Electrical Safety Authority (ESA);
- 1.7.3.7 Electronic Industries Association (EIA);
- 1.7.3.8 Illuminating Engineering Society (IES);
- 1.7.3.9 Institute of Electrical and Electronic Engineers (IEEE);
- 1.7.3.10 National Electrical Manufacturers Association (NEMA);
- 1.7.3.11 National Fire Protection Association (NFPA);
- 1.7.3.12 Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces";
- 1.7.3.13 Occupational Health and Safety Act (OHSA);
- 1.7.3.14 Ontario Building Code (OBC);
- 1.7.3.15 Ontario Electrical Safety Code (OESC);
- 1.7.3.16 Technical Standards and Safety Authority (TSSA);
- 1.7.3.17 Telecommunications Industry Association (TIA);
- 1.7.3.18 Underwriters' Laboratories of Canada (ULC);
- 1.7.3.19 Ministry of Health and Long-Term Care Regulations;
- 1.7.3.20 Material Safety Data Sheets by product manufacturers;
- 1.7.3.21 local utility inspection permits;
- 1.7.3.22 codes, standards, and regulations of local governing authorities having jurisdiction;
- 1.7.3.23 additional codes and standards listed in Trade Sections;
- 1.7.4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.

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- 1.7.5 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.
 - 1.7.6 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.
 - 1.7.7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
 - 1.7.8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review by Consultant at any time.
 - 1.7.9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
 - 1.7.10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
 - 1.7.11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
 - 1.8 Permits, Certificates, Approvals and Fees**
 - 1.8.1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities.
 - 1.8.2 Submit required applications, shop drawings, electrical distribution system protection device coordination studies, and short circuit calculations, and any other information requested by local authority.
 - 1.8.3 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.
 - 1.8.4 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.
 - 1.8.5 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.
 - 1.8.6 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.

1.9 REQUIREMENTS FOR TRADE CONTRACTOR RETAINED ENGINEERS

- 1.9.1 Professional engineers retained to perform consulting services with regard to Project work, i.e. structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- 1.9.2 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.
- 1.9.3 Liability insurance requirements are as follows:
- 1.9.3.1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - 1.9.3.2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - 1.9.3.3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - 1.9.3.4 Retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
 - 1.9.3.5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.
- 1.10 Workplace Safety**
- 1.10.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- 1.10.2 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.
- 1.11 Planning and Layout of Work**
- 1.11.1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- 1.11.2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:

- 1.11.2.1 piping requiring uniform pitch;
- 1.11.2.2 piping 100 mm (4") dia. and larger;
- 1.11.2.3 large ducts (main runs);
- 1.11.2.4 cable tray and bus duct;
- 1.11.2.5 conduit 100 mm (4") dia. and larger;
- 1.11.2.6 piping less than 100 mm (4") dia.;
- 1.11.2.7 smaller branch ductwork;
- 1.11.2.8 conduit less than 100 mm (4") dia..
- 1.11.3 As confirmed with Consultant, Mechanical Contractor is to determine final locations of major work within ceiling spaces.
- 1.11.4 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.
- 1.11.5 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.
- 1.11.6 Prepare plan and interference drawings (at a minimum drawing scale of $\frac{1}{4}"=1' 0"$) of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- 1.11.7 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.

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- 1.11.8 Control products, products requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- 1.11.9 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.
- 1.11.10 Where drawings indicate that acoustic tile ceiling is being suspended below plaster 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.
- 1.12 Coordination of Work**
- 1.12.1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include, but not be limited to following:
- 1.12.1.1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - 1.12.1.2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - 1.12.1.3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - 1.12.1.4 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.
- 1.12.2 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.
- 1.12.3 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 and protected from elements.
- 1.12.4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- 1.12.5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.
- 1.13 COMPONENT FINAL LOCATIONS**
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- 1.13.1 Owner and Consultant reserve right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries at a later date, 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.

1.14 Systems Coordination

- 1.14.1 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:
- 1.14.1.1 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;
 - 1.14.1.2 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;
 - 1.14.1.3 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 for review by Consultant;
 - 1.14.1.4 review systems requirements for component back boxes and conduits; ensure that system of conduits and boxes meet respective system wiring bending radii requirements;
 - 1.14.1.5 review specifications of each trade/Division with each trade/Division (i.e. for BAS points, elevator requirements, electrical devices in millwork, outlet box and back box requirements), to ensure proper power supplies, interconnecting wiring requirements and back box/ outlet box requirements;
 - 1.14.1.6 review with manufacturers coordination and integration requirements of their systems;
 - 1.14.1.7 review each systems communication protocols to ensure they are compatible and can communicate with each other as required;
 - 1.14.1.8 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;
 - 1.14.1.9 be present at testing and commissioning functions of each system and provide technical assistance with regards to system operations;

- 1.14.1.10 be "on-site" coordinator of respective system trades with regards to respective system coordination of installation and testing;
- 1.14.1.11 coordinate with Consultant with regards to ensuring that systems coordinate and integrate properly to satisfaction of Owner;
- 1.14.1.12 document coordination and integration requirements and maintain records for submission as part of shop drawings;
- 1.14.1.13 respond to coordination and integration requirements and be responsible for such work;
- 1.14.1.14 where a system integrator has been included for, coordinate integration requirements with system integrator.

1.15 Products

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

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- 1.15.7 In addition to manufacturer's products specified 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. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of specified or acceptable product. Consultant has sole discretion in accepting any such proposed substitution of product. Do not order such products until they are accepted in writing by Consultant.
- 1.15.8 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of specified acceptable product, at least meets space, power, design, energy consumption, and other requirements of specified product and is equivalent or better than 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.
- 1.15.9 Whenever use of product other than specified acceptable 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 specified acceptable product to be supplied at Consultant's discretion.
- 1.15.10 Any proposed changes initiated by Contractor may be considered by Consultant at Consultant's discretion.
- 1.15.11 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 CONTINUITY OF SUPPLY FOR STANDARDIZATION**
- 1.16.1 Utilize materials of one manufacturer for aspects of work, where practical. Utilize one common manufacturer for wiring devices, such as switches and receptacles, whether installed loose or in a pre-manufactured component. Coordinate with each supplier and ensure conformance with this requirement. Identify deviations to Consultant and obtain approval of change prior to proceeding with work.
- 1.17 Shop Drawings**
- 1.17.1 At start-up meeting confirm with Consultant, products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- 1.17.2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Confirm exact requirements with Consultant.
- 1.17.3 Submit for review, drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Include minimally for preparation and submission of following, as applicable:
- 1.17.3.1 product literature cuts;
 - 1.17.3.2 equipment data sheets;
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- 1.17.3.3 equipment dimension drawings;
- 1.17.3.4 system block diagrams;
- 1.17.3.5 sequence of operation;
- 1.17.3.6 connection wiring schematic diagrams;
- 1.17.3.7 functionality with integrated systems.
- 1.17.4 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.
- 1.17.5 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.
- 1.17.6 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.
- 1.17.7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - 1.17.7.1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - 1.17.7.2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- 1.17.8 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."
- 1.17.9 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.

- 1.17.10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- 1.17.11 Do not order product until respective shop drawing review process has been properly completed by Consultant.
- 1.17.12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- 1.17.13 Refer to specific requirements in other Sections.

1.18 Equipment Loads

- 1.18.1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
- 1.18.2 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.
- 1.18.3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with Consultant prior to construction.

1.19 Openings

- 1.19.1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- 1.19.2 No openings are permitted through completed structure without written approval of Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- 1.19.3 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 directed by Owner and coordinated with Consultant, do not leave any openings unprotected and unfinished overnight.

1.20 Scaffolding, Hoisting, and Rigging,

- 1.20.1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval of Consultant.
- 1.20.2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- 1.20.3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Consultant.

1.21 Notice for Required Field Reviews

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- 1.21.1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- 1.21.2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- 1.21.3 Do not conceal work until Consultant advises that it may be concealed.
- 1.21.4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.
- 1.22 Preliminary Testing**
- 1.22.1 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.
- 1.22.2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- 1.22.3 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.
- 1.22.4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.
- 1.23 Provisions for Systems/Equipment Used During Construction**
- 1.23.1 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.
- 1.23.2 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.
- 1.23.3 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, genset "serviced", paint finishes "touched-up", filters cleaned or replaced, etc.
- 1.24 Temporary Services**
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- 1.24.1 Coordinate with General Contractor, requirements for temporary services including but not limited to temporary electrical power, lighting and exit pathways. Locations of exit pathways to be as decided at discretion of General Contractor, and to be illuminated complete with emergency lighting, and provided with exit signage and fire alarm devices in accordance with requirements of local governing building code and local governing inspection authorities.
- 1.25 Cleaning**
- 1.25.1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of 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.
- 1.25.2 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.
- 1.25.3 Clean switches, receptacles, communications outlets, coverplates, and exposed surfaces.
- 1.25.4 Clean other electrical equipment and devices installed as part of this project.
- 1.25.5 For work performed in electrical equipment rooms, electrical closets and communication closets, perform following:
- 1.25.5.1 HEPA vacuum and clean interiors and buswork of switchboards, panels, cabinets and other electrical equipment of construction debris and dust prior to energization;
 - 1.25.5.2 HEPA vacuum top of switchboards, panels, cabinets, bus ducts, cable trays and conduits in room, followed by a thorough HEPA vacuuming of floors;
 - 1.25.5.3 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.
- 1.26 Record As-Built Drawings**
- 1.26.1 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:
- 1.26.1.1 dimensioned location of inaccessible concealed work;
 - 1.26.1.2 locations of control devices with identification for each;
 - 1.26.1.3 location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors;

- 1.26.1.4 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;
- 1.26.1.5 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- 1.26.1.6 location of fire alarm devices and include addresses of devices; identify fire alarm zones;
- 1.26.1.7 identify routing and location of concealed conduits/ducts of diameter 50 mm (2") and greater;
- 1.26.2 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.
- 1.26.3 Use final reviewed "as-built" drawing set to provide Revit models 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.
- 1.26.4 Submitted drawings are to be of same quality as original Contract Drawings. Revit models are to be compatible with Revit software release version confirmed with Consultant.
- 1.26.5 Prepare and submit for review with record drawings, a neat, clear, properly identified, "as-built" electrical distribution riser diagram record drawing (in same format and release version as the design document - confirmed with Consultant) of entire electrical distribution system up to and including line side connections to panelboards. Building and room outlines are to reflect "as-built" outlines. Include in diagrams for feeder types and sizes, conduit sizes, breaker, switchboard and distribution panel sizes, etc. Submit sample version to Consultant for review and comments prior to final manufacturer. Size diagrams same size as issued full Size Drawings. Mount riser diagrams on 10 mm (3/8") thick foam core complete with mylar finish cover, and hardware suitable for wall mounting in main electrical room.
- 1.26.6 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 confirm exact requirements with Consultant prior to commencing work.
- 1.27 Operating and Maintenance Manuals**
 - 1.27.1 Submit draft copy to Consultant for review. Incorporate any Consultant's comments in preparation final manuals.

- 1.27.2 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. Confirm exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - 1.27.2.1 front cover: project name label; wording – "Electrical Systems Operating and Maintenance Manual"; and date;
 - 1.27.2.2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - 1.27.2.3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - 1.27.2.4 Table of Contents sheet, and corresponding index tab sheets;
 - 1.27.2.5 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;
 - 1.27.2.6 Maintenance data is to include:
 - 1.27.2.6.1 operation and trouble-shooting instructions for each item of equipment and each system;
 - 1.27.2.6.2 schedules of tasks, frequency, tools required, and estimated task time;
 - 1.27.2.6.3 recommended maintenance practices and precautions;
 - 1.27.2.6.4 complete parts lists with numbers.
 - 1.27.2.7 Performance data is to include:
 - 1.27.2.7.1 equipment and system start-up data sheets;
 - 1.27.2.7.2 equipment test reports;
 - 1.27.2.7.3 final verification and commissioning reports.
 - 1.27.2.8 explanation of operating principles and sequences;
 - 1.27.2.9 inspection certificates issued by regulatory authorities;
 - 1.27.2.10 wiring and connection diagrams;
 - 1.27.2.11 copies of additional and revised panelboard directories;

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- 1.27.2.12 warranties;
 - 1.27.2.13 items requested specifically in Section Articles.
 - 1.27.3 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
 - 1.27.4 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.
 - 1.27.5 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.
 - 1.27.6 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 confirmed with Consultant and enhanced with bookmarks and internal document links.
 - 1.28** Project Close Out Submittals
 - 1.28.1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - 1.28.1.1 Operating and Maintenance Manuals;
 - 1.28.1.2 as-built record drawings and associated data;
 - 1.28.1.3 extended warranties for equipment as specified;
 - 1.28.1.4 operating test certificates;
 - 1.28.1.5 final commissioning report;
 - 1.28.1.6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - 1.28.1.7 other data or products specified.
 - 1.29** Instructions to Owner
 - 1.29.1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
 - 1.29.2 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.
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- 1.29.3 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:
- 1.29.3.1 Operational Requirements and Criteria: equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - 1.29.3.2 Troubleshooting: diagnostic instructions, test and inspection procedures;
 - 1.29.3.3 Documentation: equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - 1.29.3.4 Maintenance: inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
 - 1.29.3.5 Repairs: diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- 1.29.4 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.
- 1.29.5 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:
- 1.29.5.1 date instructions were given to Owner's staff;
 - 1.29.5.2 duration of instruction;
 - 1.29.5.3 names of persons instructed;
 - 1.29.5.4 other parties present (manufacturer's representative, consultants, etc.).
- 1.29.6 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.
- 1.29.7 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.
- 1.29.8 Provide USB recording of operating and instructions training for following systems:
- 1.29.8.1 emergency power gensets and control system;
 - 1.29.8.2 fire alarm system;
 - 1.29.8.3 security systems;
 - 1.29.8.4 resident-staff communication response system;
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1.29.8.5 dimming system;

1.29.8.6 BAS.

1.29.9 Provide custom video in USB format that details on site systems and equipment operations and includes following:

1.29.9.1 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;

1.29.9.2 USB to include custom site specific system/equipment screens that outline key information about system/equipment and devices used on site only;

1.29.9.3 USB to also include custom site specific video that details programming procedures in conjunction with a voiceover from on-site technician;

1.29.9.4 USB created with a main menu screen and authored with chapters to allow operator to access specific areas of training instantly.

1.29.10 Supply minimum quantity of 3 copies of DVDs for each system/equipment. Owner to have option of such information loaded and submitted on USB flash drives.

1.30 Final Inspection

1.30.1 Submit to Consultant, written request for final inspection of systems. Include written certification that:

1.30.1.1 deficiencies noted during job inspections have been completed;

1.30.1.2 field quality control procedures have been completed;

1.30.1.3 maintenance and operating data have been completed and submitted to, reviewed and accepted by Consultant;

1.30.1.4 tags and nameplates are in place and equipment identifications have been completed;

1.30.1.5 clean-up is complete;

1.30.1.6 spare parts and replacement parts specified have been provided and acknowledged by Consultant;

1.30.1.7 as-built and record drawings have been completed and submitted to, reviewed and accepted by Consultant;

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

1.30.1.9 commissioning procedures have been completed.

PART 2 - Products

2.1 Conduits

- 2.1.1 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.
- 2.1.2 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.
- 2.1.3 Galvanized steel flexible liquid tight metallic conduit to CSA C22.2 No. 56, complete with liquid-tight flexible conduit connectors at terminations.
- 2.1.4 Galvanized steel flexible metallic conduit to CSA C22.2 No. 56, complete with proper and suitable squeeze type connectors at terminations.
- 2.1.5 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.
- 2.1.6 Medium density CSA certified polyethylene flexible plastic conduit in a continuous coil of proper length.
- 2.1.7 Factory threaded rigid bronze conduit with water-tight screwed joints, fittings, and connectors.

2.2 Outlet Boxes

- 2.2.1 CSA approved stamped galvanized steel outlet boxes.
- 2.2.2 CSA certified, cast Feraloy and aluminium outlet boxes.
- 2.2.3 CSA certified rigid plastic (PVC) outlet boxes.
- 2.2.4 Standard general purpose service floor boxes: CSA approved, UL scrub water compliant, fully adjustable angular and vertically, formed steel/cast iron, round single gang / rectangular or square multi-gang as required, flush in concrete floor installation, boxes complete with conduit knockout openings, adjustable collars, hinged flip open brass covers with provisions for mounting of duplex power receptacles, telephone jacks and data jacks. Provide barriered boxes when boxes contain both power and communication outlets and different voltage levels. Size boxes to suit thickness of floor slab as confirmed with Consultant and also to suit required bending radii of conductors. Refer to drawings for number of gang requirements. Acceptable manufacturers are Hubbell, Legrand and Thomas & Betts, or approved equivalent. Special floor boxes are specified elsewhere in another Section.
- 2.2.5 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.

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- 2.2.6 Electrical boxes exposed exterior of building or in non-climate controlled locations to be weatherproof boxes complete with gasketted covers/faceplates.
- 2.3 Pullboxes and Junction Boxes**
- 2.3.1 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.
- 2.3.2 CSA certified, threaded cast Feraloy outlet boxes of an exact type to suit application, each complete with screw-on gasketted cover.
- 2.3.3 Rigid plastic (PVC), CSA certified, junction boxes and access fittings with solvent weld type joints and screw-on PVC covers.
- 2.3.4 Physical size of pullboxes to be as required by local governing electrical code to suit number and size of conduits and conductors.
- 2.3.5 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.
- 2.3.6 Boxes exposed exterior of building or in non-climate controlled locations to be weatherproof boxes complete with gasketted covers.
- 2.4 Sleeves**
- 2.4.1 Galvanized steel sleeves as follows:
- 2.4.1.1 No. 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction;
- 2.4.1.2 Schedule 40 pipe;
- 2.4.2 Schedule 40 PVC sleeves.
- 2.5 Switches**
- 2.5.1 Switches to be CSA approved, ULC listed and labelled devices.
- 2.5.2 CSA approved, heavy duty, back, and side wired, AC quiet action toggle type, 20 ampere, 120-277 V switches. Provide single way, 2-way, 3-way, and key type to suit specific application requirements.
- 2.5.3 CSA approved, heavy duty, back and side wired, AC quiet action toggle type, 20 ampere, 347 V switches.
- 2.5.4 CSA approved, heavy duty, AC quiet action, illuminated polycarbonate handle toggle type, 20 ampere, 120-277 V switches.
- 2.5.5 Pressure sensitive door switches complete with metal box, plates, and wire leads, and suitable for flush installation. Light is "ON" when door is open.
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- 2.5.6 Special switches not specified above are to be specified on drawings. Low voltage lighting controls are specified in Section entitled Lighting Control.
- 2.5.7 Acceptable manufacturers are:
- 2.5.7.1 Hubbell Canada Inc.;
 - 2.5.7.2 Legrand - Pass & Seymour;
 - 2.5.7.3 Leviton;
 - 2.5.7.4 Or approved equivalent.
- 2.6 Receptacles**
- 2.6.1 Receptacles to be CSA approved, ULC listed, certified and labelled devices.
- 2.6.2 Back and side wired, specification grade, flush, nylon face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles.
- 2.6.3 Back and side wired, specification grade, flush, nylon face, single, 20 ampere, 125 V, 3-wire grounding receptacles.
- 2.6.4 Back and side wired, specification grade, flush, nylon face, single, 20 ampere, 250 V, 2-pole 3-wire grounding receptacle.
- 2.6.5 Back and side wired, specification grade, 15 ampere, 125 V, 2-pole, 3-wire grounding, tamper-resistant (safety shutter) duplex receptacles.
- 2.6.6 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with red ground fault LED and 10ka short circuit current rating.
- 2.6.7 Tamper resistant, back and side wired, 15 ampere, 125 V complete with dual USB charging outlets (USB-A and USB-C or to the latest USB charging receptacle standard).
- 2.6.8 EEMAC type 14-30R, 30 ampere, 125/250 V, 3-pole, 4-wire single electric clothes dryer receptacles with steel faceplates.
- 2.6.9 EEMAC type 14-50R, 50 ampere, 125/250 V, 3-pole, 4-wire single electric range receptacles with steel faceplates.
- 2.6.10 Specification grade, 15 ampere, 125 V, 2-pole, 3-wire, tamper resistant, safety shutter receptacles.
- 2.6.11 Specification grade, 15 ampere, 125 V, single, 2-pole, 3-wire grounding twist lock receptacle.

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- 2.6.12 Extra heavy duty hospital grade with green dot symbol, back and side wired, flush, thermoplastic polyester face/body construction, duplex U-ground, 15 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.
- 2.6.13 Where noted that 20 A receptacles are required, include for "T" slot type of respective series of receptacles.
- 2.6.14 Colour of special switches and receptacles (unless specified above), to be as specified in PART 3 of this Section of Specification.
- 2.6.15 Special receptacles not specified above are to be specified on drawings. Low voltage lighting controls are specified in Section entitled Lighting Control.
- 2.6.16 Acceptable manufacturers are:
- 2.6.16.1 Hubbell Canada Inc.;
 - 2.6.16.2 Legrand - Pass & Seymour;
 - 2.6.16.3 Leviton;
 - 2.6.16.4 Or approved equivalent.
- 2.7 Faceplates**
- 2.7.1 Phenolic (urea thermosetting plastic) faceplates, ~~brown or~~ ivory, complete with matching screws.
- 2.7.2 Stainless steel wallplates.
- 2.7.3 NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketed, cast aluminium faceplates for standard duplex receptacles in wet locations.
- 2.7.4 NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketed, cast aluminium faceplates for GFI receptacles in wet locations.
- 2.7.5 ULC listed and labelled, single gang, vertical mounting, weather proof in-use, gasketed, clear bubble plate, silicone rubber faceplates for standard AC toggle switches in wet locations.
- 2.7.6 Galvanized steel stamped faceplates.
- 2.7.7 Colours and finishes of faceplates are specified in Part 3 of this Section.
- 2.7.8 Acceptable manufacturers are as per switches and receptacles.
- 2.8 Basket Cable Tray**
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- 2.8.1 CSA approved and labelled, 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:
- 2.8.1.1 minimum 300 mm x 100 mm (12" x 4") unless otherwise noted on drawings;
 - 2.8.1.2 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;
 - 2.8.1.3 continuous, rigid, welded steel wire mesh cable tray system;
 - 2.8.1.4 top wire safety edge;
 - 2.8.1.5 wire mesh welded at intersections;
 - 2.8.1.6 mesh sections having minimum one (1) bottom longitudinal wire along entire length;
 - 2.8.1.7 warning signs;
 - 2.8.1.8 accessories included as required.
- 2.8.2 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.
- 2.8.3 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.
- 2.8.4 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.
- 2.8.5 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).
- 2.8.6 Provide support of a center hanging configuration containing horizontal hanger brackets and vertical threaded PVC insulated rods in middle. 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).
- 2.8.7 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.

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- 2.8.8 Provide tray complete with grounding/bonding provisions, fittings, tee sections, elbows, universal dropouts, expansion fittings, etc., and required supporting and installation accessories. Provide dividers to separate various system cabling to a degree confirmed by Consultant, but typically two (2) dividers in a 300 mm (12") wide tray. 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. System accessories to be supplied by system manufacturer and be as recommended by system manufacturer for specific applications.
- 2.8.9 Acceptable manufacturers are:
- 2.8.9.1 Legrand-Cablofil;
 - 2.8.9.2 Leviton;
 - 2.8.9.3 Canadian Electrical Raceways;
 - 2.8.9.4 Hubbell;
 - 2.8.9.5 Or approved equivalent.
- 2.9 Cable Duct**
- 2.9.1 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.
- 2.9.2 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.
- 2.9.3 Lengths of ducts, number of barriers and cover types may vary depending on site installation requirements. For flush or surface mounted applications, provide removable screw-on or 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.
- 2.9.4 For surface wall mounting applications, cable duct to be complete with drilled holes for mounting and wall brackets.
- 2.9.5 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.
- 2.9.6 Entire duct system to be provided with powder coat finish of colour confirmed with Consultant.
- 2.9.7 Submit with shop drawings, copy of CSA certificate of approval for specified ducts.
- 2.9.8 Acceptable manufacturers are:
- 2.9.8.1 Legrand -Wiremold;
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- 2.9.8.2 Thomas & Betts;
- 2.9.8.3 Canadian Electrical Raceways;
- 2.9.8.4 Or approved equivalent.

2.10 Surface Service Raceways

- 2.10.1 CSA certified, ULC listed and labelled, multi-outlet, multi-channel painted steel finished service raceways to be provided for specific applications where power and communication systems are required to be distributed in surface mounted channels. Include for:
 - 2.10.1.1 duplex grounding receptacles and mounting knockout plates;
 - 2.10.1.2 data outlet mounting bracket;
 - 2.10.1.3 telephone outlet mounting bracket;
 - 2.10.1.4 dual covers (one for power and one for communications);
 - 2.10.1.5 clips, couplings, brackets, fittings, elbows, boxes, tees mounting hardware, etc., for a complete raceway system;
 - 2.10.1.6 wiring for power.
- 2.10.2 Generally, type of raceways is noted on drawings, but in absence of direction, in areas where multiple services are required, provide multi-compartment raceways to suit application. Where only single service is required, provide single type raceways.
- 2.10.3 Coordinate and measure exact dimensions for lengths, to meet site installation. Where horizontal sections meet vertical sections, provide manufacturer's proper connecting fitting such that there are no openings or exposed conductors. Ensure that bending radii requirements of various cabling standards are met.
- 2.10.4 Coordinate requirements for data/voice jacks and wiring with telecommunications network cabling specialist trade. Size raceways for computer network structured cabling in compliance with EIA/TIA Standards for required Category of cabling as per section entitled Structured Cabling System. Increase raceway sizing to suit.
- 2.10.5 Acceptable manufacturers are:
 - 2.10.5.1 Legrand-Wiremold;
 - 2.10.5.2 Thomas & Betts;
 - 2.10.5.3 Panduit;
 - 2.10.5.4 Or approved equivalent.

2.11 Service Poles

- 2.11.1 CSA approved, ULC listed and labelled, service poles for provision of power, telephone and data communications to open floor office spaces and similar locations.
- 2.11.2 Service poles consist of following features:
 - 2.11.2.1 2-compartment, (power and communications), extruded aluminum column, barriered internally to separate power wiring from communications wiring;
 - 2.11.2.2 15A-125 volt, duplex receptacles, hard wired back to panel circuit;
 - 2.11.2.3 provision of openings and mounting brackets for telephone jacks;
 - 2.11.2.4 provision of openings and mounting brackets for data communication jacks;
 - 2.11.2.5 snap open cover on communication side of pole;
 - 2.11.2.6 base plate for securing pole assembly to floor and provisions at top for clamping to T-bar ceiling system and trim plate to cover ceiling opening;
 - 2.11.2.7 a painted or anodised aluminum finish.
- 2.11.3 Generally, configuration of poles and device requirements are noted on drawings, but in absence of direction, in areas where multiple services are required, provide multi-compartment raceway poles to suit application. Where only single service is required, provide single type raceway poles.
- 2.11.4 Coordinate and measure exact dimensions to meet site installation.
- 2.11.5 Coordinate requirements for data/voice jacks and wiring with telecommunications network cabling specialist trade. Size pole raceways for computer network cabling in compliance with EIA/TIA Standards for required Category of cabling as per Section entitled Structured Cabling System. Increase raceway sizing to suit.
- 2.11.6 Acceptable manufacturers are:
 - 2.11.6.1 Legrand-Wiremold;
 - 2.11.6.2 Thomas & Betts;
 - 2.11.6.3 Wellmark;
 - 2.11.6.4 Or approved equivalent.

2.12 Firestopping and Smoke Seal Materials

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- 2.12.1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN 4-S115-M85, and CAN/ULC-S101-M 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.
- 2.12.2 Fire stopping 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 number for each specific installation. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- 2.12.3 Systems to consist of both elastomeric and intumescent materials that are compatible with abutting dissimilar materials and finishes. Coordinate material requirements with trades supplying abutting areas of materials.
- 2.12.4 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- 2.12.5 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- 2.12.6 Supply products of a single manufacturer for use on work of this Division.
- 2.12.7 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- 2.12.8 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.
- 2.12.9 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".
- 2.12.10 Acceptable manufacturers are:
- 2.12.10.1 3M Canada Inc.;
 - 2.12.10.2 Nelson;
 - 2.12.10.3 Hilti Canada;
 - 2.12.10.4 Or approved equivalent.
- 2.13 Fastening and Securing Hardware**
- 2.13.1 Concrete inserts - for concrete work for single or double conduit, cable tray, runs of three (3) or more conduits etc., and equipment, or where a grid support system is required.
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- 2.13.2 Concrete fasteners – anchors, lead cinch anchors and/or self-drilling anchors.
 - 2.13.3 Masonry inserts – expansion shields and machine bolts or, for light loads, fibre or lead plugs and screws.
 - 2.13.4 Drywall or plaster wall and/or ceiling fasteners – 2-wing spring toggles.
 - 2.13.5 Structural steel - beam clamps.
 - 2.13.6 Metal framing channels – 40 mm (1-5/8") width, galvanized steel channels complete with required fittings and ancillary hardware; acceptable manufacturers are:
 - 2.13.6.1 Unistrut;
 - 2.13.6.2 Thomas & Betts;
 - 2.13.6.3 Eaton B-Line.
 - 2.13.7 Metal "J" hooks or cable support systems for communications system cabling in accessible ceiling spaces where conduit or cable tray is not being provided. Obtain written approval of Consultant for use of J-hooks.
 - 2.13.8 Tie wraps for bundling and securing cables.
 - 2.14 Access Doors**
 - 2.14.1 Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.
 - 2.14.2 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.
 - 2.14.3 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.
 - 2.14.4 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.
 - 2.14.5 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.
 - 2.14.6 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.
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- 2.14.7 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.
- 2.14.8 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.
- 2.14.9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor, or approved equivalent.

2.15 Identification Nameplates

- 2.15.1 Laminated plastic 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. Confirm nomenclature with Consultant. Various colour configurations to be used to differentiate systems. Confirm exact colour scheme with Consultant.
- 2.15.2 Portable electronic labelling system complete with self-adhesive, permanent printed labels with required nomenclature.

2.16 Warning Signs

- 2.16.1 Semi-rigid vinyl panels with drilled holes in each corner, stainless steel screws, pressure sensitive mounting pads on back, and required printed wording. Generally, wording to be red on a white background with black trim confirmed with Consultant.

2.17 System Backboards

- 2.17.1 Construction grade fir plywood, containing no added urea formaldehyde, flame retardant prime coat painted on exposed surfaces, minimum 20 mm (3/4") thick, as sized on drawings and with flame spread rating in accordance with local governing building code requirements.

2.18 Sprinkler Protection

- 2.18.1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - 2.18.1.1 factory constructed by respective equipment manufacturers;
 - 2.18.1.2 constructed from non-combustible materials (sheet steel);
 - 2.18.1.3 enamel painted to match equipment;
 - 2.18.1.4 surfaces and edges filled/sanded smooth prior to painting;
 - 2.18.1.5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
 - 2.18.1.6 structural support finish painted to match shield.
- 2.18.2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.

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- 2.18.3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
 - 2.18.4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
 - 2.18.5 Above requirements are additional minimum "sprinkler protection" standards for equipment specified as EEMAC/NEMA 1, 2 or 12.
 - 2.18.6 Obtain CSA approval where required by local governing authorities.
 - 2.19 Rooftop Conduit Support System**
 - 2.19.1 Rooftop support systems with features as follows:
 - 2.19.1.1 CSA approved and/or ULC listed and labelled;
 - 2.19.1.2 non-penetrating of roof;
 - 2.19.1.3 vibration dampening;
 - 2.19.1.4 does not float;
 - 2.19.1.5 suitable for outdoor wet and freezing environments without damage caused by weather or freeze and thawing when exposed to de-icing chemicals;
 - 2.19.1.6 environmental friendly;
 - 2.19.1.7 constructed of recycled rubber.
 - 2.19.2 Materials:
 - 2.19.2.1 Base made of 100% recycled rubber and polyurethane pre-polymer with a uniform load capacity to suit specific load application of support (minimum 744 kg/m [500 pounds/linear foot]); each base to have a reflective red stripe.
 - 2.19.2.2 Base dimensions: 150 mm (6") wide by 125 mm (5") tall by required overall length (minimum 225 mm [9"]); this is to be minimum dimensions, but base requirements must be increased to suit specific applications as recommended by system manufacturer; includes low base steel frame C channel 1.9 mm (14 gauge) – 25 mm (1") high strut galvanized per ASTM A653; and pipe roller assembly.
 - 2.19.2.3 Base with two 13 mm (1/2") dia electro zinc all threaded rod risers and 14 ga. 25 mm (1") high galvanized steel slotted channel; adjustable height up to 400 mm (16"); refer to drawings or confirm with Consultant for exact height requirements.
 - 2.19.2.4 Attaching hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.
 - 2.19.2.5 Conduit clamps: single pipe supports constructed of galvanized steel and sized to accommodate sizing of installed conduits.
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2.19.3 Confirm with system manufacturer that selected products provide proper support for application.

2.19.4 Acceptable manufacturers are as follows:

2.19.4.1 Cooper B-Line;

2.19.4.2 Clearline Technologies (C-Port);

2.19.4.3 Erico (Caddy Pyramid);

2.19.4.4 Or approved equivalent.

PART 3 - Execution

3.1 General Conduit Installation Requirements

3.1.1 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.

3.1.2 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.

3.1.3 So as not to impair required strength of structure, following criteria to be generally followed but which is to be reviewed and coordinated with with Consultant prior to start of Work:

3.1.3.1 where conduits pass by a column, stay at least two times thickness of slab and drop away from column;

3.1.3.2 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;

3.1.3.3 maximum size of conduit in structural slabs is 1/5 of solid portion of slab thickness;

3.1.3.4 where more than two conduits are adjacent to each other, they are to be spaced greater of 3 diameters or 100 mm (4") apart;

3.1.3.5 total of depth of conduits crossing over each other is to be less than one-third thickness of slab;

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- 3.1.3.6 place conduit in middle third of thickness of slab; do not lay conduit directly on reinforcing steel;
 - 3.1.3.7 do not run conduit adjacent to parallel reinforcing bars;
 - 3.1.3.8 do not run conduit longitudinally in beam without review with Consultant; pass through beams at right angles to span of beam;
 - 3.1.3.9 where conduits pass through beams, maintain at least twice depth of beam separation away from supports;
 - 3.1.3.10 do not run conduits in slab beside a drop or beam within twice depth of slab from edge of drop or beam;
 - 3.1.3.11 do not run conduits through shear walls or columns without review with Consultant;
 - 3.1.3.12 do not place conduit in structural elements in parking garage structures, water retaining structures or structures subjected to de-icing chemicals, without review with Consultant.
 - 3.1.4 For proposed use of conduit runs underground below slab include following provisions:
 - 3.1.4.1 concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit;
 - 3.1.4.2 proper drain pit;
 - 3.1.4.3 system to be a pull-in system;
 - 3.1.4.4 20% spare conduits (with minimum of at least 1);
 - 3.1.4.5 system proposal to consider and address any effects of magnetic fields.
 - 3.1.5 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 reviewed with Consultant.
 - 3.2 Installation of Conduit**
 - 3.2.1 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
 - 3.2.2 Provide conduit as follows:
 - 3.2.2.1 for interior building surface mounted services greater than 600 V – rigid galvanized steel;
 - 3.2.2.2 for feeders exceeding 600 V for main distribution wiring in Electrical rooms, and for concealed conduit in exterior walls - rigid galvanized steel;

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- 3.2.2.3 for exposed conduit outside building, for semi-exterior areas such as loading areas, backyards, and within parking garage floor areas – rigid galvanized steel (rigid PVC where permitted by local codes and reviewed with Consultant);
 - 3.2.2.4 for exposed conduit in non-climate controlled areas, in areas of corrosive elements – epoxy coated ridged galvanized steel;
 - 3.2.2.5 for branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material-rigid PVC;
 - 3.2.2.6 for branch circuit conductors underground outside building clear of concrete, asphalt and similar paving material-flexible polyethylene plastic conduit;
 - 3.2.2.7 for conductors in surface mounted conduit of parking garage – rigid galvanized steel; conduit not to be embedded in concrete within parking garage areas, unless approved in writing by Consultant; if approval obtained from Consultant, rigid PVC may be used embedded in concrete slabs;
 - 3.2.2.8 for conductors associated with pool area outlets and equipment – surface mounted epoxy coated rigid galvanized steel or rigid PVC in concrete slab;
 - 3.2.2.9 for exposed conduit mounted at a height of less than 1200 mm (4') in electrical, mechanical or other service areas – rigid galvanized steel;
 - 3.2.2.10 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;
 - 3.2.2.11 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;
 - 3.2.2.12 at points, where conductors cross building expansion joints – galvanized steel flexible conduit with no less than 600 mm (24") of extra curve;
 - 3.2.2.13 for branch circuit conductors in poured concrete slab – rigid PVC;
 - 3.2.2.14 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;
 - 3.2.2.15 for corrosive environments – epoxy coated rigid steel;
 - 3.2.2.16 for conductors except as noted above or elsewhere in this Specification – EMT.
 - 3.2.3 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
 - 3.2.4 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.
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- 3.2.5 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.
 - 3.2.6 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.
 - 3.2.7 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.
 - 3.2.8 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
 - 3.2.9 Provide a separate ground conductor in plastic conduits.
 - 3.2.10 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.
 - 3.2.11 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.
 - 3.2.12 Unless otherwise noted, provide conduit fittings constructed of same materials as conduit and which are suitable in respects for application.
 - 3.2.13 Provide proper adaptors for joining conduits of different materials.
 - 3.2.14 Cut square and properly ream site cut conduit ends.
 - 3.2.15 Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with latest edition of 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.
 - 3.2.16 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.
 - 3.2.17 Plug ends of roughed-in conduits which are exposed during construction with approved plugs.
 - 3.2.18 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.

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- 3.2.19 Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling. Refer to drawing detail.
- 3.3** Expansion Facilities for Conduit Crossing Building Expansion Joints
- 3.3.1 Wherever concealed or surface mounted conduits cross building expansion joints, provide expansion facilities to permit free movement without imposing additional stress or loading upon support system, and to prevent excessive movement at joints and connections, in accordance with drawing details.
- 3.4** Installation of Outlet Boxes And Back Boxes
- 3.4.1 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.
- 3.4.2 Size boxes to accommodate exact supplied components and for bending radii of installed cables. Confirm requirements with respective system vendors.
- 3.4.3 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.
- 3.4.4 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where connecting conduit is rigid and boxes in perimeter wall where insulation and vapour barrier is present, and boxes in non-climate controlled areas to be "FS" or "FD" Series cast boxes unless otherwise noted.
- 3.4.5 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.
- 3.4.6 Outlet boxes in underground plastic conduit systems to be rigid PVC plastic outlet boxes, unless otherwise noted.
- 3.4.7 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. For flush floor boxes in modular constructed area shall comply with the modular construction requirements.
- 3.4.8 Provide a barriered outlet box for switches connected to normal and emergency power and share a common faceplate.
- 3.4.9 Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections and/or on drawings.
- 3.4.10 Size and arrangement of outlet boxes to suit device which they serve.
- 3.4.11 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.
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3.4.12 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.

3.4.13 Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use, to consultant's approval and reviewed with Consultant. Generally, provide stainless steel type blank coverplates.

3.5 Installation of Pullboxes and Junction Boxes

3.5.1 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.

3.5.2 Size boxes to accommodate exact supplied system and for bending radii of installed cables. Confirm requirements with respective system vendors.

3.5.3 Provide junction boxes wherever required and/or indicated on drawings and as required by local governing electrical code.

3.5.4 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.

3.5.5 Boxes in rigid conduit and EMT inside building to be stamped galvanized or prime coated steel.

3.5.6 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.

3.5.7 Boxes in plastic conduit to be rigid PVC plastic boxes complete with required couplings.

3.5.8 Pullboxes and junction boxes to be accessible after work is completed.

3.5.9 Accurately locate and identify concealed pullboxes and junction boxes on "As-built" record drawings.

3.5.10 Clearly identify main pull or junction boxes in publicly accessible areas (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless reviewed with Consultant. Paint colours to be in accordance with following schedule:

3.5.10.1 lighting-yellow;

3.5.10.2 normal power-blue;

3.5.10.3 essential power-orange;

3.5.10.4 fire alarm-red;

3.5.10.5 telephone-green;

3.5.10.6 miscellaneous signals-brown.

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- 3.5.11 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.
- 3.5.12 Cover boxes in fire walls with aluminium tape and seal with caulking.
- 3.6 Installation of Sleeves**
- 3.6.1 Where conduits, round ducts and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
- 3.6.2 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.
- 3.6.3 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.
- 3.6.4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
- 3.6.5 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. Ensure that sleeves set in exterior walls are packed and sealed with governing authority approved materials suitable for application and that both ends of sleeves are packed watertight with approved permanently flexible and water tight materials. Exact responsibility of work to be coordinated with General Trades Contractor.
- 3.6.6 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.
- 3.6.7 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
- 3.6.7.1 in Mechanical and Fan Room floor slabs, except where on grade;
- 3.6.7.2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;
- 3.6.7.3 in floors equipped with waterproof membranes.
- 3.6.8 "Gang" type sleeving to be permitted only with approval of consultant and reviewed with Consultant.
- 3.6.9 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.
- 3.7 Installation of Switches**
- 3.7.1 Provide switches 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.
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- 3.7.2 For pricing only, switches to be ivory for devices connected to normal power circuits, red for devices connected to emergency power circuits.
- 3.7.3 Every switch connected to emergency power circuits, to be illuminated toggle type.
- 3.7.4 Illuminated operation of lighted switches to suit specific applications as confirmed with Consultant.
- 3.7.5 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.
- 3.7.6 Coordinate installation of door switches with trades responsible for provision of doors and frames. Confirm exact locations of switches with Consultant to ensure optimum operation of switch to door position.
- 3.8 Installation of Receptacles**
- 3.8.1 Provide receptacles 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.
- 3.8.2 For pricing only, receptacles to be ivory for devices connected to normal power circuits, red for devices connected to emergency power circuits.
- 3.8.3 Safety shutter type receptacles to be located where shown and required by code.
- 3.8.4 Install USB charger receptacles in extra deep boxes in accordance with manufacturer's recommendations.
- 3.8.5 Install exterior receptacles located in landscaped grounds in accordance with drawing detail.
- 3.8.6 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.
- 3.9 Installation of Faceplates**
- 3.9.1 Provide each switch and receptacle 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.
- 3.9.2 Provide faceplates with suitable identification label. Colour finish to be red for devices on emergency power, but to be confirmed with Consultant.
- 3.9.3 Provide galvanized stamped steel faceplates in service areas and equipment rooms where devices are surface mounted.
- 3.9.4 Provide faceplates for housekeeping receptacles with label printed with "Housekeeping Only" lettering.

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- 3.9.5 Provide weatherproof insulated faceplates with hinged and gasketed receptacle access flaps for weatherproof receptacles denoted "WP" on drawings.
 - 3.9.6 Generally, oversized faceplates to be provided where engraved lettering is required.
 - 3.9.7 Faceplates for flush floor mounted receptacles to be forged brass rectangular faceplates.
 - 3.10 Installation of Cable Tray**
 - 3.10.1 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.
 - 3.10.2 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.
 - 3.10.3 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.
 - 3.10.4 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.
 - 3.10.5 Provide proper fittings in cable tray at points of conduit entry. Terminate conduits at or in tray with proper grommetted and bushed terminations.
 - 3.10.6 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.
 - 3.10.7 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.
 - 3.10.8 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.
 - 3.10.9 File smooth cuts to tray and re-touch with galvanizing compound.
 - 3.10.10 Install expansion connectors where cable tray crosses building expansion joints.
 - 3.10.11 After installation is complete, install warning signs on tray in visible locations.
 - 3.10.12 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.
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3.11 Installation of Cable Duct

- 3.11.1 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.
- 3.11.2 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.
- 3.11.3 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.
- 3.11.4 Provide cable duct with required covers. Provide required components and required mounting and connection accessories.
- 3.11.5 Secure surface wall mounted duct in place with mounting hardware recommended by duct manufacturer to suit specific installation.
- 3.11.6 Install and hang cable duct at maximum 1.5 m (5') centres and in accordance with manufacturer's published literature. 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.
- 3.11.7 Provide proper fittings in cable duct at point of conduit entry. Terminate conduits at or in duct with proper grommetted and bushed terminations.
- 3.11.8 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.
- 3.11.9 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.
- 3.11.10 Provide continuous paths along entire lengths of cable duct to maintain proper ground continuity. Utilize system manufacturer's proper grounding fittings and hardware.
- 3.11.11 Install expansion connectors where cable duct crosses building expansion joints.
- 3.11.12 After installation is complete, install warning signs on duct in visible locations.
- 3.11.13 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.

3.12 Installation of Surface Service Raceways

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- 3.12.1 Provide surface mounted, service raceway assemblies complete with specified and required accessories necessary for a complete electrical raceway system. Site measure for proper lengths. Provide required type and quantity of receptacles. Confirm exact types for each application with Consultant prior to ordering. Confirm finishes with Consultant prior to ordering.
 - 3.12.2 Obtain required training from manufacturer's representative on any special installation procedures. Install raceways in accordance with manufacturer's instructions to suit specific installation requirements. Use manufacturer's recommended tools for cutting and installing raceways.
 - 3.12.3 Assemble and secure raceways, boxes and other components to surfaces in accordance with manufacturer's instructions and requirements. Connect complete. Where possible butt raceway ends to adjacent walls, cabinets, counters, etc. Where raceway is to be attached to equipment or sections of millwork, install raceway for full length of equipment/millwork, unless otherwise noted. Mount-faceplates flush to raceway with no gaps. Keep number of elbows, offsets and connectors to a minimum.
 - 3.12.4 Do not exceed wire fill requirements given in manufacturer's instructions.
 - 3.12.5 Provide barriers for systems with different voltages in raceway.
 - 3.12.6 Test prewired raceways after installation work is complete.
 - 3.12.7 Provide wiring devices of types and standards as specified in wiring devices section.
 - 3.12.8 Coordinate requirements with structured cabling system vendor to ensure that raceways are suitable for and comply with standard for telecommunication jacks and cabling. Ensure that device mounting brackets are co-ordinated to suit final modular jack being installed.
 - 3.13 Installation of SERVICE POLES**
 - 3.13.1 Provide specified service poles complete with receptacles, communications facilities and required ancillary devices. Install in locations and connect complete. Site measure for proper lengths. Quantities and types of outlets required to be as shown on drawings. Confirm finishes with Consultant prior to roughing in.
 - 3.13.2 Obtain required training from manufacturer's representative on any special installation procedures. Install poles in accordance with manufacturer's instructions to suit specific installation requirements.
 - 3.13.3 Secure poles to floor and to T-bar ceiling grid system in accordance with manufacturer's instructions.
 - 3.13.4 Extend circuits from designated power panel to feed poles receptacles. Provide junction box in ceiling space. Co-ordinate installation of boxes to suit location of poles.
 - 3.13.5 Do not exceed wire fill requirements given in manufacturer's instructions.
 - 3.13.6 Provide barriers for systems with different voltages in raceway.
 - 3.13.7 Ground and bond devices as per local electrical code requirements.
 - 3.13.8 Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.

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- 3.13.9 Test prewired raceway poles after installation work is complete.
- 3.13.10 Provide wiring devices of types and standards as specified.
- 3.13.11 Coordinate requirements of modular telecommunication jacks with structured cabling system vendor to ensure that raceways are suitable for and comply with standard for telecom jacks and cabling. Ensure that device mounting brackets are co-ordinated to suit final modular jack being installed.
- 3.14 Installation of Firestopping and Smoke Seal Materials**
- 3.14.1 Where electrical 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. Submit to Consultant, copies of certificates of compliance from an independent testing agency, attesting that fire stopping and smoke seal materials meet ULC requirements. Openings not in immediate vicinity of working areas are to be firestopped and sealed same day as being opened.
- 3.14.2 Examine condition of voids to be filled to ensure suitability for systems. Verify installation of service penetrations and adjacent construction has been completed. Prepare substrates and surfaces to a clean, dry, frost-free condition, and primed to firestop system manufacturer's recommendations to receive firestopping system.
- 3.14.3 Install fire stopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and fire stopping materials.
- 3.14.4 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- 3.14.5 After installation work is complete, arrange for 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.
- 3.15 Supply of Access Doors**
- 3.15.1 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.
- 3.15.2 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.
- 3.15.3 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.
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- 3.15.4 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.
- 3.15.5 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.
- 3.16 Installation of Fastening and Securing Hardware**
- 3.16.1 Provide fasteners and similar hardware required for conduit, duct, raceway, conductors, etc. and for equipment hanger and/or support material unless otherwise noted.
- 3.16.2 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.
- 3.16.3 Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs, and screws.
- 3.16.4 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.
- 3.16.5 Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where reviewed with Consultant, weld hanging and support provisions to structural steel.
- 3.16.6 Explosive powder actuated fasteners are not permitted unless specific written approval for their use and type has been obtained from Consultant.
- 3.16.7 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.
- 3.16.8 Provide "J" hooks in accessible ceiling spaces where conduit is not provided for structured cabling runs or other telecommunication cabling, as approved by Consultant.
- 3.16.9 Comply with J-hook manufacturer's loading limitations and spacing criteria. 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.
- 3.16.10 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.
- 3.16.11 Comply with Structural Engineer's limitations for maximum penetrations of securing hardware into concrete slabs.
- 3.17 Installation of Identification Nameplates**
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- 3.17.1 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 "EMERGENCY POWER SYSTEM".
- 3.17.2 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.
- 3.17.3 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.
- 3.17.4 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.
- 3.17.5 Nameplates to be mechanically secured lamacoid and be colour coded as follows:
- 3.17.5.1 Normal Power Black with white letters;
 - 3.17.5.2 Emergency Power Red with white letters;
- 3.17.6 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:
- 3.17.6.1 Phase A – red;
 - 3.17.6.2 Phase B – black;
 - 3.17.6.3 Phase C – blue;
 - 3.17.6.4 Neutral – white;
 - 3.17.6.5 Ground - green.
- 3.17.7 Confirm print size type and size, colours, sizing and nomenclature of nameplates with Consultant prior to ordering. Submit sample board.
- 3.18 Installation of Terminal Backboards**
- 3.18.1 Provide specified terminal backboards for communication systems and electrical distribution equipment.
- 3.18.2 Securely wall mount each backboard with proper fasteners to suit wall construction.
- 3.18.3 Unless otherwise noted, size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions.

3.19 Installation of Warning Signs

3.19.1 Provide warning signs as applicable for following:

3.19.1.1 on doors into transformer vault(s);

3.19.1.2 on doors into high voltage switchgear room(s);

3.19.1.3 on doors to genset room/enclosure;

3.19.1.4 on doors into main electrical rooms;

3.19.1.5 for other applications as noted.

3.19.2 Secure signs to equipment with stainless steel screws. Number of signs required and sign wording, symbols, and colours to be reviewed with Consultant, and local electrical utility, where applicable.

3.20 Installation of Rooftop Support System

3.20.1 Install rooftop support system for conduits/raceways in accordance with manufacturer's instructions and recommendations to suit type of raceway and roofing materials.

3.20.2 If gravel top roof, remove gravel from around and under pipe support. Coordinate work with building roofing vendor.

3.20.3 Consult roofing vendor for roof membrane compression capacities and roof loading limitations. Comply with restrictions.

3.20.4 Use properly sized clamps to suit conduit sizes. Ensure that installation and use of system does not invalidate roof warranties.

3.20.5 Engage roofing vendor to inspect installation and verify that installation has not damaged roof.

3.21 Branch Circuit Balancing

3.21.1 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.

3.21.2 At request of Consultant, perform necessary tests to show compliance with above requirement. Make such tests after building is occupied.

3.22 Equipment Bases and Supports

3.22.1 Provide equipment bases, supports and concrete housekeeping pads for mounting of floor standing equipment and luminaire pole bases.

3.22.2 Secure floor mounted equipment in place on 100 mm (4") high concrete housekeeping pads, 100 mm (4") wider and longer than equipment base dimensions. Chamfer edges of bases. Include for seismic restrains as required by local governing building code.

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- 3.22.3 Supply dimensioned drawings, templates, and anchor bolts for proper setting of equipment on bases and pads. Be responsible for required levelling, alignment, and grouting of equipment.
- 3.22.4 Submit to Consultant for review, dimensioned shop drawings of structurally designed concrete pads or bases for support of large, heavy equipment. Indicate on shop drawings total weight of pad or base, reinforcement, and equipment for which it is required.
- 3.22.5 Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.
- 3.23 Excavation and Backfill**
- 3.23.1 General trades are responsible for excavation and backfill outside the building footprint. The Electrical Contractor is responsible for any under-slab excavation, bedding and backfill, within the building footprint for electrical works.
- 3.23.2 Before commencement of excavation for work, determine in consultation with Consultant, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure that trades concerned are aware of their presence.
- 3.23.3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.
- 3.23.4 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Be responsible for confirming that inverts and locations are correct, prior to commencing excavation. Where discrepancies are found, immediately inform Consultant, and await a direction.
- 3.23.5 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.
- 3.23.6 Provide excavation, backfill, and related work required for your work. Obtain a copy of soil test report if available from Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of Work.
- 3.23.7 Grade bottom of excavation. In firm, undisturbed soil, lay services directly on soil. Backfill excess excavation with 13,790 kPa (2,000 psi) concrete. Grade bottom such that ducts are installed to drain as per Consultant's direction.
- 3.23.8 Prepare new bedding under service in unstable soil, in fill, and in cases where bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins, compact to maximum possible density and support service by means of 200 mm (8") thick concrete cradles spanning full length between firm supports. Refer to detail on drawings.
- 3.23.9 Where excavation is necessary in proximity to and below level of any footing, backfill with 13,790 kPa (2,000 psi) concrete to level of highest adjacent footing. Proximity is determined by angle of repose as reviewed with Consultant.
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- 3.23.10 Do not open trenches ahead of installation of services and backfilling more than weather permits. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically reviewed with Consultant.
- 3.23.11 Before backfilling, arrange for inspection of work by Consultant Do not backfill work unless reviewed with Consultant. Remove shoring during backfilling.
- 3.23.12 Backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6") thickness, compacted to a density of 100% Standard Proctor. Hand compact first layers up to compacted level of 300 mm (12") above top of service. Hand or machine compact balance up to grade using approved equipment.
- 3.23.13 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement. Generally, final surface toppings are responsibility of another Division of Work. Coordinate exact requirements with General Contractor to ensure surface toppings are provided as required to match adjacent surfaces.
- 3.23.14 Unless otherwise directed in Division 02, store and dispose of excavated materials as follows:
- 3.23.14.1 during progress of contract, place material as directed in such a manner that minimum damage or disfigurement of ground and which in no causes way impedes progress of work;
 - 3.23.14.2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.
- 3.23.15 Provide pumping equipment as required to keep excavations free of water.
- 3.23.16 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to Consultant for review.
- 3.23.17 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.
- 3.24 Cutting, Patching and Core Drilling**
- 3.24.1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling required for installation of your work. Perform cutting in a neat and true fashion, with proper tools and equipment. Patching is to exactly match finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.
- 3.24.2 Criteria for cutting holes for additional services:
- 3.24.2.1 cut holes through slabs only; no holes to be cut through beams;
 - 3.24.2.2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
 - 3.24.2.3 keep at least 100 mm (4") clear from beam faces;

- 3.24.2.4 space at least 3 hole diameters on centre;
- 3.24.2.5 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;
- 3.24.2.6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
- 3.24.2.7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.
- 3.24.3 Where core drill or saw cut an opening is required for conduits and/or conductors penetrate construction, size openings to leave 13 mm (1/2") clearance around conduit and/or conductors, and pack and seal and 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.
- 3.24.4 Prior to drilling or cutting an opening, determine, in consultation with Consultant, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any reinforcement bars concealed behind building surface to be cut and locate openings to suit.
- 3.24.5 Fire stop and seal openings as specified, and patch as required before end of workday. No openings are to be left open overnight unless coordinated with Consultant.
- 3.25 Finish Painting of Electrical Work**
 - 3.25.1 Unless otherwise noted, finish painting of exposed Electrical Divisions work is to be performed as part of work of Division 09.
 - 3.25.2 Provide identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Confirm exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
 - 3.25.2.1 pull boxes and junction boxes;
 - 3.25.2.2 communication system conduit;
 - 3.25.2.3 genset exhaust piping.
 - 3.25.3 Spray painting is not permitted unless reviewed and approved by Consultant.
- 3.26 Provisions for Furniture Systems**
 - 3.26.1 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.
 - 3.26.2 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.

- 3.26.3 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.

3.27 Conduit Provisions for Miscellaneous Systems

- 3.27.1 Provide following components to accommodate future installation of various miscellaneous systems by system installers who are to provide equipment and wiring:
- 3.27.1.1 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;
 - 3.27.1.2 outlet boxes - standard galvanized steel, each complete with a blank type faceplate, and as specified in Part 2;
 - 3.27.1.3 pull boxes, junction boxes, back boxes and sleeves - and as specified in Part 2.
- 3.27.2 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.
- 3.27.3 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.
- 3.27.4 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.
- 3.27.5 Confirm exact requirements and locations of equipment with Consultant and respective system installers prior to roughing-in.
- 3.27.6 Refer to system riser diagrams on drawings.
- 3.27.7 Quantities for outlets to be as per floor plan drawings and not riser diagrams.

3.28 DOOR HARDWARE

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- 3.28.1 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. Refer to electrical and door hardware scope matrix.
- 3.28.2 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.
- 3.28.3 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.
- 3.28.4 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.
- 3.28.5 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.
- 3.28.6 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.
- 3.28.7 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.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- 1.2.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.
- 1.2.2 Ontario Electrical Safety Code (OESC).
- 1.2.3 Ontario Building Code (OBC)
- 1.2.4 CSA-C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
- 1.2.5 CSA-C22.2 No. 48, Nonmetallic Sheathed Cable.
- 1.2.6 CSA-C22.2 No. 51, Armoured Cables.
- 1.2.7 CSA-C22.2 No. 52, Underground secondary and service-entrance cables.
- 1.2.8 CSA-C22.2 No. 65, Wire Connectors.
- 1.2.9 CSA-C22.2 No. 75, Thermoplastic-Insulated Wires and Cables.
- 1.2.10 CSA-C22.2 No. 123, Metal Sheathed Cables.
- 1.2.11 CSA-C22.2 No. 124, Mineral Insulated Cable; To ULC S139 600V and hose stream; UL 2196; Mineral Insulated Cables.
- 1.2.12 CSA-C22.2 No. 131, Type TECK 90 Cable.
- 1.2.13 CSA-C22.2 No. 208, Fire Alarm and Signal Cable.

PART 2 - PRODUCTS

2.1 GENERAL LOW VOLTAGE POWER CABLES

- 2.1.1 CSA approved, ULC labelled and certified. Unless otherwise noted, conductors to be copper in general and be suitable for applications as noted in governing local electrical code.
- 2.1.2 Subject to discussion with the construction management team, aluminium alloy conductors are acceptable for feeders of amperage rating 200A above except for life safety emergency feeders. Copper conductors shall be used for service feeders feeding switchboard. Install aluminium alloy conductors with hardware and connected in accordance with conductor manufacturer's instructions and as per requirements of local governing electrical code. Resize conductors and conduits from copper-based sizing as required, maintaining ampacity ratings noted, in compliance with local governing electrical code.

- 2.1.3 "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.
- 2.1.4 "T90 Nylon", CSA certified, single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 90°C (194°F) dry conductor temperature, -10°C (-14°F) minimum installation temperature, PVC insulated, nylon covered.
- 2.1.5 "TWU" single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 60°C (140°F) conductor temperature, -40°C (-40°F) minimum installation temperature, PVC insulated suitable for wet and buried installations, colour coded.
- 2.1.6 "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.
- 2.1.7 "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).
- 2.1.8 "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).

2.2 CONNECTORS

- 2.2.1 Armoured cable connectors must be proper squeeze type connectors and plastic anti-short bushings at terminations.
- 2.2.2 Connectors for conductors connecting to devices as per local governing electrical requirements, CSA certified, 600 volts, rated pressure type connectors.
- 2.2.3 For conductors sized 3/0 and greater, provide long barrel double crimp, 2 hole compression type lug connectors, unless otherwise noted.

2.3 FIRE RATED CABLES

- 2.3.1 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.
- 2.3.2 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.
- 2.3.3 Manufacturer's termination kits: connectors for MI conductors to be cable manufacturer's proper connectors and accessories as recommended by the manufacturer to suit specific applications.
- 2.3.4 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.

- 2.3.5 Brass plates for cable openings in ferrous metal enclosures.
- 2.3.6 Include for required cable manufacturer's accessories and identification labelling.
- 2.3.7 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 and termination of cabling. After completion of Work, manufacturer's technician to review installation work and provide in writing that installation work has been performed to satisfaction of cable manufacturer.
- 2.3.8 Acceptable manufacturer of fire rated MI type cables is Pentair Thermal Management or approved equivalent.

2.4 STANDARD CONTROL AND COMMUNICATIONS CABLES

- 2.4.1 ULC listed and labelled, CSA certified to C22.2 No. 127, No. 18 AWG "TEW" thermoplastic insulated, solid copper wire rated for 600 volts service, and 105°C (220°F) conductor temperature, complete with required number of copper conductors and colour coding.
- 2.4.2 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.

2.5 LOW VOLTAGE TECK CABLES

- 2.5.1 Provide cables as follows:
 - 2.5.1.1 certified to CAN/CSA C22.2 No.131, Type TECK 90 Cable;
 - 2.5.1.2 rated for outdoor, weather resistant and wet locations applications;
 - 2.5.1.3 600/1000 V rated;
 - 2.5.1.4 Conductor: Bare, Soft drawn, Class B Compact or Compressed Stranded Copper conductors per ASTM;
 - 2.5.1.5 insulation: chemically cross linked thermosetting polyethylene (XLPE);
 - 2.5.1.6 bonding conductor (1/C Cable): Soft drawn bare copper;
 - 2.5.1.7 inner jacket: sunlight resistant PVC jacket tightly applied over assembly, to prevent slipping of core in a vertical position;
 - 2.5.1.8 armour: flexible interlocked aluminum armour, over inner jacket for mechanical protection;
 - 2.5.1.9 overall PVC jacket rated -40°C (-40°F).
 - 2.5.1.10 barrier tape over shield.
- 2.5.2 Acceptable manufacturers are:
 - 2.5.2.1 Nexans;

2.5.2.2 Prysmian Cables (Pirelli);

2.5.2.3 General Cable;

2.5.2.4 Aetna Cables;

2.5.2.5 Kerite Company.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

- 3.1.1 If identified in documents, verify that field measurements and conditions are as identified.
- 3.1.2 Cable routing on drawings is schematic and approximate. Route cable as required to meet project conditions. Determine exact routing and lengths on site.
- 3.1.3 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.

3.2 CO-ORDINATION

- 3.2.1 Co-ordinate work with work provided under other electrical work and work of other trades.
- 3.2.2 Determine required separation between cable and other work.
- 3.2.3 Determine cable routing to avoid interference with other work.
- 3.2.4 Submit any alternative cable routing to Consultant for review prior to proceeding with work.

3.3 INSTALLATION OF CONDUCTORS

- 3.3.1 Provide required conductors. Ensure fire rated conductors are provided for applications as required by local governing codes, standards and local governing authorities.
- 3.3.2 In applications where multiple conductors in conduit are being run, provide a trapeze configuration of 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 also be permitted in applications approved by Consultant. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.
- 3.3.3 Conductors, unless otherwise noted, to be as follows:
 - 3.3.3.1 underground inside or outside building and for non-climate controlled areas - "TWU" or "RWU90";
 - 3.3.3.2 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";

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- 3.3.3.3 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;
 - 3.3.3.4 climate controlled areas branch circuit wiring 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 6m (20') run permitted);
 - 3.3.3.5 for climate controlled areas wiring except as noted above or specified elsewhere in Specification or as noted on drawings - "T90 Nylon" or "RW90".
 - 3.3.4 Support flexible armoured cable in ceiling spaces and in stud wall construction with steel 2 hole cable straps to "Code" requirements. Flexible armoured cables must run in a neat manner parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables as specified. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation.
 - 3.3.5 Low voltage conductors to typically be No. 18 AWG "TEW" except for use in fire alarm system applications, unless otherwise noted. Provide specified fire alarm cables for fire alarm system applications or security system applications as approved by Code and local governing authorities. Conductors not installed in conduit or raceways to be fire insulated rated in accordance with latest governing Code Flame Spread requirements.
 - 3.3.6 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 appended to end of this Section.
 - 3.3.7 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.
 - 3.3.8 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:
 - 3.3.8.1 Phase A - red;
 - 3.3.8.2 Phase B - black;
 - 3.3.8.3 Phase C - blue;
 - 3.3.8.4 Ground - green;
 - 3.3.8.5 Neutral - white;
 - 3.3.8.6 Control - orange.
 - 3.3.9 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraided.
 - 3.3.10 Control conductors, in addition, to be numbered.
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- 3.3.11 Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.
- 3.3.12 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- 3.3.13 Install low voltage conductors in conduits, unless otherwise noted within Documents.
- 3.3.14 Comply with local electrical code requirements and conductor manufacturer's recommendations when terminating and connecting aluminium conductors.

3.4 INSTALLATION OF FIRE RATED CONDUCTORS

- 3.4.1 Submit with shop drawings, copy of manufacturer's detailed installation manual and testing procedures. Provide minimum 2 hour fire rated type "MI" CSA approved, ULC listed and labelled, mineral insulated copper conductors for following:
 - 3.4.1.1 emergency feeders from generators to transfer switches;
 - 3.4.1.2 feeders to firefighters' elevators;
 - 3.4.1.3 feeders to fire pumps and sprinkler pumps;
 - 3.4.1.4 feeders to smoke venting fans;
 - 3.4.1.5 feeders to emergency lighting panel boards;
 - 3.4.1.6 feeders to fire alarm control panels and transponders;
 - 3.4.1.7 fire alarm risers;
 - 3.4.1.8 feeders as required by Code requirements;
 - 3.4.1.9 applicable local governing code required applications for control and signalling conductor circuits of and between life safety equipment and systems;
 - 3.4.1.10 feeders and conductors as noted on drawings.
- 3.4.2 Provide fire rated type "MI" conductors for specific feeders as required and as noted. Install type "MI" copper sheathed, mineral insulated 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.
- 3.4.3 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 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.

- 3.4.4 Make terminations of "MI" conductors with manufacturer's approved components and in accordance with the 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. For 99°C applications, cable lugs shall be temperature rated as such.
- 3.4.5 When pulling cable, apply pulling tension to the conductor not in the sheath of the cable. Limit cable pulling tension to as recommended by cable manufacturer.
- 3.4.6 Terminate cable in the equipment with termination kits as per cable manufacturer's instructions.
- 3.4.7 Ground cabling as per cable manufacturer's instructions and as per local governing electrical code requirements.
- 3.4.8 Take necessary precautions when handling cable on reel to ensure that no damage will result in the uncoiling process.
- 3.4.9 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.
- 3.4.10 Test MI cables after installation, in strict accordance with cable manufacturer's instructions. 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 drying procedures until resistance reaches cable manufacturer's listed acceptable level.

3.5 INSTALLATION OF TECK CABLES

- 3.5.1 Provide cables as required for specific applications. Handle, install, and terminate in accordance with manufacturer's recommendations and instructions and as herein specified.
- 3.5.2 When pulling cable, apply pulling tension to conductor not in sheath of cable. Limit cable pulling tension to as recommended by cable manufacturer.
- 3.5.3 Terminate cable in equipment with lugs and termination kits as per cable manufacturer's instructions.
- 3.5.4 Installation of cable splices and terminations to be made by personnel skilled in this type of work.
- 3.5.5 Ground shielding as per cable manufacturer's instructions.
- 3.5.6 Take necessary precautions when handling cable on reel to ensure that no damage will result in uncoiling process.
- 3.5.7 No splices are allowed unless justified by cable pulling tension calculations and approved in writing by Consultant. Obtain approval of splice location from Consultant.

END OF SECTION

APPENDIX – VOLTAGE DROP SCHEDULES

MAXIMUM BRANCH WIRING DISTANCE FOR 120 VOLT SYSTEM AT 3% VOLTAGE DROP

WIRE SIZE	BREAKER SIZE (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No. 12	-	24.4	18.3	-	-	-	-	-	-	-
No. 10	-	38.1	29.0	19.1	-	-	-	-	-	-
No. 8	-	59.4	44.2	30.5	22.9	-	-	-	-	-
No. 6	-	91.4	70.1	47.2	35.1	28.2	23.6	-	-	-
No. 4	-	-	109.7	73.2	54.9	42.7	38.1	32.0	27.4	-
NO. 2	-	-	-	114.3	85.3	68.6	57.9	50.3	41.1	35.0
No. 1	-	-	-	-	103.6	85.3	73.2	61.0	54.9	43.4
No. 1/0	-	-	-	-	128.0	102.9	85.3	73.2	64.0	48.8
No. 2/0	-	-	-	-	-	121.9	100.6	86.9	74.7	60.9
No. 3/0	-	-	-	-	-	-	118.1	102.1	88.4	70.1
No. 4/0	-	-	-	-	-	-	-	120.4	102.9	83.8
250 MCM	-	-	-	-	-	-	-	-	114.3	91.4
300 MCM	-	-	-	-	-	-	-	-	-	103.6

Note: Distances indicated in metres from panel to load for single phase.

END OF APPENDIX

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 26 05 00 - Common Work Results for Electrical.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

- 2.1.1 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.
- 2.1.2 Ground Conductors: Solid copper, insulated and bare to suit application and code requirements; and bond conductors.
- 2.1.3 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.
- 2.1.4 Main/Sub-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.
- 2.1.5 Ground Connections:
- 2.1.5.1 Below Grade: Cadweld as supplied by Erico Products or approved equal, exothermic-welded type connectors.
 - 2.1.5.2 Above Grade or in Manholes: Compression type connectors; Exothermic connections permitted above grade if approved by Consultant.
 - 2.1.5.3 When making ground and bonding connections, apply a corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between metals used.
- 2.1.6 Ground Pit: Flush in grade grounding pits with following features:
- 2.1.6.1 removable cast concrete cover with recessed lifting handle;
 - 2.1.6.2 cast iron or precast concrete pit;
 - 2.1.6.3 ground rod, ground clamps and grounding conductors as required;
 - 2.1.6.4 clay sewer tile for proper drainage.
- 2.1.7 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.
- 2.1.8 Miscellaneous ancillary components to complete grounding and bonding work to requirements of local governing electrical authority and codes.

2.2 TELECOMMUNICATIONS

- 2.2.1 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 (e.g., 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.
- 2.2.2 LAN Room Ground Bus: 50 mm x 9 mm x 300 mm (2" x 3/8" x 12") copper ground bus with eight (8) drilled taped holes; mounted on walls with standoff insulators.
- 2.2.3 Ground Conductor for Grounding Grid and Associated Connections: Number 3/0 AWG bare, 7-strand medium hard-drawn copper unless indicated otherwise.
- 2.2.4 Ground Braid: constructed from flat 98% conductivity tinned copper grounding braid.

PART 3 - EXECUTION

3.1 GENERAL GROUNDING AND BONDING REQUIREMENTS

- 3.1.1 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.
- 3.1.2 Perform ground resistivity testing of soil to determine measurement expressed in ohm meters as defined by IEEE 80-2000 - IEEE Guide for Safety in A.C. Substation Grounding. Use 4-point method with Model 4610 or Model 4500 Ground Tester or equal, and insertion of four equally spaced and in-line electrodes into test area.
- 3.1.3 Provide applicable high voltage grounding requirements in accordance with local governing electrical code and requirements identified in issued Documents.
- 3.1.4 Provide a ground electrode consisting of minimum four (4) ground rods (unless otherwise detailed or otherwise required by local governing electrical code) driven into grade in an arrangement as required and interconnected with minimum No. 3/0 bare copper conductor.
- 3.1.5 Drive and bury ground rods at depth in accordance with local governing electrical code.
- 3.1.6 Connect station equipment to ground electrode with 2 runs of minimum No. 3/0 bare copper conductor.
- 3.1.7 Provide applicable grounding requirements for local electrical utility's pad mounted transformer in accordance with local utility's requirements. Provide a ground electrode consisting of minimum four (4) ground rods (unless otherwise detailed or otherwise required by local utility) driven into grade in an arrangement as required and interconnected with minimum No. 3/0 bare copper conductor. Drive and bury ground rods at depth in accordance with local governing electrical code. Connect transformer to ground electrode with 2 runs of minimum No. 3/0 bare copper conductor.

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- 3.1.8 Within designated electrical room, provide a ground electrode consisting of minimum four (4) ground rods (unless otherwise detailed or otherwise required by local governing electrical code) driven into grade in an arrangement as required and interconnected with minimum No. 3/0 bare copper conductor. Drive and bury ground rods at depth in accordance with local governing electrical code.
 - 3.1.9 Provide 50 mm x 9 mm (2" x 3/8") continuous length, copper ground bus around perimeter of main/sub-main 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 (2) independent flexible braided copper ground straps, one (1) bolted to door frame, one (1) bolted to door, each connected to ground bus.
 - 3.1.10 Connect ground electrode to perimeter ground bus with two (2) minimum No. 3/0 copper conductor connected with approved fittings. Connect each electrical room ground busbar back to main/sub-main electrical room perimeter ground bus with minimum No. 3/0 copper conductors.
 - 3.1.11 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.
 - 3.1.12 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.
 - 3.1.13 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.
 - 3.1.14 When buses are in place, bolts have been tightened, and lugs have been installed, coat entire installation with two (2) 100% covering coats of suitable shellac to prevent bus from oxidizing.
 - 3.1.15 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.
 - 3.1.16 Effectively bond building structures to main grounding system (grid).
 - 3.1.17 Provide separate insulated ground wire for each isolated ground receptacle.
 - 3.1.18 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.
 - 3.1.19 In areas of raised floor systems, provide copper ground system as sized and detailed on drawings and as per local governing electrical code requirements. Bond ground system to every third raised floor support using Burndy Inc., ground clamps, and connects system to building ground system in conduit. Bond every metallic conduit which penetrates raised floor to raised floor stringer system

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- 3.1.20 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.
 - 3.1.21 Ground metal sheathing and any exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond any metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
 - 3.1.22 Bond metal work associated with pools such as reinforcing steel, piping, ladders, etc., above ground loops by copper conductors in accordance with local governing electrical code. Clean water pump prior to bond being using approved clamps. At your discretion, make several bonds at various locations or collect wires and make one (1) bond. Ensure that electrical equipment associated with these piping systems are grounded 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.
 - 3.1.23 Provide separate ground connection for bathtubs.
 - 3.1.24 Provide service conductors exceeding 400 amperes with minimum No. 3/0 AWG grounding conductors, unless otherwise noted.
 - 3.1.25 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.
 - 3.1.26 Make ground connections in slab or buried underground using local governing electrical authority approved welded copper connections.
 - 3.1.27 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.
 - 3.1.28 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.

3.2 ADDITIONAL TELECOMMUNICATIONS GROUNDING

- 3.2.1 Comply with TIA/EIA-607 grounding and bonding requirements.
- 3.2.2 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- 3.2.3 Ground bonding jumpers to be continuous with no splices. Use shortest length of bonding jumper possible.

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- 3.2.4 Provide ground paths which are permanent and continuous with a 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.
- 3.2.5 Bonding Jumpers:
- 3.2.5.1 Use insulated ground wire of size and type if identified on Drawings if not identified, comply with local governing code, but which is to be a minimum of No. 6-AWG insulated copper wire.
 - 3.2.5.2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - 3.2.5.3 Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- 3.2.6 Bonding Jumper Fasteners:
- 3.2.6.1 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 lockwashers.
 - 3.2.6.2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover; e.g., zinc-plated acorn nuts, on any bolts extending into wireway or cable tray to prevent cable damage.
 - 3.2.6.3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
 - 3.2.6.4 Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.
- 3.2.7 Building Ground Busbars:
- 3.2.7.1 Provide busbar hardware at each communications room and connect to pigtail extensions of building grounding ring.
 - 3.2.7.2 Verify that ground ring pigtail is same type and size conductor used for main building grounding ring.
- 3.2.8 Telecommunications Ground Busbars:
- 3.2.8.1 Provide communications room telecommunications ground busbar hardware at cable tray height.
 - 3.2.8.2 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 3/0 AWG).

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- 3.2.9 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 No. 6-AWG ground wire bonding jumpers.
 - 3.2.10 Ground metallic conduit at each end using No. 6-AWG bonding jumpers.
 - 3.2.11 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

PART 1 - GENERAL

1.1 SUBMITTALS

- 1.1.1 Submit as part of shop drawing submission, copies of:
 - 1.1.1.1 electrical distribution system protective device coordination study and short circuit calculations;
 - 1.1.1.2 arc flash analysis report.
- 1.1.2 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 are acceptable to Consultant. 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.
- 1.1.3 If formal completion of studies and reports may cause delay in equipment manufacture, approval 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.
- 1.1.4 Submit after completion of factory testing, copies of completed product testing reports.
- 1.1.5 Submit after installation and testing, copies of:
 - 1.1.5.1 completed testing reports with completed test results sheets;
 - 1.1.5.2 certificate of approvals from local governing authorities, manufacturers' of systems and equipment and testing companies.
- 1.1.6 Verify 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.

PART 2 - PRODUCTS

2.1 GENERAL SCOPE OF WORK

- 2.1.1 Include for but not be limited to following:
 - 2.1.1.1 preparing and submitting preliminary coordination study and short circuit calculations and recommendations on required relays, sensors and CT's for proper system coordination and protection;
 - 2.1.1.2 preparing and submitting arc flash study with calculations for use in determining required electric shock and arc flash protection;

- 2.1.1.3 product manufacturers providing equipment inspection, testing, start-up, adjustments and verification;
- 2.1.1.4 independent 3rd party testing of electrical distribution system equipment and associated products;
- 2.1.1.5 independent 3rd party testing of systems and equipment as noted;
- 2.1.1.6 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;
- 2.1.1.7 coordination of work with testing company and equipment/system manufacturer's authorized technician in performing adjustments and start-up procedures to equipment/systems;
- 2.1.1.8 preparing testing reports and documentation for submission to Consultant.

PART 3 - EXECUTION

3.1 PRELIMINARY COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- 3.1.1 Immediately after award of Contract liaise with local electrical supply authority for information on relays and other protective devices installed on their system and substations which affect co-ordination of site electrical distribution system.
- 3.1.2 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.
- 3.1.3 Prepare preliminary coordination study and calculate available fault currents. Combine into preliminary report and submit minimum one hard copy and electronic copy to Consultant for review.
- 3.1.4 Prepare report to typical standards as specified in respective coordination study and short circuit calculation report articles in this Section.

3.2 DISTRIBUTION SYSTEM COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- 3.2.1 Prepare 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.
- 3.2.2 Submit coordination study and short circuit calculations reports as part of shop drawing submission as specified in Part 1 article - Submittals. Ensure that results and Consultant's reviewed comments from these reports are incorporated into electrical distribution equipment shop drawings.
- 3.2.3 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.

3.2.4 Provide and carry out following:

- 3.2.4.1 prepare a set of coordination curves on K.E. No. 336E Time Current Characteristic graph paper;
- 3.2.4.2 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.
- 3.2.4.3 Plot time-current characteristic curves for following:
 - 3.2.4.3.1 main and feeder protective devices at voltage levels used in distribution system;
 - 3.2.4.3.2 protective devices associated with largest motor in each mechanical DP, refrigeration machine compressors and largest device in each distribution panel;
 - 3.2.4.3.3 motor generator protective devices, damage curves and current decrement curves.

- 3.2.5 Cooperate with and obtain from other manufacturers a list of equipment requiring protective devices to be used in distribution system and prepare coordination curves as soon as possible. Be responsible, along with other manufacturers' equipment connected to distribution system, to ensure that proper control and protective devices are selected such that they coordinate with protective devices.
- 3.2.6 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.
- 3.2.7 Where automatic transfer switches are provided, submit coordination results 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.
- 3.2.8 Document testing, coordination study and arc flash analysis in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. 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.

3.3 GENERAL ELECTRICAL WORK TESTING

- 3.3.1 In addition to tests required by local governing authorities having jurisdiction, local codes and regulations, perform following:
 - 3.3.1.1 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;
 - 3.3.1.2 establish and ensure proper motor rotation - measure full load running currents and check overload elements - report to Consultant any discrepancies which are found; be responsible for any damage caused by reverse rotation;
 - 3.3.1.3 demonstrate to Consultant that branch circuit voltage drop is within specified units;

3.3.1.4 ensure that devices are commissioned and operable.

3.3.2 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.

3.4 SYSTEMS INSPECTION, TESTING, START-UP AND VERIFICATION

3.4.1 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:

3.4.1.1 check component connections and overall installation;

3.4.1.2 adjust sound systems for high quality, distortion free performance, free from noise, cross-talk, hum or other interference;

3.4.1.3 test and adjust system and ascertain that components are as specified and ensure that products operate as designed;

3.4.1.4 provide start-up procedures for systems and equipment;

3.4.1.5 verify and certify system component operations;

3.4.1.6 prepare, document and evaluate test results;

3.4.1.7 authenticate test results with signature of authorized testing Engineer/Technician;

3.4.1.8 check and verify nameplates;

3.4.1.9 provide maintenance and operating instructions to Owner's personnel.

3.4.2 Perform work properly documented, and in accordance with manufacturer's instructions and recommendations.

3.4.3 Perform work under presence of Owner/Consultant/Commissioning Agent at times approved by Owner and reviewed with Consultant.

3.4.4 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.

3.4.5 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.

3.4.6 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.

3.4.7 Bind documents under cover and submit minimum one hard copy and electronic copy to Consultant.

3.5 ELECTRICAL DISTRIBUTION SYSTEM TESTING AND VERIFICATION

3.5.1 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.

3.5.2 Services to be performed by an approved testing company and be initially conducted prior to system/equipment being energized and further testing when energized, and include following items, where applicable:

- 3.5.2.1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration of protective devices to conform to requirements of approved coordination curves);
- 3.5.2.2 function test of associated control devices;
- 3.5.2.3 replacement of fuses destroyed during testing;
- 3.5.2.4 an acceptance test in presence of Consultant;
- 3.5.2.5 presence, for length of time required, of qualified and competent equipment manufacturer's service representative during start-up;
- 3.5.2.6 carry out insulation resistance testing of outgoing feeders with respect to ground;
- 3.5.2.7 inspection and testing of cables, bus duct, power panels, lighting panels, transformers, power receptacles and switches;
- 3.5.2.8 inspection and testing of electrical system auxiliary systems and devices such metering, power factor capacitors, UPS, isolated power centres, transfer switches, inverters, central battery systems, generators sets and load banks;
- 3.5.2.9 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;
- 3.5.2.10 inspection and testing of motor control centres, starters and variable frequency drives;
- 3.5.2.11 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;
- 3.5.2.12 verification and certification work of equipment and systems;

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- 3.5.3 Perform services procedures properly documented, and in accordance with manufacturer's instructions and recommendations.
 - 3.5.4 Forward to Consultant for review, minimum 3 hard copies and electronic file of engineering and testing report.
 - 3.5.5 Where relays, breakers, etc., do not perform to Consultant reviewed coordination curves, revise as part of work.
 - 3.5.6 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.
 - 3.5.7 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 report for Consultant's review. Submit recorded test data (properly bound) with report, in each case.
 - 3.5.8 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.
 - 3.5.9 Provide testing and coordination of emergency power distribution system to ensure that system performs in accordance to latest requirements of CSA Standard C282. Ensure that engine-generator set manufacturer and testing and coordination companies co-operate to ensure that CSA requirements are fulfilled. 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.
 - 3.5.10 Provide visual and mechanical inspection of ground system and verify that it is in compliance with issued documents and local governing electrical code requirements.
 - 3.5.11 Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on main grounding electrode or system in order 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 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.
 - 3.5.12 Additionally, perform testing of lighting control systems and devices to ensure conformance with ASHRAE 90.1 requirements.

- 3.5.13 Document testing, coordination study and arc flash analysis in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. 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.
- 3.5.14 Acceptable companies to provide this work are to be independent of successful manufacturers providing distribution system equipment and include:
- 3.5.14.1 G.T. Woods;
 - 3.5.14.2 AC Tesla;
 - 3.5.14.3 Pelikan Inc;
 - 3.5.14.4 Eaton Electric Services Division;
 - 3.5.14.5 Schneider Electric Services Division;
 - 3.5.14.6 Siemens Electric Services Division.

3.6 UPS TESTING

- 3.6.1 In addition to standard specified testing requirements, UPS system manufacturer to include during onsite testing, full documented testing and results including but not limited to following:
- 3.6.1.1 recording functional alarms and voltage levels at which alarm occurs, on UPS system;
 - 3.6.1.2 recording critical load alarms and voltage levels at which alarm occurs, on UPS system;
 - 3.6.1.3 recording minimum and maximum adjustment of voltage potentiometer on system;
 - 3.6.1.4 recording levels and checking functionality of battery equalize feature;
 - 3.6.1.5 testing operation of remote EPO functions;
 - 3.6.1.6 recording load testing data with 0%, 50% and 100% load for function of input VAC/IAC/THD%, VDC/IDC (charging), output VAC/ Φ - Φ V average/IAC, output kW/kVA/Hz and output voltage THD%;
 - 3.6.1.7 determine voltage regulation from 0% to 100% full load;
 - 3.6.1.8 determine voltage unbalance of system at 0%, 50% and 100% kW load;
 - 3.6.1.9 record transient response of system under load steps of 0-50%, 50-0%, 50-100%, 100-50%, 100% (UPS to bypass), 100% (bypass to UPS) and 100% simulated fuse failure; load percentages; Refer to kW rating of unit; record 3-phases of output voltage, 1-phase of output current and one phase of input voltage; attach printouts with report;

- 3.6.1.10 perform battery discharge test; record battery details, specifications and operating data; load system to 100% kW load and record DCV and DCA at one minute intervals from 0-20 minutes, record 3-phases of output voltage, one phase of output current and one phase of input voltage; attach printouts with report;
 - 3.6.1.11 record voltage levels and times at which Battery Discharge/Low Battery Warning/Low Battery Shutdown occur during discharge test;
 - 3.6.1.12 during battery charge (no load), record battery current limit (ADC, 10%) and reduced battery current limit (ADC, 1%);
 - 3.6.1.13 after battery recharge current has reached OA following battery capacity test, perform 125% overload test and verify/record overload alarm, input current limit (115%), reduced input current limit (100%), overload transfer alarm, auto-retransfer primed alarm and auto-retransfer successful (no alarm);
 - 3.6.1.14 perform full load system burn-in; record at 30 minute intervals with 100% kW on system for 4 hours continuous, O/P volts $\Phi A-B/\Phi B-C/\Phi C-A$, O/P amps $\Phi A/\Phi B/\Phi C$; if failure occurs, repair and start test over from beginning until 4 hours continuous operation are achieved;
 - 3.6.1.15 test system options and features to ensure proper operation.
- 3.6.2 Document testing in report signed by UPS manufacturer's technician. Include for hard copies and electronic copy of report to be submitted to Consultant for review.

3.7 SHOCK AND ARC FLASH PROTECTION

3.7.1 General:

- 3.7.1.1 Provide for electric shock and arc flash protection as required by local governing electrical code and local governing authorities.
- 3.7.1.2 Determine severity of potential exposure, planning safe work practices and selecting personal protective equipment under general guidelines of governing edition of CSA Z462.
- 3.7.1.3 Design safety signs and labels for applications to equipment under general guidelines of ANSI Z535.4.
- 3.7.1.4 Determine arc flash hazard distance and incident energy that workers may be exposed to from electrical equipment under general guidelines of IEEE 1584.
- 3.7.1.5 Incorporate documentation with distribution system testing and coordination study report.

3.7.2 Arc Flash Hazard Analysis:

- 3.7.2.1 Perform Arc Flash Hazard analysis according to IEEE 1584 equations that are presented in NFPA70E, Annex D.
- 3.7.2.2 Retrieve short circuit calculations and clearing times of phase overcurrent devices from short circuit and coordination study specified previously.

- 3.7.2.3 Calculate flash protection boundary and incident energy at significant locations in electrical distribution system (switchboards, switchgear, motor-control centres, panelboards, busway and splitters) where work could be performed on energized parts.
- 3.7.2.4 Arc-Flash Hazard Analysis to include significant locations in 240 V and 208 V systems fed from transformers equal to or greater than 125 kVA.
- 3.7.2.5 Specify safe working distances for calculated fault locations based upon calculated arc flash boundary considering incident energy of 1.2 cal/cm².
- 3.7.2.6 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.
- 3.7.2.7 Arc Flash computation to include both line and load side of main breaker calculations, where necessary.
- 3.7.2.8 Base Arc Flash calculations to be based on actual overcurrent protective device clearing time. Cap maximum clearing time at 2 seconds based on IEEE 1584 section B.1.2.
- 3.7.3 Arc Flash Warning Labels:
 - 3.7.3.1 Provide minimum 90 mm x 127 mm (3.5" x 5") thermal transfer type label of high adhesion polyester for each work location analysed.
 - 3.7.3.2 Label to have an orange header with wording, "WARNING, ARC FLASH HAZARD", and include following information:
 - 3.7.3.2.1 location designation;
 - 3.7.3.2.2 nominal voltage;
 - 3.7.3.2.3 flash protection boundary;
 - 3.7.3.2.4 hazard risk category;
 - 3.7.3.2.5 incident energy;
 - 3.7.3.2.6 working distance;
 - 3.7.3.2.7 engineering report number, revision number and issue date.
 - 3.7.3.3 Machine print labels with no field markings.
 - 3.7.3.4 Provide Arc Flash labels for following equipment (as applicable to project and required by codes and standards) and base labels on recommended overcurrent device settings:
 - 3.7.3.4.1 panelboards;

- 3.7.3.4.2 motor control centres/VFDs;
- 3.7.3.4.3 distribution transformers;
- 3.7.3.4.4 switchboards;
- 3.7.3.4.5 transfer switches;
- 3.7.3.4.6 genset control equipment;
- 3.7.3.4.7 switchgear;
- 3.7.3.4.8 medium voltage switches and breakers;
- 3.7.3.4.9 other equipment as required by local governing authorities.

3.8 INFRARED SCANNING

- 3.8.1 Provide infrared scanning of Work and connections to electrical distribution equipment as noted.
- 3.8.2 Infrared scanning process to include but not be limited to following:
 - 3.8.2.1 use of latest technology infrared fast scanning thermal imaging camera with colour digital conversion thermographic imaging capabilities; camera to be capable of determining temperature differences using generated isotherms;
 - 3.8.2.2 scanning distribution system with ability to detect 1°C between subject area and reference at 30°C;
 - 3.8.2.3 equipment to detect emitted radiation and convert detected radiation to visual image;
 - 3.8.2.4 infrared surveys to be performed during periods when equipment is under intended full operating load;
 - 3.8.2.5 perform scanning of essential power equipment when gensets are in operation and essential power is on line.
- 3.8.3 Some guidelines for interpretation of temperature gradients are:
 - 3.8.3.1 temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation;
 - 3.8.3.2 temperature gradients of 7°C to 15°C indicate deficiency; required repair as time permits as directed by Consultant;
 - 3.8.3.3 temperature gradients of 16°C and above indicate major deficiency; requires repair immediately.
- 3.8.4 Document testing in a report signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review. Report to include but not be limited to include:

- 3.8.4.1 indication of problem area (location of "hot spot");
- 3.8.4.2 indication of temperature rise between "hot spot" and normal or reference area;
- 3.8.4.3 indication of cause of heat rise;
- 3.8.4.4 indication of phase unbalance, if present;
- 3.8.4.5 indication of areas scanned;
- 3.8.4.6 colour photographs and thermograms of deficient area as seen on imaging system;
- 3.8.4.7 summary of work;
- 3.8.4.8 list of test equipment;
- 3.8.4.9 faults, corrections required, recommendations;
- 3.8.4.10 retesting of corrected faults.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

- 1.1.1 Read and comply with the requirements of Division 01.
- 1.1.2 This section includes special requirements for the commissioning of Division 26 equipment and systems and this work will form part of the overall commissioning process.
- 1.1.3 The requirements in this section do not replace requirements identified in other technical specification sections, but identify the minimum commissioning activities required.
- 1.1.4 Provide the test results reports to the Owner's representative.
- 1.1.5 Development of the final detailed requirements for commissioning shall be the responsibility of the Owner's Commissioning Agent

1.2 REFERENCE STANDARDS AND GUIDELINES

- 1.2.1 Division 26 commissioning shall be completed in accordance with the latest version of the following standards in addition to those in Division 01:
- 1.2.2 CSA Z320, Building Commissioning Standard & Check Sheets
- 1.2.3 CAN/CSA C282 – Emergency Electrical Power Supply for Buildings
- 1.2.4 The local utility company and other authorities having jurisdiction should be consulted for additional requirements.

1.3 COMMISSIONING OBJECTIVES

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

1.4 RELATED WORK

- 1.4.1 Be responsible for all tests detailed in this specification
- 1.4.2 Interface, cooperate and coordinate with the Owner's Commissioning Agent and attend commissioning meetings. Perform commissioning activities for aspects of work provided in Electrical Divisions and perform corrective work identified by the Commissioning Agent.
- 1.4.3 Fire alarm system and following Division 26 systems and equipment shall be totally commissioned and operating before date of "Substantial Completion":
 - 1.4.3.1 Electrical Distribution Switchgear and Switchboards
 - 1.4.3.2 High Voltage Cables and Low Voltage Cables
 - 1.4.3.3 Motor Starters and VFD Drivers
 - 1.4.3.4 Transformers

- 1.4.3.5 Gensets
- 1.4.3.6 Auto Transfer Switches
- 1.4.3.7 Distribution Panelboards and Branch Circuit Panelboards
- 1.4.3.8 UPS
- 1.4.3.9 Coordination Study and On-Site Testing
- 1.4.3.10 Lighting and Lighting Control Systems
- 1.4.3.11 Other systems as noted in corresponding specifications.
- 1.4.4 Only utilize electricians licensed to conduct tests with previous experience in the testing procedures. Contractor shall inform the Owner's representative, in writing, who they intend to use with a list of experience and projects completed.
- 1.4.5 Co-ordinate with other trades for work which affects the operation of the Division 26 systems, before submitting request for testing and commissioning.
- 1.4.6 Hire manufacturer's technicians who will conduct tests and training on their equipment required as part of their installation requirements.
- 1.4.7 Co-operate with the Independent Testing Contractors to provide assistance during the testing procedures.
- 1.4.8 Perform site testing and commissioning only after equipment is installed and operational.
- 1.4.9 Schedule all tests and provide notice to the Owner a minimum of 48 hours prior to testing commencing. Tests may be witnessed by the Owner's representative.

1.5 WRITTEN WORK PRODUCTS

- 1.5.1 Installation Start-up and Testing Schedule
 - 1.5.1.1 Submit to the Owner's representative prior to the schedule testing start date, a comprehensive installation / start-up testing schedule identifying all activities to take place. Refer to construction schedule. Include draft forms to demonstrate intended performance for each and every system. Information for each system will include but not be limited to the following:
 - 1.5.1.1.1 Date of test.
 - 1.5.1.1.2 Individual(s) involved.
 - 1.5.1.1.3 System being tested.
 - 1.5.1.1.4 Description of functionality of the system.
 - 1.5.1.1.5 Demonstration of proper operation.
 - 1.5.1.2 Revise the draft forms to the Owner's representative's satisfaction prior to the test date.
- 1.5.2 Static Verification and Start-Up Documentation
 - 1.5.2.1 Provide copies of certificates of all factory and site testing in complete detail bearing in each case the signature of the Party responsible for the tests.
 - 1.5.2.2 All equipment or system deficiencies identified by factory or site testing procedures, to be corrected by Contractor prior to obtaining a "Certificate of Substantial Completion".
 - 1.5.2.3 Complete all Static Verification Checklists prior to start-up of the respective systems.

- 1.5.2.4 Document and submit all start-up test results of approved forms for review by the Design Consultant.
- 1.5.2.5 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- 1.5.3 System Operating Manual
 - 1.5.3.1 The systems operating manual shall be prepared by Contractor.
 - 1.5.3.2 The Division 26 System Operating Manual shall be sub-divided into system sections. Each system section shall contain followings as applicable:
 - 1.5.3.2.1 The design intent.
 - 1.5.3.2.2 The system location and areas served by that system.
 - 1.5.3.2.3 Equipment included in that system.
 - 1.5.3.2.4 System schematic.
 - 1.5.3.2.5 Sequence of Operation for the system in the normal and emergency modes.
 - 1.5.3.2.6 Final operating parameter set points
 - 1.5.3.2.7 Trouble shooting recommendations.
- 1.6 COMMISSIONING PROCESS**
 - 1.6.1 General
 - 1.6.1.1 Read and comply with the requirements of Division 01.
 - 1.6.2 Factory Testing
 - 1.6.2.1 Contractor shall include factory testing and approved certification where required
 - 1.6.2.2 Contractor shall inform manufacturers of all factory and site testing requirements.
 - 1.6.3 Start-up Testing
 - 1.6.3.1 Division 26 contractors shall follow the start-up testing procedures listed in this section, Section 01 91 13, and as recommended by the manufacturers of equipment and are responsible for complete systems so they are fully functional prior to scheduling Functional Performance Testing.
 - 1.6.3.2 Division 26 contractors shall coordinate start-up schedules with Owner to ensure enabling works for other divisions are completed prior to testing of other dependent systems.
 - 1.6.4 Functional Testing
 - 1.6.4.1 Functional testing is to begin when the systems are confirmed to be fully operational, and are deemed to be complete and ready for final witnessing.
 - 1.6.4.2 Functional testing may begin prior to final completion of a system or sub-system at the discretion of the Owner and the Project Manager, but this does not relieve the contractor from fully completing and demonstrating the systems following partial testing.
 - 1.6.4.3 Where equipment monitoring, scheduling, and/or control is connected to the BAS, full control and monitoring through the BAS must be demonstrated to complete a Functional Performance Test for that equipment or system.
 - 1.6.5 Training of Owner's Personnel

1.6.5.1 Support the overall training program through provision of training for Division 26 equipment and systems through provision of training by manufacturer's representatives and/or own forces including written training manuals.

1.6.5.2 Submit a Training Plan and schedule outlining the equipment or systems to be covered, company/person leading the session, topic(s) of discussion, location, and time allotted for each session.

1.6.6 Refer to agreed commissioning process.

1.7 WARRANTY

1.7.1 Manufacturer Warranty: Manufacture warranty shall be 1-year standard warranty against defects and/or deficiencies unless otherwise as noted in the product specification sections.

1.7.2 Warranty starts at substantial completion for the building.

PART 2 - PRODUCT

2.1 TEST EQUIPMENT

2.1.1 Provide all tools, equipment, labour and materials required to perform Division 26 testing and commissioning as specified.

2.2 SWITCHBOARD TESTING

2.2.1 Barriers, bus insulators, bushings, etc. shall be inspected and cleaned to remove any accumulated construction dust or dirt.

2.2.2 All debris shall be removed from all compartments.

2.2.3 Insulators should be inspected for evidence of contaminated surface or physical damage, such as cracked or broken segments.

2.2.4 Contractor shall submit to the Owner's representative results of the factory insulation resistance tests including HiPot & BIL tests, metering tests and circuit breaker tests.

2.2.5 Contractor shall conduct an inspection of the equipment on site to verify the operation of the breakers under no load conditions.

2.2.6 Contractor shall conduct a site insulation resistance test.

2.2.7 Contractor shall conduct an arch flash study and short circuit system coordination.

2.2.8 Contractor shall document the results of the tests on the associated forms. The forms shall be forwarded to the Owner's representative for verification.

2.2.9 When Contractor has completed these tests and the results have been verified by the Owner's representative the Independent Testing Contractor shall conduct the co-ordination study tests.

2.2.10 Ensure paint finishes are unblemished and uniform.

2.2.11 Check ground bus connections.

2.2.12 Operate operable components. Confirm alignment, phase rotation and verify correct functioning of tripping mechanisms.

2.2.13 Verify fuse, breaker and instrument settings.

2.2.14 Exercise relays and breakers trip mechanism.

2.2.15 Ensure breaker lubrication.

- 2.2.16 Set and calibrate relays and trips.
- 2.2.17 For metering instruments:
 - 2.2.17.1 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
 - 2.2.17.2 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- 2.2.18 Perform factory tests to obtain correct calibration. Test:
 - 2.2.18.1 Primary and secondary voltage at no load.
 - 2.2.18.2 Primary and secondary voltages at normal load.
 - 2.2.18.3 Primary and secondary current in each phase.
 - 2.2.18.4 kW and kVA.
 - 2.2.18.5 Reconnect loads as necessary to achieve satisfactory phase balance.
- 2.2.19 Inspect phase barriers for tracking and tightness.
- 2.2.20 For indoor load interrupter switches, operate switch on line under normal load conditions ten (10) times in presence of the Owner's representative and prove operating functions.

2.3 INSULATION TESTING

- 2.3.1 Megger all lighting and power circuit feeders and bus ducts. If ground resistance on any circuit is less than that required by CSA or other governing regulations, such circuits are to be considered defective and must be replaced.
- 2.3.2 For circuits up to 350V, use 500V instrument. For 350V to 600V, use 1000V instrument. Check resistance to ground before energizing.
- 2.3.3 Conduct voltage tests at the completion of the installation in the presence of the Owner's representative and carry out such corrective measures as may be required.

2.4 INFRA-RED SURVEY

- 2.4.1 Provide a thermographic survey of accessible items of all new equipment using an infrared imaging system to detect any 'hot spot' locations which could lead to failure or the initiation of a fire. Provide a report outlining the details of all problem locations and containing thermograms of any suspect areas, as well as comments to probable cause and recommendations for repair.
- 2.4.2 Provide a thermographic survey with electrical system loaded, once between substantial completion and prior to expiration of 1 year warranty.

2.5 HARMONIC CONTENT

- 2.5.1 Measure and chart the current magnitude of the base condition and the third to thirteenth harmonic and total harmonic distortion present at the following locations:
 - 2.5.1.1 Power feeders (at switchboard).
 - 2.5.1.2 Lighting feeders (at switchboard).
 - 2.5.1.3 Elevator feeders in Machine Room
 - 2.5.1.4 Emergency generator(s) terminals
 - 2.5.1.5 Chiller feeder terminal(s)

2.5.1.6 Harmonic filter equipment terminals.

2.5.2 Ensure that all electrical equipment supplied under this Division, for this project, has an individual harmonic content for voltage of less than 5% and that the total harmonic content for voltage for the building is less than 3%.

2.5.3 If necessary, install harmonic filters to meet the above requirements.

2.6 GROUND FAULT PROTECTION SYSTEMS

2.6.1 Inspect relays visually for condition and clean where necessary.

2.6.2 Check all connections for tightness.

2.6.3 Inspect contacts and burnish where necessary.

2.6.4 Apply settings to each relay as specified in the short circuit, protection, co-ordination study and test operation by means of a relay test set.

2.6.5 Verify each protective system by means of primary current injection through the zero phase sequence transformer. This will provide correct operation of both the transformer and relay as well as proper functioning of the circuitry through to the breaker tripping elements.

2.7 GROUNDING

2.7.1 Perform grounding test before energizing electrical system, and disconnect ground fault indicator during tests.

2.7.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of the Owner's representative and local authority having jurisdiction.

2.7.3 Retain services of specialty grounding study, and provide a report and calculation as required in Section 35 of CSA C22.1.

2.7.4 The study should include building H.V. transformer equipment grounding requirements.

2.7.5 Submit report to the Owner's representative in triplicate, and include additional copy in operation and maintenance manual.

2.8 HEATING CABLE

2.8.1 Field test cables with a 2500V megger to test cables for continuity and 200 megohms (minimum) insulation value and record readings as follows:

2.8.1.1 On cable reel, upon receipt of cable.

2.8.1.2 Before installation

2.8.1.3 After installation.

2.8.1.4 Before topping pouring.

2.8.1.5 During topping pouring at 5 minute intervals.

2.8.1.6 24 hours after pouring.

2.9 LOAD BALANCE

2.9.1 Measure phase current to panelboards with normal loads (lighting and mechanical loads) operating at time of acceptance. Adjust branch circuit connections as required to obtain balance of current between phases and record changes.

- 2.9.2 Measure phase voltages at loads and adjust transformer taps to obtain readings with 2% of rated voltage of equipment.
- 2.9.3 Submit, at completion of work, a report listing phase and neutral currents on panelboards and dry-core transformers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

2.10 POWER TRANSFORMERS

- 2.10.1 Ensure factory tests are carried out to CSA C9.
- 2.10.2 Submit production test certificates for:
 - 2.10.2.1 Voltage ratio.
 - 2.10.2.2 Polarity or angular displacement.
 - 2.10.2.3 No-load losses.
 - 2.10.2.4 Full load losses.
 - 2.10.2.5 Dielectric withstand, applied and induced.
 - 2.10.2.6 Exciting current.
 - 2.10.2.7 Resistance (transformers above 500 kVA).
- 2.10.3 Submit type test certificates for:
 - 2.10.3.1 Temperature rise
 - 2.10.3.2 Sound level.
 - 2.10.3.3 Radio influence voltage.
 - 2.10.3.4 Partial discharges (corona).
 - 2.10.3.5 Basic insulation impulse level.
- 2.10.4 At the site, energize transformers and adjust any cooling fan controls if required.

2.11 GENERATOR

- 2.11.1 Prepare data sheets in duplicate with spaces to record:
 - 2.11.1.1 Date.
 - 2.11.1.2 Generator set serial No.
 - 2.11.1.3 Engine, make, model, serial No.
 - 2.11.1.4 Alternator, make, model, serial No.
 - 2.11.1.5 Voltage regulator, make and model.
 - 2.11.1.6 Rating of generator set, kW, kVA, V, A, r/min, Hz.
- 2.11.2 The manufacturer's engineers and the Owner's representatives signature shall be on the completed forms to indicate concurrence in results of test, and that same equipment is at site, that was factory tested.
- 2.11.3 Initial Installation Performance Tests:
 - 2.11.3.1 Upon completion of the installation of the emergency power supply system, the installation shall be tested to ensure conformity to the requirements of the CAN/CSA-C282 standard.

2.11.4 Operational Test

- 2.11.4.1 With the engine in a "cold start" condition and the emergency load at its normal operating level, a power failure shall be simulated by opening all switches or breakers that supply the normal power to the building or facility. The test load shall be that load which is normally served by the emergency power system.
- 2.11.4.2 The operational test shall be continued for 1h, after which normal power shall be restored to the building or facility and satisfactory transfer of the load shutdown of the emergency generating set shall be demonstrated.
- 2.11.4.3 The following data shall be observed and recorded:
 - 2.11.4.3.1 time delay on start;
 - 2.11.4.3.2 the cranking time until the engine starts and runs;
 - 2.11.4.3.3 the time required to come up to operating speed.
 - 2.11.4.3.4 the time required to achieve a steady-state condition with all switches transferred to the emergency position;
 - 2.11.4.3.5 the voltage, frequency, and amperes at start-up and at any observed change in load;
 - 2.11.4.3.6 the engine oil pressure, water temperature where applicable and battery charge rate at 5 min intervals for the first 15 minutes and at 15 minute intervals thereafter;
 - 2.11.4.3.7 the time delay on retransfer for each transfer switch;
 - 2.11.4.3.8 the time delay on engine cooldown and shutdown;
- 2.11.4.4 Full Load Test
 - 2.11.4.5.1 the emergency generator set shall be subjected to a 4h 100% load test;
 - 2.11.4.5.2 the building load may serve as part or all of the test load if it is continuous, supplemented by a load bank if required. Full load shall equal the nameplate kW rating of the emergency generator set less the applicable derating factors for site conditions. A unity power factor is acceptable for onsite testing, provided that rated load tests at the rated power factor have been performed by the manufacturer of the emergency generator set prior to shipment;
 - 2.11.4.5.3 the full load test may be initiated by any method that will start the engine and, immediately upon reaching its rated speed, pick up the full load in one step.
 - 2.11.4.5.4 the data shall be recorded at first load acceptance and every 15 min thereafter until the completion of the test period;
- 2.11.4.6 Cycle Crank Test
 - 2.11.4.7.1 the engine shall be prevented from running by utilizing any method recommended by the manufacturer. The control switch shall then be placed in the "run" position to cause the engine to crank;
 - 2.11.4.7.2 the crank cycle shall be observed and recorded;
 - 2.11.4.7.3 the crank cycle shall be repeated a second time to demonstrate that the batteries or compressed air have sufficient capacity for a total cranking time of 60 seconds.

2.11.4.7.4 the time required to recharge the batteries or the compressed air shall be demonstrated as appropriate;

2.11.4.8 Safety Shutdown and Alarms

2.11.4.9.1 the emergency supply shall be tested as recommended by the manufacturer to ensure that all safety shutdowns and alarms respond;

2.11.4.10 Ventilation

2.11.4.11.1 it shall be demonstrated that the ventilating system will maintain the room temperature within the allowable tolerances;

2.11.4.11.2 at the end of the testing check the battery voltage to demonstrate the battery charger has returned batteries to fully charged state;

2.11.4.12 Refill fuel tank to full capacity.

2.11.5 Manual of Operating and Maintenance Instructions

2.11.5.1 A manual containing mechanical and electrical drawings and instructions for the operation and maintenance of the supplied emergency generating

2.11.5.2 equipment shall be provided. It shall cover all elements affecting the reliable operation of the emergency electrical power system, including the engine-generator set and associated accessories, the generator control panel, the protective devices, and the transfer switch(es)

2.11.5.3 The manual shall be in English and French. At least two copies shall be provided.

2.12 AUTOMATIC TRANSFER SYSTEM (FOR EACH AUTOMATIC TRANSFER SWITCH)

2.12.1 Set selector switch in 'Test' position to ensure proper standby start, running, transfer, retransfer. Return selector switch to 'Auto' position to ensure standby shutdown.

2.12.2 Set selector switch in 'Manual' position and check to ensure proper performance.

2.12.3 Set selector switch in 'Engine Start' position and check to ensure proper performance. Return switch to 'Auto' to stop engine.

2.12.4 Set selector switch in 'Auto' position and open normal power supply disconnect.

2.12.5 Standby generator should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby generator should shutdown.

2.13 POWER PANEL TESTING

2.13.1 Conduct an inspection of the equipment on site to verify equipment data and breaker ratings. This data shall be documented on the equipment verification forms.

2.14 RECEPTACLE PANEL TESTING

2.14.1 Conduct an inspection of the equipment on site to verify equipment data and breaker ratings. This data shall be documented on the equipment verification forms.

2.15 LIGHTING PANELS TESTING

2.15.1 Conduct an inspection of the equipment on site to verify equipment data and breaker ratings. This data shall be documented on the equipment verification forms.

2.16 LIGHTING SYSTEM

- 2.16.1 Verify correct lamp position, lamp type, colour temperature and operation of all luminaires.
- 2.16.2 With all lighting in operation, and at night, measure the "average" illumination on the floor or tread (by establishing the maximum and minimum) level in the following locations, using a portable, illuminance photometer, cosine corrected, static or optical lensed, digital readout, tested, calibrated and certified accurate to within 2%, or video camcorder, together with suitable software for illuminance measurements data to be obtained:
 - 2.16.2.1 Every exit, public corridor, corridor providing access to exit for the public, electrical equipment room, main electrical room and hoistway pit.
 - 2.16.2.2 All rooms and spaces in all departments, including storage rooms, service rooms, service hallways and stairways.
 - 2.16.2.3 Elevator machine rooms.
- 2.16.3 With just emergency lighting in operation, and at night, measure the "average" illumination on the floor or tread (by establishing the maximum and minimum) level in the following locations, using a portable, illuminance photometer, cosine corrected, static or optical lensed, digital readout, tested, calibrated and certified accurate to within 2%, or video camcorder, together with suitable software for illuminance measurements data to be obtained.
 - 2.16.3.1 Exits.
 - 2.16.3.2 Principal routes providing access to exit in an open floor area, or in a 'suite'.
 - 2.16.3.3 Public corridors.
 - 2.16.3.4 Floor areas or parts thereof where the public may congregate.

2.17 GENERAL TESTING

- 2.17.1 With the system completely connected and lamped, perform the following tests:
 - 2.17.1.1 Control and switching - circuits shall be tested for the correct operation of devices, switches and controls. Test is required for minimum 10% similar applications.
 - 2.17.1.2 Polarity tests - sockets shall be tested for correct polarity. Test is required for minimum 10% similar applications.
 - 2.17.1.3 Voltage test - The maximum drop in potential permitted will be in conformance with OESC for 120/208V branch circuits and 347/600V feeder circuits. Test shall be passed for the longest circuit for each rating as a minimum. Any deficiency in this respect shall be corrected.
 - 2.17.1.4 Phase balance – measure the load on each phase at each switchboard, distribution panelboard and lighting and power panelboard, and rearrange phase connections as necessary to balance the load on each phase. After making any such changes, make available to the Owner's representative drawings or marked prints showing the modified connections.
 - 2.17.1.5 Supply voltage - measure the line voltage of each phase at the load terminals of the main breaker and report the results in writing to the Owner's representative. This test shall be carried out when all electrical equipment are in use.
 - 2.17.1.6 Motor loading - measure the line current of each phase of each motor operating under load and report results in writing to the Owner's representative. Upon indication of any imbalance or overload, thoroughly examine the electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the architect.

- 2.17.1.7 General operations - energize and put into operation each and every electrical circuit and item. Necessary repairs, alterations, replacements, tests and adjustments required shall be made for complete and satisfactory operating systems.

2.18 FIRE ALARM SYSTEM

- 2.18.1 For factory and site testing, ensure that Testing Engineer is a member in good standing of Canadian Fire Alarm Association (CFAA).
- 2.18.2 Be present and witness factory testing of all hardware and software components of the system.
- 2.18.3 Prepare data sheets in duplicate with spaces to record:
 - 2.18.3.1 Date.
 - 2.18.3.2 Manufacturer's name and system number.
 - 2.18.3.3 Control panel serial number.
 - 2.18.3.4 Data gathering panel (DGP) serial number(s).
 - 2.18.3.5 Annunciator serial number(s).
 - 2.18.3.6 Testing methodology, results of tests and remedial work undertaken.
 - 2.18.3.7 Signatures of testing and manufacturer's Engineers indicating concurrence with results of tests, and that some equipment is at site that was factory tested.
- 2.18.4 Conform with latest issue CAN/ULC -S537 "Standard for the Verification of Fire Alarm System Installations".
- 2.18.5 At the completion of the installation of all system equipment and devices and after the connection to all elevators, motors, fans, ventilation and smoke controls, test and verify the entire system using the supervisory services of the manufacturer.
- 2.18.6 After the testing and verification task is completed, and all deficiencies rectified, notify the electrical Owner's representative and the Fire Department, and in their presence demonstrate the proper functioning of the entire system.
- 2.18.7 Provide upon completion of the verification procedures, an approved certificate of verification to the Owner's electrical representative. Display one copy near the control panel, and retain a copy with the system documentation. Provide an equipment schedule listing each device and showing confirmation that it was verified.
- 2.18.8 Inspect and test the wiring to every device to verify that removal of the device or breaking the wire will cause the trouble signals to operate on open circuit, short circuit, ground fault or the removal of any plug-in component. Inspect wiring to ensure that individual terminations have been provided for all conductors and that where applicable correct polarities have been observed.
- 2.18.9 Inspect all equipment installed as part of the system for visible damage or tampering which might interfere with its intended operation.
- 2.18.10 Test devices which are field adjustable to ensure that their settings are acceptable under ambient conditions at the location of installation.
- 2.18.11 Operate each and every manual initialing device to verify their proper operation.
- 2.18.12 Use a heat source to test the operation of each and every resettable or self- restoring heat detector. For non-resettable type, simulate the detectors operation by shorting terminals on the detector base.

- 2.18.13 For each and every area type smoke detector, test detector sensitivity according to the manufacturer's recommendations. Test detector operation by introducing recommendations. Test detector operation by introducing "smoke" into the detector. For duct smoke detectors check field sensitivity against air velocity to establish the correct relationship as required by the manufacturer.
- 2.18.14 Test flame detectors as per manufacturer's recommendation.
- 2.18.15 Test all audible signal appliances for acceptable operation. Determine that the signal is audible throughout the building above normal ambient noise, and verify that adequate power is available from both normal and standby sources under the maximum system load.
- 2.18.16 Make installation of additional signals or revisions to power sources to ensure audibility prior to completion of the inspection before a certificate of verification can be issued.
- 2.18.17 Test annunciators to ensure proper operation, voltage, zoning and visibility of all legends.
- 2.18.18 Inspect the system power supply to ensure that it is properly fused, locked away from unauthorized interruption, adequate to meet system requirements and separated from auxiliary device power source such that a fault in such circuit cannot affect fire alarm system control unit power.
- 2.18.19 Inspect battery units for protection from accidental damage and for adequate ventilation. Connect batteries permanently to a properly fused charging circuit dedicated to the alarm system batteries.
- 2.18.20 Simulate ground, shorts and breaks on alarm and signaling circuits to ensure proper operation of trouble signals.
- 2.18.21 Test all control equipment for acceptable operation. inspect and test of all cable terminals, plug connectors, plug-in circuits, lamp sockets and controls to confirm that their mechanical and electrical connections and mounting are acceptable, and where applicable to confirm their electrical supervision.
- 2.18.22 Verify that field wiring is terminated on a single conductor per terminal basis.
- 2.18.23 Test all lamps and indicators for acceptable operation. Operate all control functions to verify correct response. Perform simulation of open circuits, short circuits and ground fault on all relevant components to confirm proper trouble circuit response.
- 2.18.24 Test ancillary equipment connections for proper operation. Inspect such equipment to ensure that faults in it will not interfere with alarm system operation.
- 2.18.25 Test the fire hall connection and any other outgoing connections for acceptable operation.
- 2.18.26 Test elevator controls for acceptable operation.
- 2.18.27 Test damper controls and annunciation for acceptable operation.
- 2.18.28 Test fan shutdown and smoke mode systems for acceptable operation.
- 2.18.29 Test sprinkler flow switches, supervisory valves and pressure switches for acceptable operation.
- 2.18.30 Inspect and test interconnections between control panels, and annunciators for continuity.
- 2.18.31 Test signals from generator and engine for "trouble" and "running", signals from fire pump(s) for "power off" and "running", and signals to any security, fire alarm, intercom, music and dimming systems for correct operation.
- 2.18.32 On completion of all tests and verification provide the Owner's representative with a certificate of test and verification and proof of liability insurance for tests and verification.

2.19 BATTERIES

- 2.19.1 Check battery voltage and specific gravity of each cell in accordance with manufacturer's instructions.

- 2.19.2 Float charge battery to ensure battery fully charged and in stable condition.
- 2.19.3 Discharge battery at rated load for 2 hour.
- 2.19.4 Check battery voltage and specific gravity of each cell.

2.20 BATTERY CHARGERS

- 2.20.1 Energize battery charger and operate until battery shows full charge.
- 2.20.2 Discharge battery to full discharge condition.
- 2.20.3 Recharge battery, recording DC voltage and current once per hour for 8 hours. Test battery to ensure it has reached at least 95% full charge.
- 2.20.4 Continue charging to ensure charger changes from equalize rate to float charge rate.
- 2.20.5 Demonstrate that automatic timer controls charging and correctly transfers from equalize to float charge after selected period.
- 2.20.6 Simulate faults to demonstrate that alarm lights and audible alarms are performing as designed
- 2.20.7 At end of tests with battery in fully charged condition, operate charger on "float" for minimum period of 24 hours to ensure stable condition is reached and held.

2.21 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- 2.21.1 Prepare data sheets in duplicate with spaces to record:
 - 2.21.1.1 Date
 - 2.21.1.2 UPS, make, model, serial No.
 - 2.21.1.3 Voltage input and output. Confirm it matches building voltage.
 - 2.21.1.4 Rating of UPS kW, kVA, frequency, P.F. Confirm it matches engineer's specification.
 - 2.21.1.5 The manufacturer's engineers and the Owner's representative's signature shall be on the completed forms to indicate concurrence in results of test, and that same equipment is at site, that was factory tested.
- 2.21.2 Verify that there is adequate space to service the equipment.
- 2.21.3 Inspect equipment for damage and repair, replace or repaint as required.
- 2.21.4 Confirm air filters are new and in place.
- 2.21.5 Inspect interior and insure it is free from dirt, dust, debris and check for loose connections and components.
- 2.21.6 Verify the rating and integrity of the following:
 - 2.21.6.1 Input power cables
 - 2.21.6.2 Input fuses
 - 2.21.6.3 Harmonic filter, if equipped
 - 2.21.6.4 DC bus input cables
 - 2.21.6.5 Bypass panel cables
 - 2.21.6.6 Output power cables
 - 2.21.6.7 Neutral and chassis ground bonded at one point

- 2.21.6.8 Chassis ground is present and ground straps between cabinets have been installed
- 2.21.6.9 Output fuse connections.
- 2.21.7 UPS batteries are to be inspected and checked for:
 - 2.21.7.1 Visible indication of container damage, cracks, deformation, etc.
 - 2.21.7.2 Visible indication of leakage.
 - 2.21.7.3 Check for ground faults in the battery rack
 - 2.21.7.4 Check resistance between (+) terminal and rack
 - 2.21.7.5 Check resistance between (-) terminal and rack
 - 2.21.7.6 Check all battery cable terminations.
- 2.21.8 Measure input and bypass voltage to ensure it is within specifications.
- 2.21.9 Verify phase sequence is ABC.
 - 2.21.9.1 Verify battery charger DC voltage and voltage polarity are correct.
 - 2.21.9.2 Start-up UPS and verify load is protected on UPS power.
 - 2.21.9.3 Stop inverter and verify load has been transferred to by phase.
 - 2.21.9.4 With the unit running on protected UPS power open main feeder to the UPS and verify load operates on battery.
- 2.21.10 Operate EPO button and verify loss of power from the UPS output terminals.
- 2.21.11 Test operation of placing UPS on maintenance bypass and back to protected UPS power.
- 2.21.12 Use control panel to obtain the following readings:
 - 2.21.12.1 Input voltage VBC, BVC and VCA
 - 2.21.12.2 Bypass voltage VAN, VBN and VCN
 - 2.21.12.3 Bypass voltage VAB, VBC and VCA
 - 2.21.12.4 Inverter voltage VAN, VBN and VCN
 - 2.21.12.5 Inverter voltage VAB, VBC and VCA
 - 2.21.12.6 Load voltage VAN, VBN and VCN
 - 2.21.12.7 Input current 11, 12 and 13
 - 2.21.12.8 Bypass current 11, 12 and 13
 - 2.21.12.9 Inverter current 11, 12 and 13
 - 2.21.12.10 Load current 11, 12 and 13
 - 2.21.12.11 Load Crest Factor 11, 12 and 13
 - 2.21.12.12 Frequency INP, BYP, and INV
 - 2.21.12.13 Load kW P1, P2, and P3
 - 2.21.12.14 Load kVA P1, P2 and P3
 - 2.21.12.15 Power Factor
 - 2.21.12.16 Battery UBAT, IBAT, T BAT

- 2.21.12.17 Operate unit at 25 degrees C for four hours at full load using appropriate load bank.
- 2.21.12.18 Perform battery drain test to confirm batteries perform as specified.

PART 3 - **END OF SECTION**

PART 1 - GENERAL

1.1 SUBMITTALS

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

1.2 Product Compatibility

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

PART 2 - PRODUCTS

2.1 ELECTRONIC TIMERS

- 2.1.1 Electronic timers for indoor applications to control lighting loads or motor loads (where occupancy sensor is not suitable or required) to be provided as required for applications. Electronic timers to be CSA approved types with features as follows:

- 2.1.1.1 flush mounting into single gang wall box;
- 2.1.1.2 solid state electronics with LCD display;
- 2.1.1.3 8 interval presets;
- 2.1.1.4 tamper resistant time-on interval can be preset;
- 2.1.1.5 flicker of lights and/or beep audible warning begins 2 minutes before time-out;
- 2.1.1.6 no minimum loads required;
- 2.1.1.7 complete with decorator type face with matching faceplate.

- 2.1.2 Acceptable manufacturers are:

- 2.1.2.1 Tork;
- 2.1.2.2 Intermatic;
- 2.1.2.3 Paragon Electric;
- 2.1.2.4 Or approved equivalent.

2.2 WALL BOX DIMMERS

- 2.2.1 ULC listed and labelled, CSA approved wall box dimmers as follows:

- 2.2.1.1 of type and size to suit intended loads;

- 2.2.1.2 air gap accessible without removing faceplate, to meet UL20 and UL1472 short circuit test requirement for snap switches;
- 2.2.1.3 withstand voltage surges up to 600 V and current surges up to 200 A as per ANSI/IEEE C62.41;
- 2.2.1.4 voltage regulated;
- 2.2.1.5 power failure memory;
- 2.2.1.6 LC filtering to minimize RFI;
- 2.2.1.7 linear slide with smooth and continuous square law dimming curve operation;
- 2.2.1.8 snap on faceplate (seamless multi-gang at locations with multiple devices);
- 2.2.1.9 finish to Consultant's direction.
- 2.2.2 Where noted for applications of multiple wall box dimmers located in one location, provide CSA approved, NEMA 2 type, flush wall mounting, electrical cabinet with hinged locking front door, of painted enamel painted steel construction, complete with conduit knockout entries, flush trim and sized to accommodate dimmers. Refer to applicable drawing detail.
- 2.2.3 Acceptable manufacturers are:
 - 2.2.3.1 Legrand-Watt Stopper;
 - 2.2.3.2 Lutron;
 - 2.2.3.3 Acuity Brands;
 - 2.2.3.4 Or approved equivalent.
- 2.3 OCCUPANCY SENSORS**
 - 2.3.1 CSA approved devices to provide automatic control of lighting with following components:
 - 2.3.1.1 power and slave packs;
 - 2.3.1.2 dual technology occupancy sensors;
 - 2.3.1.3 controls and daylight sensors;
 - 2.3.1.4 wiring in conduit and mounting hardware.
 - 2.3.2 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 emergency power circuits and normal power circuits.
 - 2.3.3 For applications in general areas: ceiling mounted, dual technology type sensors as follows:
 - 2.3.3.1 combination passive infrared and ultrasonic technologies;

-
- 2.3.3.2 when both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;
 - 2.3.3.3 low voltage or line voltage operation to suit specific applications;
 - 2.3.3.4 360° lens area coverage, extending out up to 6 m (20') and area of 92.9 m² (1000 ft²);
 - 2.3.3.5 low profile ceiling mounting design;
 - 2.3.3.6 integral light sensor;
 - 2.3.3.7 adjustable sensitivity and digital time delay;
 - 2.3.3.8 walk-through mode;
 - 2.3.3.9 LED indication of occupancy detection;
 - 2.3.3.10 isolated relay for interconnection to auxiliary control systems where required.
- 2.3.4 For applications in washrooms and small storage rooms: wall mounted dual technology sensors as follows:
- 2.3.4.1 wall switch sensor turns lights OFF and ON based on occupancy;
 - 2.3.4.2 factory default operation is for Manual-ON mode, so that users turn light on only when needed;
 - 2.3.4.3 variety of control options including Auto-ON operation, walk-through and test mode; additional settings allow choice of which sensing technologies hold ON or retrigger lighting;
 - 2.3.4.4 colour matched lens and low profile design;
 - 2.3.4.5 wide dispersion lens area coverage, extending out up to 10 m (35') and area of 37 m² (400 ft²);
 - 2.3.4.6 infrared and ultrasonic technologies;
 - 2.3.4.7 adjustable time delays and sensitivity;
 - 2.3.4.8 manual pushbutton operation (override);
 - 2.3.4.9 low voltage or line voltage operation to suit specific applications;
 - 2.3.4.10 complete with required mounting accessories.
- 2.3.5 For controlling 2 independent light loads/circuits in one space/room: dual technology occupancy sensors as follows:
- 2.3.5.1 dual relay, infrared and ultrasonic technologies wall switch sensor;

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- 2.3.5.2 when both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;
 - 2.3.5.3 colour matched lens and low profile design;
 - 2.3.5.4 wide dispersion lens area coverage, extending out up to 10 m (35') and area of 37 m² (400 ft²);
 - 2.3.5.5 adjustable time delays and sensitivity;
 - 2.3.5.6 manual pushbutton operation (override);
 - 2.3.5.7 selectable walk-through, test and presentation modes;
 - 2.3.5.8 low voltage or line voltage operation to suit specific applications;
 - 2.3.5.9 complete with required mounting accessories.
- 2.3.6 For corridors or wide space coverage: Ceiling mounted, ultrasonic technology type sensors as follows:
- 2.3.6.1 ultrasonic technologies;
 - 2.3.6.2 when ultrasonic technology detects occupancy, lights turn ON automatically; once lights are ON, detection holds lights ON until occupancy is no longer detected and time delay elapses;
 - 2.3.6.3 low voltage or line voltage operation to suit specific applications;
 - 2.3.6.4 corridor applications to include linear lens area coverage, extending out up to 13.5 m (45') in 2 directions;
 - 2.3.6.5 wider spaces applications to include wide dispersion coverage to suit space, up to 200 m² (2200 ft²);
 - 2.3.6.6 low profile ceiling mounting design;
 - 2.3.6.7 integral light sensor;
 - 2.3.6.8 adjustable digital time delay;
 - 2.3.6.9 LED indication of occupancy detection;
 - 2.3.6.10 isolated relay for interconnection to auxiliary control systems where required.
- 2.3.7 For outdoor control of lighting: outdoor motion sensor:
- 2.3.7.1 weatherproof and raintight enclosure;
 - 2.3.7.2 operating temperature from minus 40°C to 54°C (-40°F to 130°F);
 - 2.3.7.3 adjustable head,
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- 2.3.7.4 with minimum 270° of coverage;
- 2.3.7.5 adjustable light level from 5.4 lux to 2150 lux (0.5 fc to 200 fc);
- 2.3.7.6 isolated relay with NO and NC outputs;
- 2.3.7.7 13 mm (1/2") threaded conduit nipple for attachment to standard weatherproof electrical box with faceplate;
- 2.3.7.8 voltage rating to suit application.
- 2.3.8 Override switches to be wall mounting in single gang recessed outlet boxes.
- 2.3.9 Day light sensors to be provided where required for dimming or controlling lights in areas of windows and atriums/sky lights.
- 2.3.10 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.
- 2.3.11 Relays to be provided as required to integrate sensors to BAS. Coordinate exact requirements with central lighting control system vendor and BAS vendor.
- 2.3.12 Wiring in conduit, mounting hardware and ancillary devices to be provided as per manufacturer's requirements.
- 2.3.13 System to be complete with initial 1 year parts and labour warranty, with additional extended 5 years parts warranty.
- 2.3.14 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.
- 2.3.15 Where sensors are interconnected to dimming system, ensure that they are 100% compatible with respective control systems, dimmers and LED drivers. Confirm with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.
- 2.3.16 Where devices are connected to lighting control system, acceptable device manufacturers to be as recommended by manufacturers of the lighting control system.
- 2.3.17 Generally, acceptable manufacturers are:
 - 2.3.17.1 Legrand-Watt Stopper;
 - 2.3.17.2 Lutron;
 - 2.3.17.3 Acuity Brands;
 - 2.3.17.4 Leviton;
 - 2.3.17.5 Or approved equivalent.

2.4 DIGITAL LIGHTING CONTROLS

2.4.1 CSA approved devices to provide digital lighting management system for automatic control of lighting in larger areas and corridors to suit specific applications as per system manufacturer's recommendations. Include for but not be limited to providing following components:

- 2.4.1.1 controllers;
- 2.4.1.2 dual technology occupancy sensors;
- 2.4.1.3 controls and daylight sensors;
- 2.4.1.4 power and slave packs;
- 2.4.1.5 wiring in conduit and mounting hardware.
- 2.4.1.6 Low voltage digital wall switches as follows:
 - 2.4.1.6.1 ON/OFF low voltage buttons to control individual or multiple loads;
 - 2.4.1.6.2 IR transceiver for wireless configuration and control;
 - 2.4.1.6.3 LED status indicators;
 - 2.4.1.6.4 single gang decorator wall plates;
 - 2.4.1.6.5 configuration button for "Push n' Learn";
 - 2.4.1.6.6 with number of button switches as required;
 - 2.4.1.6.7 RJ45 connectors.
- 2.4.1.7 Low voltage digital dimming wall switch as follows:
 - 2.4.1.7.1 for dimming control of one or more lighting loads;
 - 2.4.1.7.2 to raise or lower light levels, recall a preset level and turn lights on or off;
 - 2.4.1.7.3 IR transceiver for wireless configuration and control;
 - 2.4.1.7.4 LED status indicators;
 - 2.4.1.7.5 LED bar graph to indicate light level;
 - 2.4.1.7.6 single gang decorator wall plates;
 - 2.4.1.7.7 configuration button for "Push n' Learn";
 - 2.4.1.7.8 RJ45 connectors.
- 2.4.1.8 Digital wireless configuration tool as follows:

- 2.4.1.8.1 digital handheld wireless tool for remote configuration of system, that enables system and device modifications via pushbutton, without ladders or tools;
- 2.4.1.8.2 configures sensors, switches, controllers;
- 2.4.1.8.3 intuitive navigation pad provides interface for users to view current system parameters of system network and make changes by navigating through simple menus;
- 2.4.1.8.4 adjustable occupancy sensor parameters include sensitivity, time delay and trigger modes;
- 2.4.1.8.5 dimming parameters include low/high trim, preset level and lamp burn in time;
- 2.4.1.8.6 daylighting adjustments include operating mode, setpoints, fade times and time delays;
- 2.4.1.8.7 adjusts light level of dimmed loads;
- 2.4.1.8.8 OLED screen;
- 2.4.1.8.9 2-way IP communication via IR transceiver;
- 2.4.1.8.10 Battery operated;
- 2.4.1.8.11 Includes batteries, carrying case and belt clip.
- 2.4.1.9 Emergency lighting control unit as follows:
 - 2.4.1.9.1 self-contained device that permits lighting control devices to control lighting fixtures connected to emergency power source as well as fixtures connected to normal power source;
 - 2.4.1.9.2 upon loss of normal power, unit functions to maintain operation of designated emergency lights or activates operation of connected emergency lights;
 - 2.4.1.9.3 push to test operation button feature;
 - 2.4.1.9.4 LED indication for emergency and normal power operation.

2.4.2 Digital Sensors:

- 2.4.2.1 For applications in general areas: Ceiling mounted, digital, dual technology type sensors as follows:
 - 2.4.2.1.1 low voltage operating with 360° lens area coverage;
 - 2.4.2.1.2 low profile ceiling mounting design;
 - 2.4.2.1.3 combination passive infrared and ultrasonic technologies;
 - 2.4.2.1.4 "Plug n'Go" automatic configuration;

- 2.4.2.1.5 "Push n' Learn" configuration functionality;
- 2.4.2.1.6 IR transceiver;
- 2.4.2.1.7 LED indicators;
- 2.4.2.1.8 LCD display and pushbuttons for setup;
- 2.4.2.1.9 integral light sensor;
- 2.4.2.1.10 isolated relay for interconnection to auxiliary control systems if required;
- 2.4.2.1.11 walk-thru and test mode functions;
- 2.4.2.1.12 adjustable sensitivity and digital time delay;
- 2.4.2.1.13 RJ45 connectors.

2.4.3 Switching and dimming photo sensor as follows:

- 2.4.3.1 multi-zone (3) switching and dimming open loop digital photo sensor;
- 2.4.3.2 monitors the daylight contribution through a window or skylight and works with room controller to maintain design light levels in each lighting zone;
- 2.4.3.3 daylight responsive on/off, bi-level, tri-level or dimming control;
- 2.4.3.4 60 degree spatial response;
- 2.4.3.5 IR transceiver for wireless configuration and control;
- 2.4.3.6 "Plug n'Go" automatic configuration;
- 2.4.3.7 LED status indicators;
- 2.4.3.8 RJ45 connectors.

2.4.4 Digital input/output interface:

- 2.4.4.1 allows seamless integration with third party devices to provide additional functionality in digital lighting management system;
- 2.4.4.2 Plug n' Go configuration;
- 2.4.4.3 Push n' Learn functionality for personalizing system settings to accommodate application needs
- 2.4.4.4 self-contained switching power supply and relay system
- 2.4.4.5 five status LEDs and configuration LED;

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- 2.4.4.6 Hold-on/Hold-off, occupancy sensor, time clock, load shed, cleaning switch and key switch modes available through DIP switch configurations;
 - 2.4.4.7 over-current protection;
 - 2.4.4.8 plenum rated.
 - 2.4.5 Low Voltage Switches:
 - 2.4.5.1 low voltage, quiet, single-pole, double throw momentary contact switch used with low voltage lighting control panels;
 - 2.4.5.2 appearance matches conventional toggle switches and fits standard switch plate openings;
 - 2.4.5.3 key operated type where required.
 - 2.4.6 Fire alarm interface module to interconnect fire alarm such that activation of fire alarm will initiate lighting control system to go into emergency sequence, typically raising dimmed lighting to full brightness and returning lighting levels back to levels before fire alarm event;
 - 2.4.7 Additional system interfaces, modules and connectors as required to integrate other components to provide a complete system.
 - 2.4.8 Include pre-terminated cables and segment network wire, and junction boxes as required completing system connections.
 - 2.4.9 Power packs to be self-contained, 347/120VAC/24VDC (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 emergency power circuits and normal power circuits.
 - 2.4.10 Override switches to be wall mounting in single gang recessed outlet boxes.
 - 2.4.11 Day light sensors to be provided where required to dim or control lights in areas of windows and atriums/sky lights.
 - 2.4.12 Provide wiring, mounting hardware, connectors, jacks, and ancillary devices as per manufacturer's requirements. Wiring to be typically minimum CAT 5e unshielded twisted pair conductors terminated with RJ45 connectors. Comply with manufacturer's installation requirements. Submit block wiring diagram of system as part of shop drawings.
 - 2.4.13 System to be complete with initial 1 year parts and labour warranty, with additional extended 5 years parts warranty.
 - 2.4.14 Include costs 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.
 - 2.4.15 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.
 - 2.4.16 Acceptable manufacturers are:
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- 2.4.16.1 Legrand-Watt Stopper;
- 2.4.16.2 Lutron;
- 2.4.16.3 Acuity Brands;
- 2.4.16.4 Leviton;
- 2.4.16.5 Or approved equivalent.

2.5 LOW VOLTAGE LIGHTING RELAYS AND SWITCHES

2.5.1 CSA approved, factory tested relays and associated devices for low voltage lighting control, as follows:

- 2.5.1.1 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;
- 2.5.1.2 24 V, momentary contact, switches, single, ivory pushbutton type with pilot and location light LEDs;
- 2.5.1.3 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs;
- 2.5.1.4 24 V, momentary contact, ivory toggle type switches;
- 2.5.1.5 number of gangs as required, suitable for switches specified and complete with mounting brackets and matching screws;
- 2.5.1.6 power supplies sized as required;
- 2.5.1.7 wiring in conduit, in accordance with system manufacturer's requirements;

2.5.2 Acceptable manufacturers are:

- 2.5.2.1 Legrand Watt Stopper;
- 2.5.2.2 Acuity Brands;
- 2.5.2.3 Lutron;
- 2.5.2.4 Leviton;
- 2.5.2.5 Or approved equivalent.

2.6 LOW VOLTAGE LIGHTING CONTROL SYSTEM

2.6.1 CSA approved, automatic lighting control system and integrated factory pre-wired, assembled and tested panels for low voltage lighting control.

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- 2.6.2 Control system software and central programming computer terminal provides full system automation and control of panels. Software provides Windows compatible factory created custom colour screens and graphics with reports, schedules, operating conditions. Software allows user friendly programmable and automatic control of system panels and connected lighting circuits. Control station terminal includes:
- 2.6.2.1 Pentium 4 class PC terminal complete with minimum 500 GB hard drive, minimum 512 MB RAM; exact terminal requirements to be as per system manufacturer's recommendations;
 - 2.6.2.2 Windows operating system software;
 - 2.6.2.3 DVD/CD/R/W drive;
 - 2.6.2.4 minimum 480 mm (19") LCD flat panel display monitor;
 - 2.6.2.5 PC connectivity, TCP/IP connections, historical and runtime accumulation, graphic programming and control;
 - 2.6.2.6 interface cards, I/O devices and connecting cables as required;
 - 2.6.2.7 other ancillary devices to provide a full and functional system.
- 2.6.3 CSA approved, factory pre-wired, assembled and tested panels for low voltage lighting control, as follows:
- 2.6.3.1 NEMA 1 enamelled painted steel tubs for relay panels, with hinged, key lockable, surface or flush mounting cover and drip shield;
 - 2.6.3.2 panel interiors consisting of motherboard with relay LED status indication, colour coded connections, card slots and barrier to separate voltage levels;
 - 2.6.3.3 panels sized suitable for up to forty-eight (48) relays as required;
 - 2.6.3.4 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;
 - 2.6.3.5 colour coded and labelled terminals with push-on connections;
 - 2.6.3.6 panel identification card in plastic pouch affixed inside of cover;
 - 2.6.3.7 barrier for separation of high voltage (class 1) and low voltage (class 2) wiring;
 - 2.6.3.8 screwless, removable plug-in connections for low voltage terminations;
 - 2.6.3.9 DIN rail mounted contactors, NO or NC as required and compatible with and of rating to suit lighting, ballasts and loads being connected and controlled;
 - 2.6.3.10 power supply as required to supply sufficient power to system components;
 - 2.6.3.11 master ON/OFF group switching card to sequence or any number of relays in a panel ON/OFF without requiring handheld device or special programming tools; pushbutton controls with LED indicators to be provided for group operation and status;
 - 2.6.3.12 individual direct overrides to be provided for each relay or per group as zoned on drawings;

- 2.6.3.13 group switching card;
- 2.6.3.14 interface modules, network clock, photocontrol package as required to provide automatic control, distributed processing and communications with central system control software, other panels and Mechanical Division building automation system;
- 2.6.4 Additional system components to include but not be limited to following:
 - 2.6.4.1 24 V, momentary contact, switches, single, ivory pushbutton type with pilot and location light LEDs;
 - 2.6.4.2 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs, and removable lens cap for labelling each switch with laminated tape;
 - 2.6.4.3 24 V, momentary contact, ivory toggle type switches;
 - 2.6.4.4 number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;
 - 2.6.4.5 wiring in conduit, in accordance with system manufacturer's requirements;
 - 2.6.4.6 programming and interfacing module cards for integration to BMS to suit required system sequence of operation of lighting circuits;
 - 2.6.4.7 confirm sequence of operation with Consultant.
- 2.6.5 System panels to be sized to accommodate 20% future components.
- 2.6.6 Supply with shop drawings, detailed wiring diagrams and floor plans identifying lighting controls and lighting panels being integrated to and any mechanical systems interconnections. Include sample proposed graphic displays with shop drawing submission. Final sequence of operation and layout of graphics to be approved by Consultant prior to start of Work.
- 2.6.7 Acceptable manufacturers are:
 - 2.6.7.1 Legrand Watt Stopper;
 - 2.6.7.2 Acuity Brands;
 - 2.6.7.3 Lutron;
 - 2.6.7.4 Leviton;
 - 2.6.7.5 Or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION OF WALL BOX DIMMERS

- 3.1.1 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. Confirm faceplate colour prior to ordering.

- 3.1.2 Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.1.3 Where identified, provide central enclosure cabinet for mounting dimmers within and connect complete. Clearly identify each dimmer and enclosure with engrave Lamacoid nameplates. Confirm exact nomenclature with Consultant prior to ordering.
- 3.1.4 When installation is complete, check and test operation of each dimmer and adjust as required.
- 3.1.5 Ensure that each dimmer is properly sized to suit connected load.

3.2 INSTALLATION OF OCCUPANCY SENSORS

- 3.2.1 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.
- 3.2.2 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.
- 3.2.3 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.
- 3.2.4 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.
- 3.2.5 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.
- 3.2.6 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.
- 3.2.7 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.
- 3.2.8 Confirm finishes of sensors with Consultant prior to ordering.
- 3.2.9 Confirm mounting heights with Architect and manufacturer prior to roughing-in and installation.
- 3.2.10 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.

- 3.2.11 After installation is complete, provide for manufacturer's authorized representative to inspect, test and verify system performance and installation.
- 3.2.12 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.
- 3.2.13 Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.3 INSTALLATION OF LOW VOLTAGE LIGHTING CONTROLS

- 3.3.1 Provide low voltage lighting components as required. Connect complete.
- 3.3.2 Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.3.3 Flush mount low voltage switches into wall mounted electrical boxes. Provide suitable mounting bracket and faceplate for each switch. Confirm finishes with Consultant prior to ordering.
- 3.3.4 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. Exact locations to be confirmed with Consultant prior to start of work.
- 3.3.5 Locate locations of boxes on as-builts.
- 3.3.6 Clearly label each box and label low voltage switching circuits.
- 3.3.7 Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.4 Installation of Low Voltage Lighting Control System

- 3.4.1 Provide required components for low voltage control of lighting. Where required, integrate to Mechanical Divisions BAS system. Refer to notes on drawings.
- 3.4.2 Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.4.3 Provide system terminal in location as confirmed with Owner and/or Consultant prior to start of Work. Prepare sample software screens for submission as part of shop drawings. Provide custom programming of system in sequence which is to be confirmed with Owner and/or Consultant prior to start of Work.
- 3.4.4 Provide relay panels for both emergency power and normal power lighting loads being controlled. Initially install tubs during construction work and install interiors during finishing work. Locate panels with dimmer panels as required. Ensure that wall space is sufficient for proper access for service and maintenance as per code requirements. Advise Consultant where spacing is an issue. Provide power, control, and communication wiring in conduit to each panel as required. Confirm exact wiring type and requirements with system manufacturer. Control/communication wiring to generally be daisy chained between panels.

- 3.4.5 Confirm emergency sequence of operation with Consultant prior to start of Work and include required hardware and software and interfaces to other integrated systems. Coordinate interfaces with respective system vendors.
- 3.4.6 Flush wall mount low voltage switches into recessed wall boxes, complete with a mounting bracket and faceplate for each switch. Confirm finishes with Consultant prior to ordering.
- 3.4.7 Locate panels adjacent to branch circuit panelboards to which lighting loads are connected. Clearly identify low voltage switching circuits.
- 3.4.8 Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- 3.4.9 Coordinate work with BAS vendor for required interconnections. Extend wiring in conduit to required interconnection to BAS panels. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.
- 3.4.10 Clearly label each panel and label low voltage switching circuits.
- 3.4.11 Upon completion of installation, provide following:
 - 3.4.11.1 inspection, testing and verification of system;
 - 3.4.11.2 re-verification of failed or replaced components;
 - 3.4.11.3 signed verification report.
- 3.4.12 Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 26 05 00 - Common Work Results for Electrical.
- 1.1.2 Section 26 05 26 - Grounding and Bonding.
- 1.1.3 Section 26 05 31 - Electrical Concrete Products.

1.2 SUBMITTALS

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

1.3 BREAKERS

- 1.3.1 Breakers to be NEMA rated types, and for switchboards and distribution panelboards, breakers when frame sized 225 amperes and greater, to be provided with solid state adjustable trip units with long time, short time and instantaneous time (LSI) functions and time delays. Set trip units at ratings as per coordination study as required for proper coordination. Provide ground fault alarm and trip functions at breaker trip rating above 600A, as coordinated with results of coordination study and as confirmed with Consultant.
- 1.3.2 Size breakers as per drawings and/or schedules, but in absence of direction, size breakers to suit intended application, to suit coordination study requirements and in accordance with local governing electrical safety code.

1.4 DIGITAL CHECK METERS

- 1.4.1 Digital check meters shall be provided at power distribution switchboard/ panelboard for main distributions, mechanical loads, and kitchen loads. Provide digital check meters as noted on drawings.

PART 2 - PRODUCTS

2.1 MAIN SECONDARY SWITCHBOARDS

- 2.1.1 Switchboard requirements are specified herein with additional requirements noted on drawings and in other Sections.
- 2.1.2 Switchboard shall have 50kA interrupting rating. Final interrupting rating shall comply with the coordination study and short circuit calculation performed by the electrical contractor.
- 2.1.3 Switchboards are indoor, metal enclosed, standardized switchboards that are CSA approved and ULC listed and labelled as per code requirements. Switchboards are suitable for use in building ground system with short circuit capacity as scheduled, but in absence of direction, are to suit specific application to local governing electrical code requirements.
- 2.1.4 Where applicable, requirements to comply with local governing electrical utility standards and regulations for incoming electrical services.

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- 2.1.5 Switchboards to comply with and be manufactured in accordance with latest editions of following:
- 2.1.5.1 CSA 22.2 No.31;
 - 2.1.5.2 EEMAC G8-3;
 - 2.1.5.3 ANSI-C37.20/C37.13/C37.17/C37.51;
 - 2.1.5.4 NEMA SG-5/SG-3;
 - 2.1.5.5 UL 1558.
- 2.1.6 Power air circuit breakers are to comply with:
- 2.1.6.1 ANSI-C37.13/C37.16/C37.17;
 - 2.1.6.2 NEMA SG-3;
 - 2.1.6.3 UL 1066.
- 2.1.7 Structure:
- 2.1.7.1 Switchboard consists of individual sections bolted together to form an enclosed, self-contained, self-supporting structure with necessary facilities for proper ventilation. Sections are of modern welded or bolted construction, fabricated from sheet steel in accordance with EEMAC, NEMA and CSA requirements and reinforced wherever necessary to provide adequate strength. Front doors are formed type, fabricated with cold rolled sheet steel and complete with handle lock operators and locking tabs. Rear access is provided with rear doors of hinged type with thumb screw hardware. Unless otherwise required, top and side panels are secured suitably to a channel type base. Refer to drawings for specific access requirements. After fabrication, switchboard is factory cleaned, bonderized, and finished in ANSI grey enamel.
 - 2.1.7.2 Entire enclosure to be in accordance with NEMA 1 or NEMA 2 requirements with additional sprinkler proof requirements. Top of each cell to be complete with a "drip-shield" designed to shed water without dripping on cell. Ventilation louvres to be designed to prevent penetration of water spray from activated sprinklers, onto live components. Doors and component openings to be gasketed.
 - 2.1.7.3 Full height and depth fire retardant and non-hygroscopic barriers are provided in sections, from top to bottom and from front to rear to contain faults and to minimize passage of ionised gases between vertical sections.
 - 2.1.7.4 Where required to suit onsite access restrictions, switchboard to be shipped to site in sections, and assembled on site.
- 2.1.8 Future Cells:
- 2.1.8.1 Provide bus terminations for future extensions and gasketed water-tight removable side panels to accommodate installation and connection of future cells.

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- 2.1.8.2 Where future breakers are indicated, provide bus, necessary provisions and blank covers.
 - 2.1.8.3 Where required, drill and plate main bus and switchboard for provision for future extension of additional vertical cell sections at each end of switchboard.
 - 2.1.9 Bus Bars:
 - 2.1.9.1 Main bus bars are constructed of top quality, 98% pure, rectangular copper bars, silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers to ensure maximum pressure and even current distribution at each joint. Bus and connections are designed so that maximum temperature rise in any part of switchboard will not exceed 65C° (117F°) over an ambient temperature of 40°C (104°F). Bus is properly isolated and designed to carry currents as required.
 - 2.1.9.2 Continuous ground bus not less than 6 mm (1/4") x 50 mm (2") cross section area extending length of switchboard and is solidly bolted to steel framework. Ground bus is constructed of same material as main bus and is complete with suitable lugs for grounding connections outlined on drawings. Ground bus is rated for momentary current rating equal to or greater than that of apparatus in switchboard.
 - 2.1.9.3 Supply required bolts, nuts, and washers for field connection of bus joints between cells.
 - 2.1.10 Control Wiring:
 - 2.1.10.1 Each cell to be complete with required control wiring and terminal blocks. Control wiring is type "SIS", minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
 - 2.1.10.2 Terminal blocks are pressure type and complete with removable marking strips.
 - 2.1.10.3 Shorting blocks are enclosed barrier type within control cubicle.
 - 2.1.11 Switchboard Arrangement and Components:
 - 2.1.11.1 Switchboard cell arrangements and components are as detailed on drawings.
 - 2.1.11.2 Do not run main bussing lower than 300 mm (12") above finished floor level.
 - 2.1.12 Main and Tie Breakers:
 - 2.1.12.1 Air circuit breakers, with electrically operated, stored energy, fixed mounted breaker assembly mounted behind a full sized flanged type heavy gauge steel panel and a nameplate giving breaker rating. Where current limiting is required for greater interrupting rating to suit specific application, provide air circuit breakers with integral current limiting fuses as per manufacturer's standards.
 - 2.1.12.2 Breaker assembly consists of an operating mechanism, 3-pole units, and a solid-state adjustable tripping unit. Operating mechanism provides 2-step stored energy closing. One (I) stroke of operating handle charges spring, after which breaker may be closed by pushing a button. A tripping button and a breaker position indicator are provided. Breaker has facilities for padlocking in open position.
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- 2.1.12.3 Breakers are complete with a microprocessor based solid state tripping unit having adjustable tripping functions including but not limited to, long time pick-up, long time delay, short time pick-up, short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay. Trip settings are to be as determined by distribution system testing and coordination study. Include for required trip settings and settings as required to provide a coordinated protective devices throughout electrical distribution system as required by local governing electrical code and authorities.
- 2.1.12.4 Tripping unit includes three (3) sensors, one (1) on each phase conductor, arranged such that a trip signal from any sensor opens all three (3) poles of breaker.
- 2.1.12.5 Trip unit includes LED indication of mode and trip and a display panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring. Complete system selective coordination is provided with individually adjustable time/current shaping solid state elements. Unit contains an integral test panel with selector switch and pushbutton. Unit is with auxiliary power module for power source. Trip unit includes emergency monitoring and display of peak demand, present demand and energy consumption.
- 2.1.12.6 Main and tie breakers are UL listed for application of 100% of its trip setting and are capable of carrying its full rated ampere capacity, indefinitely without tripping. No external source of power is to be necessary to trip breaker in event of a fault or overload. Necessary tripping energy to be derived from monitoring current transformers provided with breaker. Breaker is operated with a two-step stored energy mechanism to provide a maximum five cycle closing and is provided with colour coded breaker status indicators to indicate position of contacts.
- 2.1.12.7 Actuator mechanically trips breaker when a tripping pulse is emitted by trip unit. When solid-state unit does not have an instantaneous tripping element, it has a discriminator feature to provide instantaneous tripping only when breaker is being closed into a fault. Trip unit includes test plug terminals to permit convenient field checking of calibration, and is equipped with long, short, instantaneous, time delay, ground fault functions and ground tripping indication determined and required to suit distribution system testing and coordination study.
- 2.1.12.8 Breakers are provided with a 120 V fused secondary control circuit transformer for breaker closing and tripping current.
- 2.1.12.9 Provide shunt trip operators, as required.
- 2.1.12.10 Provide electrically operated breaker pushbuttons, manual trip button, breaker position indicators, breaker 'open/close' lamps, and "push to test" lights. Breaker open operators to be equipped with safety cover to prevent in advertent operation.
- 2.1.12.11 Emergency charging handle provided for manual charging if control power is lost. A manual closing lever is included to permit closing circuit breaker with compartment door closed.
- 2.1.12.12 Accessories supplied with breakers consist of manufacturer standard items, including three (3) spare fuses of each type and size used in each switchboard. Control fuses are form II HRC types.

2.1.13 Utility Metering Provisions:

- 2.1.13.1 Confirm with and coordinate local electrical utility requirements and provide as required.
- 2.1.13.2 Metering cells for utility metering and current and potential transformers and associated fuses to suit utility requirements and respective applications. Supply CT's/PT'S to switchboard manufacturer, for factory installation into metering cells, and secondary to be connected to terminal blocks. Provide minimum 38 mm (1-1/2") diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
- 2.1.14 Circuit Breakers Distribution Section:
 - 2.1.14.1 Circuit breaker distribution section consists of moulded case, bolt on circuit breakers with an interrupting capacity as scheduled and frame size to suit application. Refer to Part 1 for requirements of breakers to be provided with solid state adjustable trip units.
 - 2.1.14.2 As noted on the single line diagram, selected breaker assembly consists of an electrically operated, stored energy, operating mechanism, so that the breaker can be controlled by the automatic source transfer control.
- 2.1.15 Switch and Fuse Distribution Section:
 - 2.1.15.1 Switch and fuse section with quick-make, quick-break, visible contact load break switches with operating handles and facilities for locking in either ON or OFF position, and unless otherwise noted, HRC Form I, Class J current limiting fuses.
- 2.1.16 Current and Potential Transformers:
 - 2.1.16.1 Potential transformers are of compartment type and incorporate current limiting fuses.
 - 2.1.16.2 Current transformers have ratios to suit application, a mechanical rating equal to momentary rating of circuit breakers, and be insulated for full voltage rating of switchgear.
 - 2.1.16.3 Current and potential transformers for local electrical utility metering are to be supplied by utility and are shipped to switchboard manufacturer's factory for factory mounting and connection.
- 2.1.17 Incoming and Outgoing Conductor Connection Facilities:
 - 2.1.17.1 Provide required facilities and hardware for cable in conduit and/or bus duct as shown and noted.
- 2.1.18 Surge Protective Devices (SPD):
 - 2.1.18.1 Switchboards to be complete with integral SPD unit installed in dedicated cell. Unit to be factory installed and connected onto bussing through integral disconnect as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts. Unit to be maintenance free. Additional features include following:
 - 2.1.18.1.1 Type 1;

- 2.1.18.1.2 In accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
- 2.1.18.1.3 Maximum voltage protection rating to not exceed 700 V (120/208 V system) or 1500 V (600/347V system); (L-N, L-G, N-G);
- 2.1.18.1.4 Minimum nominal discharge current rating of 10 kA;
- 2.1.18.1.5 Minimum short circuit current rating of 100 kA;
- 2.1.18.1.6 Peak surge current 250 KA per phase;
- 2.1.18.1.7 High-performance EMI/RFI noise rejection filter;
- 2.1.18.1.8 indicator LED on units to identify protection integrity status of metal-oxide varistors; indicator to be visible on front of switchboard;
- 2.1.18.1.9 Standard manufacturer's minimum 5 years parts and labour warranty.

2.1.19 Lightning Protection:

- 2.1.19.1 For switchboards fed from feeders extending from exterior of building, provide Ohio Brass or equivalent, metal oxide polymer lightning protection arrestors of rating to suit application and as recommended by switchboard manufacturer.

2.1.20 Accessories:

- 2.1.20.1 Manufacturer's standard accessories, spare parts and maintenance tool kit.
- 2.1.20.2 Wall mounting spare fuse rack.
- 2.1.20.3 Manufacturer's installation drawings.

2.1.21 Testing, Start-up, Verification and Training:

- 2.1.21.1 Perform standard factory testing and submit copy of detailed reports to Consultant for review.
- 2.1.21.2 Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor.
- 2.1.21.3 Be present to assist during third party testing.
- 2.1.21.4 Perform testing at times coordinated with Consultant.
- 2.1.21.5 Provide instructions on system operating and maintenance.

2.1.22 Mimic Bus and Nameplates:

2.1.22.1 Red, single line vinyl bus approximately 3 mm (1/8") thick x 9 mm (3/8") wide, representing internal bussing and components, riveted to front of switchboard and extending through handles of respective breakers; engraved Lamacoid nameplates to be secured with stainless steel screws, adjacent each panel component and identifying each component.

2.1.22.2 Finish colours, sizes, and nomenclature to be confirmed with Consultant.

2.1.23 Acceptable manufacturers are:

2.1.23.1 Eaton (Cutler-Hammer);

2.1.23.2 Schneider Electric (Square D);

2.1.23.3 Siemens Electric Ltd;

2.1.23.4 ABB;

2.1.23.5 Or approved equivalent.

2.2 AUTOMATIC TRANSFER SWITCHES

2.2.1 CSA approved, automatic transfer and bypass isolation switch, double-throw, electrically operated, mechanically held, fully protected, complete with voltage sensing relays, a manual transfer facility incorporating spring handles, current ratings as indicated, arc chutes, magnetic blow-out coils and components necessary to provide proper performance and operation. Automatic transfer and bypass isolation switch to conform to CSA requirements including latest edition of CSA Standard, C22.2 No. 178, "Automatic Transfer Switches" and be sized on drawings.

2.2.2 Transfer switches to be of withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system coordination study prepared as part of scope of Work.

2.2.3 Automatic transfer and bypass-isolation switch to be provided to manually permit convenient electrical bypass and isolation of automatic transfer that could not otherwise be tested and maintained without interrupting load. Bypass of load to either normal and emergency power source with complete isolation of automatic transfer switch to be possible regardless of status of automatic transfer switch. Bypass isolation to permit proper operation by one (1) person through movement of a maximum of two (2) handles at a common dead front panel. Entire system to consist of two (2) elements, automatic transfer switch and bypass-isolation switch, which is to be furnished completely factory interconnected and tested.

2.2.4 Automatic transfer switch to consist of a power transfer module and a control module, interconnected to provide complete automatic operation. Automatic transfer switch to be mechanically held and electrically operated by a single solenoid mechanism energized from source to which load is to be transferred. Switch to be rated for continuous duty and be inherently double throw. Switch to be mechanically interlocked to ensure only one (1) of two (2) possible positions - normal or emergency. Automatic transfer switch to be suitable for use with emergency sources such as an engine or turbine driven generator source or another utility source.

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- 2.2.5 Control panel consists of a digital microprocessor controller with LCD display. Panel to be supplied with a protective cover and be mounted separately from transfer switch for ease of maintenance. Interconnecting wiring harness to include a keyed disconnect plug to enable control panel to be disconnected from transfer switch for routine maintenance. Sensing and control logic to be provided on printed circuit boards. Interfacing relays to be industrial grade plug-in type with dust covers.
- 2.2.6 Main contacts to transfer in 70 milliseconds or less and to be protected by separate arcing contacts with arc barriers between poles. Inspection of contacts (movable and stationary) and coils to be possible from front of switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle to be provided for maintenance purposes. Handle to permit operator to stop contacts at any point throughout entire travel to properly inspect and service contacts when required.
- 2.2.7 Automatic transfer switches and bypass isolation switches utilizing components of moulded case circuit breakers, contactors, or parts thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.
- 2.2.8 Sensing and control logic panel to utilize solid-state sensing to initiate emergency mode of operation upon reduction of normal source to below 90% of nominal voltage and retransfer to normal when normal source restores to 90% and above of nominal. Pick-up voltage to be adjustable from 85%-100% of nominal and dropout voltage to be adjustable from 75%-98% of pick-up value.
- 2.2.9 Transfer switch to be complete with following features:
- 2.2.9.1 time delay one (1) to override momentary normal source outages to delay transfer switch and engine starting signals; adjustable from 0.5-6 seconds and initially set at 1 second;
 - 2.2.9.2 time delay (2B) for controlled time of load transfer to emergency; adjustable from 0-8 minutes and initially set at 0 minutes;
 - 2.2.9.3 time delay (2E for unloaded running time delay for emergency generator cool-down; adjustable from 0-30 minutes and initially set at 5 minutes;
 - 2.2.9.4 time delay (3A) on retransfer to normal source set to automatically by-pass if emergency source fails and normal source is available; adjustable from 0-30 minutes and initially set at 5 minutes;
 - 2.2.9.5 an engine start contact which closes on normal power failure to initiate engine start-up;
 - 2.2.9.6 selector switches to perform "TEST", "AUTO", "RESET", "MANUAL(or OFF)" and "ENGINE START" functions;
 - 2.2.9.7 pilot lights (P/L) to indicate switch positions;
 - 2.2.9.8 suitable connections for conductors specified;
 - 2.2.9.9 frequency relay to prevent emergency load transfer until frequency of emergency source has reached its set value;
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- 2.2.9.10 in-phase monitoring of motor load with generator for transfer from normal to emergency and vice versa, by means of a monitor to sample relative phase angle and frequency different and to signal transfer switch to close when two (2) voltages are at required phase angle;
- 2.2.9.11 two-way bypass isolation switch to permit load to be connected to either normal or emergency source, to permit transfer switch to be removed from service without power feedback to transfer switch connections, and to provide a transfer test position to enable testing transfer switch operation under no load conditions;
- 2.2.9.12 overlapping neutral contacts as required;
- 2.2.9.13 auxiliary contacts as required to operate connected systems such as alarms, with provision of at least two (2) normally open and two (2) normally closed auxiliary contacts;
- 2.2.9.14 indicators to show switch position;
- 2.2.9.15 momentary contact switch to allow built-in time delay on retransfer to normal to be bypassed;
- 2.2.9.16 pilot light to illuminate when load is connected to emergency source;
- 2.2.9.17 engraved Lamacoid nameplates identifying switch and components.
- 2.2.10 Automatic transfer switches supplying power for elevators to be equipped with a selective load disconnect and time delay control circuit to inhibit transfer for a preset amount of time to allow elevator controls to sense contact position of transfer switch to program itself to accommodate up-coming transfer.
- 2.2.11 Transfer switch enclosure to be free standing enamelled steel, minimum NEMA 1 cubicle with sprinkler-proof provisions including drip shield, ventilation louvers designed to protect live components from water spray from activated sprinklers and gasketed doors and openings. Units to be finished in ANSI grey enamel.
- 2.2.12 Include for manufacturer's authorized representative to provide after installation onsite inspection, testing, start-up, verification, and user training of transfer switches.
- 2.2.13 Acceptable manufacturers are:
 - 2.2.13.1 ASCO Power Technologies Canada;
 - 2.2.13.2 Cummins Onan;
 - 2.2.13.3 Caterpillar;
 - 2.2.13.4 GE (ABB);
 - 2.2.13.5 Or approved equivalent

2.3 DISTRIBUTION TRANSFORMERS

- 2.3.1 Dry type transformers as per drawing schedule, CSA approved and/or ULC listed and labelled, constructed and factory tested in accordance with latest requirements of following:

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- 2.3.1.1 CSA Standard C9;
 - 2.3.1.2 CAN/CSA C22.2 No. 47;
 - 2.3.1.3 CAN/CSA-C802.2
 - 2.3.1.4 UL 1561;
 - 2.3.1.5 NEMA TP1;
 - 2.3.1.6 Local governing authority codes and standards.
- 2.3.2 Dry type transformers to be complete with:
- 2.3.2.1 minimum NEMA 3R enclosure with a rigid end frame, removable plates, a terminal compartment; ventilation louvres designed to prevent penetration of water spray from activated sprinklers onto live parts, and gasketed doors and component openings;
 - 2.3.2.2 Class "H", 220°C class, silicone type coil insulation, such that winding temperature rise to not exceed 150°C(270°F) and enclosure temperature rise not exceed 65°C(117°F) under full load in a 40°C (104°F) ambient temperature;
 - 2.3.2.3 top mounted factory painted drip shield for floor mounted transformers; bottom mounted drip tray for wall/ceiling mounted transformers.
- 2.3.3 Features for each transformer include:
- 2.3.3.1 copper windings;
 - 2.3.3.2 core construction consisting of stacked laminations of high permeability silicone steel;
 - 2.3.3.3 vacuum impregnated polyester or epoxy resin;
 - 2.3.3.4 lugs or pressure type terminals to suit primary and secondary conductors;
 - 2.3.3.5 four (4) 2-1/2% full capacity taps; two (2) above normal and two (2) below normal; taps located on primary winding;
 - 2.3.3.6 an integral vibration dampening system with anti-vibration pads used between core and enclosure;
 - 2.3.3.7 seismic restraint requirements to suit local governing authority requirements and codes;
 - 2.3.3.8 unless otherwise noted, sound level and basic impulse level to meet CSA C9 requirements; unless otherwise noted, transformers 300 kVA and larger to have noise level 3dB below CSA C9 requirements;
 - 2.3.3.9 efficiency meeting or exceeding CSA C802.2;
 - 2.3.3.10 factory painted with an ANSI grey enamel finish;
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- 2.3.3.11 aluminum nameplate indicating impedance rating, weight, connection diagram, style and serial number, riveted to front of enclosure.

2.3.4 Additional features include and as noted on the drawings:

- 2.3.4.1 K factor 13 rating as per ANSI/IEEE C57-110;
- 2.3.4.2 electrostatic shielding;
- 2.3.4.3 neutral sized for twice rated current;
- 2.3.4.4 common mode noise attenuation 60 dB minimum.
- 2.3.4.5 full load voltage regulation not more than 1% at 80% power factor.

2.3.5 Acceptable manufacturers are:

- 2.3.5.1 Hammond Power Solutions;
- 2.3.5.2 Schneider Electric;
- 2.3.5.3 REX Power Magnetics;
- 2.3.5.4 STI Power;
- 2.3.5.5 Or approved equivalent.

2.4 DISTRIBUTION PANELBOARDS

- 2.4.1 Factory assembled dead front panelboards as per drawing schedules, manufactured to CSA Standard C22.2. No. 29. Generally, interrupting capacities are scheduled, but in absence of direction, provide to capacity to suit intended application to suit local governing electrical code.
- 2.4.2 Circuit breaker type distribution panelboards to be single or double row as required and complete with moulded case, bolt-on circuit breakers calibrated for 40°C (104°F) ambient temperature and conforming to CSA Standard C22.2 No. 5 (Note No. 1). Locate both main lugs and neutral bar at same end. Shield main lugs through a removable cover. Identify each circuit breaker adjacent breaker handle. Refer to Part 1 for requirements of breakers to be provided with solid-state adjustable trip units. Group mount circuit breakers.
- 2.4.3 Switch and fuse type distribution panelboards, complete with quick-make, quick-break, visible contact load break switches with operating handles projecting through dead front panel and interlocked with switch mechanism, facilities for padlocking in either ON or OFF position, and, unless otherwise noted, HRC Form I, Class "J" fuses.
- 2.4.4 Distribution panelboards of rating greater than 1200 amperes rating to be switchboard types as specified for the Secondary Switchboards.
- 2.4.5 Panelboard interior to have three flat bus bars stacked and aligned vertically with insulators laminated between phases. Insulators support and provide phase isolation to entire length of bus. A solidly bonded equipment ground bar and a neutral bar to be provided.

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- 2.4.6 Bus bars (phases, grounds and neutrals) to be hard drawn electrical grade copper, silver plated and extend throughout panel.
- 2.4.7 Interior trim to be of dead-front construction to shield user from energized parts. Main circuit breaker and main lug interiors to be field convertible for top or bottom incoming feed.
- 2.4.8 Panelboard boxes to be constructed of code gauge, hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements, complete with removable ends and wiring gutter space on sides in accordance with CSA requirements. Panelboards in kitchen to be provided with stainless steel trims and NEMA 2 enclosure.
- 2.4.9 Floor mounted enclosures to be free-standing type, reinforced as required to provide adequate strength.
- 2.4.10 Include main breakers for panelboards as scheduled. Main breakers to be automatic moulded case breakers with solid state trip units as specified in Part 1 article.
- 2.4.11 Enclosures located in climate controlled areas to be minimum NEMA 1. Surface mounted panelboards to be complete with drip shield. Ventilation louvres to be designed to prevent penetration of water spray onto live components. Conduit entries to be sealed watertight. Units to be factory painted in ANSI grey enamel. Recessed backboxes (tubs) need not be finished painted.
- 2.4.12 Distribution panelboards sized 600 A and less and panelboards not located in secured electrical rooms/closets require doors. Panelboards sized up to 600A and panelboards located in unsecure areas to be complete with doors, latches, and keyed alike locks. Locks to be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. Supply 2 keys with each lock.
- 2.4.13 Panelboards to include for future breaker provisions as noted on schedules. Make provision for space for breakers, bussing for full panel size and where spare breakers are scheduled, breakers with required connector kits. Unused spaces provided, unless otherwise specified, to be fully equipped for future devices, including appropriate connectors and mounting hardware.
- 2.4.14 Panelboards as scheduled to be complete with integral surge protective devices (SPDs). Unit to be factory installed and connected onto bussing through integral disconnect/breaker as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts. Unit to be maintenance free. SPD features include:
- 2.4.14.1 Type 1;
- 2.4.14.2 in accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
- 2.4.14.3 maximum voltage protection rating to not exceed 700 V (120/208 V system) or 1500 V (600/347V system); (L-N, L-G, N-G);
- 2.4.14.4 minimum nominal discharge current rating of 10 kA;
- 2.4.14.5 minimum short circuit current rating of 100 kA;
- 2.4.14.6 peak surge current 150 KA per phase;
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- 2.4.14.7 indicator LED on units to identify protection integrity status of metal-oxide varistors; indicator to be visible on front of panelboard;
 - 2.4.14.8 high-performance EMI/RFI noise rejection filter;
 - 2.4.14.9 standard manufacturer's minimum 5 years parts and labour warranty.
 - 2.4.15 Acceptable manufacturers are:
 - 2.4.15.1 Eaton (Cutler-Hammer);
 - 2.4.15.2 Schneider Electric (I-Line Series);
 - 2.4.15.3 Siemens Electric Ltd;
 - 2.4.15.4 ABB;
 - 2.4.15.5 Or approved equivalent.
 - 2.5 BRANCH CIRCUIT PANELBOARDS**
 - 2.5.1 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.
 - 2.5.2 As scheduled, panelboards are of types:
 - 2.5.2.1 120/208 V, 3-phase and single phase with 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;
 - 2.5.2.2 347/600 V, 3-phase panelboards with bolt-on moulded case circuit breakers with an interrupting capacity as scheduled or in absence of direction to be of capacity for intended application to local governing electrical code requirements.
 - 2.5.2.3 Panelboards shall be 60 circuits with 22kA interrupting rating except the reference noted or scheduled on drawings. Final interrupting rating shall comply with the coordination study and short circuit calculation performed by the electrical contractor.
 - 2.5.2.4 200A and above breakers will have electronic adjustable type trip, and 200A below breakers will have thermal magnetic trip.
 - 2.5.3 Where ground fault circuit interrupting (GFCI) type breakers are required by code and/or scheduled, provide ground fault, CSA Class "A", Group 1, combination thermal magnetic bolt-on circuit breakers with solid-state ground fault interrupters.
 - 2.5.4 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.

- 2.5.5 Panels fed from K13 transformers will have 200% neutrals, except panels for kitchen appliances, mechanical equipment and specific loads have no major harmonic impact.
- 2.5.6 For climate controlled areas, panelboards are to be complete with NEMA 1 enclosure, with sprinkler-proof provisions including gasketed openings. Surface mounted panels to include drip shields.
- 2.5.7 Panelboards in kitchen to be provided with stainless steel trims and NEMA 2 enclosure.
- 2.5.8 For non-climate controlled areas, panelboards are to be complete with NEMA 3R enclosure.
- 2.5.9 Panels, doors and trim are to be factory painted with ANSI grey enamel finish. Recessed backboxes (tubs) need not be finished painted.
- 2.5.10 Equip breakers of frame size 225 amperes and greater, with solid state adjustable trip units.
- 2.5.11 Equip circuit breakers connected to dedicated equipment or devices with handle locks.
- 2.5.12 Acceptable manufacturers are:
 - 2.5.12.1 Eaton (Cutler-Hammer);
 - 2.5.12.2 Schneider Electric (Square D);
 - 2.5.12.3 Siemens Electric Ltd.;
 - 2.5.12.4 ABB;
 - 2.5.12.5 Or approved equivalent.

2.6 DISCONNECT SWITCHES

- 2.6.1 Heavy duty, CSA approved, disconnect (safety) switches. Features include:
 - 2.6.1.1 front operated with a handle suitable for padlocking in "OFF" position and arranged so that enclosure cover cannot be opened while handle is in "ON" position
 - 2.6.1.2 operating mechanisms: quick-break, positive acting with visible blades and a line terminal shield;
 - 2.6.1.3 fusible units with fuse clips suitable for HRC fuses, unless otherwise noted;
 - 2.6.1.4 ampere rating, number of poles and fuse requirements as indicated on drawings;
 - 2.6.1.5 factory primed and painted switch enclosures.
- 2.6.2 Disconnects for variable speed drives to be suitable for use with such drives and include auxiliary switch/contact to de-energize control power circuit, as required and as applicable.
- 2.6.3 Enclosures for disconnects mounted in interior climate controlled areas and standard non-climate controlled areas to be NEMA 3R. For corrosive environmental applications, enclosures to be minimum NEMA 4X.

2.6.4 Acceptable manufacturers are:

- 2.6.4.1 Eaton (Cutler-Hammer);
- 2.6.4.2 Siemens Electric Ltd.;
- 2.6.4.3 Schneider Electric (Square D);
- 2.6.4.4 ABB;
- 2.6.4.5 Or approved equivalent.

2.7 FUSES

- 2.7.1 Unless otherwise indicated, fuses to be Form I, Class "J" HRC fuses for constantly running equipment, and Form II, Class "C" HRC fuses for motorized equipment that cycle "ON" and "OFF".
- 2.7.2 Fuses to be of type suitable for applications as required by local governing electrical codes and in coordination with respective equipment manufacturer's recommendations in which fuses are required. Coordinate also with Mechanical Division Contractor for requirements for Mechanical Division equipment.
- 2.7.3 Fuses to be of product of one manufacturer.
- 2.7.4 Acceptable manufacturers are:
 - 2.7.4.1 Mersen (Ferraz Shawmut);
 - 2.7.4.2 English Electric Ltd.;
 - 2.7.4.3 Noram;
 - 2.7.4.4 Cooper Bussmann;
 - 2.7.4.5 Or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHBOARDS

- 3.1.1 Provide switchboards and locate into positions. Base layout, design, connections and requirements for supplied accessories from documents and reviewed shop drawings. Carefully examine drawings and site conditions to ensure that equipment can be positioned into their designated positions, without difficulty. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance.
- 3.1.2 Coordinate cable entry location to match incoming conductors. Allow sufficient space for required cable bending radii and connections.

- 3.1.3 Assemble individual sections of switchboard in accordance with manufacturer's recommendations and instructions, and secure assembly to concrete base. Ensure that bus joint bolts are torqued to manufacturer's prescriptions.
- 3.1.4 Provide seismic restraints as required by local governing authorities and codes.
- 3.1.5 Coordinate delivery and installation of local electrical utility supplied metering transformers.
- 3.1.6 Arrange for switchboard manufacturer to provide necessary drawings for erection and installation of switchboard. In addition, if required, obtain from manufacturer necessary copies of detail, erection, etc., drawings required for approval of installation from local electrical utility and any other authority having jurisdiction. Obtain required approvals.
- 3.1.7 Install controls and displays at height of between a minimum 1200 mm (4') to a maximum of 1800 mm (6') above finished floor level.
- 3.1.8 Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.
- 3.1.9 Ground and bond equipment to ground electrode grids as per local governing electrical code and inspection authority requirements. Refer also requirements of grounding and bonding article.
- 3.1.10 Install and test SPD as per manufacturer's instructions.
- 3.1.11 Test remote alarms.
- 3.1.12 Test automatic source transfer control and sequence of operation.
- 3.1.13 Arrange switchboard in configuration as indicated on drawings and as per reviewed shop drawings.
- 3.1.14 Make necessary incoming and outgoing power cable connections to equipment in strict accordance with equipment and cable manufacturer's recommendations. Ensure connections, bus flanges and terminations are suitable for specific incoming and outgoing cables/bus ducts.
- 3.1.15 Arrange for switchgear manufacturer's personnel to provide inspection and testing of switchboard prior to energizing system.
- 3.1.16 Provide engraved Lamacoid nameplates with nomenclature confirmed with Consultant.
- 3.1.17 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.2 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES

- 3.2.1 Provide transfer switches as required for each application. Refer to drawings for transfer switch ratings and mounting locations. Advise transfer switch manufacturer of coordination study available fault current results to ensure transfer switches are provided of withstand current rating meeting available fault current at location of each transfer switch.
- 3.2.2 Install in accordance with manufacturer's instructions to suit specific applications. Mount stand-alone units to concrete bases. Provide seismic restraints as required. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Connect complete.
- 3.2.3 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.
- 3.2.4 Where required in emergency power distribution system connected to gensets, provide wiring in conduit from genset control panel to appropriate transfer switches contacts to initialise engine start-up upon loss of normal power and provide signals to transfer switches to initiate appropriate operations. Provide MI fire rated conductors to transfer switches used for life safety applications. Where load banks are connected to genset control system during testing, include for required interconnection wiring in conduit for loss of normal power signal to load bank controllers to initiate dropping load bank to pick-up essential building loads.
- 3.2.5 Review electrical systems, fire alarm system and elevator requirements with respective equipment vendors and coordinate required power and control interconnections. Provide required wiring in conduit between system equipment allowing for respective system equipment trades to make final connections to their own equipment. Provide MI fire rated conductors to equipment used for life safety applications.
- 3.2.6 Ground and bond switches as per local electrical code requirements. Refer also to requirements of grounding and bonding Section.
- 3.2.7 When installation is complete, arrange for system manufacturer to visit site to check, test, start-up, and certify system. In presence of Consultant, perform a complete operational test of system to ensure that system operates satisfactorily under operating conditions specified.
- 3.2.8 Coordinate transfer switch testing with engine-generator set testing to ensure that complete emergency power plant operates correctly. Adjust as required.
- 3.2.9 Arrange for manufacturer to provide a letter certifying compliance with requirements of this Specification. Certification to identify, by serial number(s), equipment involved.
- 3.2.10 Provide engraved Lamacoid nameplates with nomenclature confirmed with Consultant.
- 3.2.11 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.3 INSTALLATION OF DISTRIBUTION TRANSFORMERS

- 3.3.1 Locate transformers into position. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Comply with manufacturer's instructions and recommendations.

- 3.3.2 Secure transformers 75 KVA and larger to a concrete housekeeping pad on Vibro-Acoustics Ltd. type "RSR" vibration isolation pads.
- 3.3.3 Secure transformers smaller than 75 KVA in place on an angle wall mounting bracket support assembly located approximately 300 mm (12") below ceiling. Provide support assembly and adequately secure to wall and/or ceiling construction.
- 3.3.4 Provide seismic restraints as required by local governing codes.
- 3.3.5 Ensure that transformers are equipped with lugs or connections suitable for primary and secondary connections. Isolate primary and secondary connections from transformer enclosures by means of 300 mm - 450 mm (12" to 18") of liquid-tight flexible conduit.
- 3.3.6 Ground and bond equipment to ground electrode grids as per local governing electrical code and inspection authority requirements. Refer also requirements of Section entitled – Grounding and Bonding.
- 3.3.7 Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.
- 3.3.8 Provide engraved Lamacoid nameplates and warning signs with nomenclature reviewed with Consultant.
- 3.3.9 When installation is complete, test and check secondary voltages. Make all required adjustments and submit to Consultant a test report indicating secondary voltage readings and any adjustments made to achieve proper voltages. Furthermore, when building is in normal use, re-check voltages and make any required adjustments.
- 3.3.10 Refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.4 INSTALLATION OF DISTRIBUTION PANELBOARDS

- 3.4.1 Provide distribution panelboards and install into locations and connect complete. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance.
- 3.4.2 Install floor mounted panelboards on concrete housekeeping pads. Provide seismic restraints as required by local governing authorities and codes. Surface wall mount other panelboards, unless otherwise noted, independent of connecting conduit.
- 3.4.3 Equip each panelboard with suitable lugs to accommodate main and branch conductors as scheduled. Identify panelboard and breakers with Lamacoid identification nameplate with nomenclature to Consultant's approval.
- 3.4.4 Connect SPD in accordance with manufacturer's instructions and with dedicated breaker.

3.4.5 Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also to requirements of grounding and bonding article.

3.4.6 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.5 INSTALLATION OF PANELBOARDS

3.5.1 Provide factory assembled branch circuit panelboards and install into locations and connect complete. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Load panels with breakers as scheduled.

3.5.2 Support cabinets and enclosures independent of connecting conduit, and accurately install with reference to wall finishes.

3.5.3 Equip panelboards with suitable lugs or provisions to accommodate main and branch conductors scheduled.

3.5.4 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.

3.5.5 Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also requirements of Section entitled – Grounding and Bonding.

3.5.6 Turn over to Consultant, prior to application for a Certificate of Substantial Performance of Work, a quantity of two (2) panelboard cabinet or enclosure keys per panelboard.

3.5.7 Where two (2) or more panelboards are installed in one (1) cabinet, equip panelboards with double lugs and increase gutter capacity to accommodate additional cabling.

3.5.8 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 to Consultant's approval.

3.5.9 Include for spaces for future breakers, spare breakers and additional breakers for miscellaneous mechanical loads are included as per schedules and as specified.

3.5.10 Test and verify ground fault circuit interrupting breakers as follows:

3.5.10.1 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;

3.5.10.2 megger load side neutral on GFCI protected branch circuits to ensure that neutral is not grounded on load side of GFCI;

3.5.10.3 verify GFCI operation with a temporary load (100 watt lamp in an insulated socket with pigtail leads);

3.5.10.4 provide a written report confirming that tests have been performed and that system is functioning properly.

- 3.5.11 Ground and bond panel as per local electrical code requirements. Refer also to requirements of grounding and bonding article.
- 3.5.12 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.6 INSTALLATION OF DISCONNECT SWITCHES

- 3.6.1 Provide disconnects switches and install into locations and connect complete. Ensure adequate clearance is provided as per local code requirements and as required for access for operation and maintenance. Install as follows:
 - 3.6.1.1 wherever shown on drawings and/or specified herein;
 - 3.6.1.2 wherever required by MCC/VFD/starter schedule drawings;
 - 3.6.1.3 for motorized equipment which cannot be seen from motor starter location or is more than 9 m (30') from starter location (in accordance with local governing electrical code requirements);
 - 3.6.1.4 for "packaged" equipment fed from a motor starter panel.
- 3.6.2 Ensure enclosure ratings are suitable for intended applications.
- 3.6.3 Provide engraved Lamacoid nameplate with nomenclature reviewed with Consultant.

3.7 INSTALLATION OF FUSES

- 3.7.1 Install fuses in mounting devices immediately before energizing circuit.
- 3.7.2 Ensure correct fuses fitted to physically matched mounting devices.
- 3.7.3 Ensure correct fuses fitted to assigned electrical circuit.
- 3.7.4 Provide a complete set of fuses for each fusible disconnect, motor starter, and similar fusible equipment provided or supplied.
- 3.7.5 Supply 3 spare fuses of each size and type used on project, mount fuses in cabinet. Secure cabinet in wall location as reviewed with Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 SUBMITTALS

- 1.1.1 Submit shop drawings for products of this Section.
- 1.1.2 Include photometric data, LEDs, and drivers information for each luminaire.
- 1.1.3 Photometric data to include: total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lumen rating in accordance with IESNA testing procedures.
- 1.1.4 Include copy of certification that lenses, and louvers comply with local governing building code requirements for flame spread ratings.
- 1.1.5 For poles, submit documentation that poles supplied are suitable for steady wind velocity and gust velocity of area of installation, and suitable for total effective projected area of mounted lighting equipment.
- 1.1.6 For exterior site areas or parking areas, where luminaires are proposed that are not from based specified manufacturer, provide luminaire manufacturer's computer prepared detailed photometric layout drawings with complete photometry showing performance levels of proposed luminaires. Clearly identify lighting levels, quantity, locations, mounting heights, etc. Identify variances from base design.

1.2 WARRANTY

- 1.2.1 Warranty requirements are as follows:
 - 1.2.1 unless otherwise noted, LED and LED drivers for a period of five (5) years from date of acceptance of Work by Owner for its intended use;
 - 1.2.2 include costs for personnel, equipment and labour for replacing replaceable LED modules drivers covered under warranty;

PART 2 - PRODUCTS

2.1 LUMINAIRES

- 2.1.1 Provide luminaires in accordance with Schedule of Luminaires.
- 2.1.2 Some luminaires as noted or directed by Consultant or identified in other Division documents may be supplied by Owner or under another Division of Work. Include in Bid, Work and materials to accommodate such fixtures, including:
 - 2.1.1 receiving and inspecting fixtures;
 - 2.1.2 complete installation;
 - 2.1.3 providing basic installation hardware not supplied by luminaire manufacturer;

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- 2.1.4 aiming and connecting;
 - 2.1.5 providing power feeders and conduit/boxes;
 - 2.1.6 cleaning, adjusting and testing;
 - 2.1.7 providing lamps where documented or as scheduled, unless otherwise noted or directed by Consultant or supplied with fixture by fixture manufacturer;
 - 2.1.8 provide required power connections and where luminaires are controlled via remote low voltage controller;
 - 2.1.9 include for installation of controller and providing required low voltage wiring in conduit and necessary connections;
 - 2.1.10 coordination of exact requirements with supplier of fixtures and Consultant prior to installation.
 - 2.1.3 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%.
 - 2.1.4 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.
 - 2.1.5 Provide neoprene or silicone gasketting, barriers and stops where required to prevent light leaks or water/water vapour penetration.
 - 2.1.6 Fabricate housings to allow for easy accessibility and replacement of parts.
 - 2.1.7 Reflectors and reflecting cones or baffles to be free of any tooling marks, spinning lines or marks by other assembly techniques. Finishes to be equal to first quality polished, baffled, and anodized "Alzak".
 - 2.1.8 Lenses and louvers to comply with local governing building code and other local governing code flame spread rating requirements.
 - 2.1.9 Unless otherwise noted, construct acrylic lens from 100% virgin acrylic and not less than 3.22 mm (0.125") thick. Glass lenses to be minimum 9.5 mm (0.375") thick.
 - 2.1.10 Recessed luminaires with replaceable/serviceable parts must be accessible from lens side (ie. room side) of fixtures to allow for proper accessibility.
 - 2.1.11 Luminaires to be factory assembled and tested prior to delivery on site.
 - 2.1.12 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.

- 2.1.13 Exit signs are "green running man" pictogram LED type with 120VAC input.
- 2.1.1 Public areas and residence areas: Edge-lit type;
- 2.1.2 Back of house: Extruded aluminium type.
- 2.1.14 When requested, submit luminaire samples.
- 2.1.15 Dimensions for coves, valances, and strips as shown on drawings are for bidding purposes only. Job measure for exact dimensions of louvres, lenses and strips.
- 2.1.16 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.
- 2.1.17 Confirm exact colours and finishes of luminaires with Consultant after award of contract but prior to ordering. Obtain information in time to meet installation schedule.
- 2.1.18 Products of same specified type to be of same manufacturer.

2.2 LEDS AND DRIVERS

2.2.1 General features include:

2.2.1 CSA approved, ULC listed and labelled;

2.2.2 Operating temperature: range through -20°C (-4°F) to 50°C (122°F);

2.2.3 With rapid and changing development of LED technology, provide most technically proven and most advanced and successfully tested LED technology at time of installation;

2.2.4 Specification standards to meet requirements of IES LM 79 and LM-80.

2.2.5 Be 100% compatible with connected dimmer controls to provide dimming down to 1%.

2.2.2 Light emitting diodes (LEDs) features to include:

2.2.1 LEDs to be selected from same colour bin size for consistency in chromaticity and meet ANSI C78 377A as a minimum;

2.2.2 generally, colour temperature range to be from 2700 K to 6500 K; specific temperature requirements to be identified on Schedule of Luminaires;

2.2.3 minimum CRI of 80 ;

2.2.4 rated life (based on 70% lumen depreciation level) from 50,000 to 70,000 hours.

2.2.3 Driver (ballast) features to include:

2.2.1 Operate from 60 Hz input source of 120 VAC with sustained variations of $\pm 10\%$ (voltage and frequency) with no damage to driver;

2.2.2 Output regulated to $\pm 5\%$ across load range;

2.2.3 Power factor greater than 0.90;

2.2.4 Total harmonic distortion less than 20%;

2.2.5 Class A sound rating;

2.2.6 Comply with ANSI C62.41 Category A for transient protection.

2.2.4 Acceptable manufacturers to be as recommended by luminaire manufacturers.

2.3 EMERGENCY LIGHTING UNITS

2.3.1 CSA approved, 120 VAC/12 VDC or 120 VAC/24 VDC as noted on the drawings, emergency lighting battery units. Units are complete with batteries, charger, dual lamp heads per unit (where shown); cabinet and 1.2 m (4') AC cord and plug set. Units to also be complete with automatic testing and self-diagnostic circuitry, and remote monitoring provisions. System to be designed to provide emergency lighting levels in accordance with local governing building requirements.

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- 2.3.2 Chargers are fully automatic, solid-state type that automatically and instantaneously energizes lamp load upon failure of AC supply. Battery protection circuit automatically shuts down lamp load when battery reaches full discharge. Chargers to fully recharge battery in 12-24 hours and be current limited and short circuit proof.
- 2.3.3 Room housing genset and automatic transfer switch to be equipped with emergency lighting battery units and lamps to ensure a minimum lighting level of 50 lux for a period of minimum 2 hours, at equipment locations requiring service and adjustment. Circuit feeding battery unit to be equipped with a transient voltage surge protective device (SPD). Provide SPD unit in accordance with battery unit manufacturer's recommendations to suit CSA C282 requirements. SPD unit to comply with latest requirements of ANSI/IEEE C62.41, cUL 1449, and have maximum surge current of 125 kA/phase.
- 2.3.4 Batteries to be long life sealed lead, maintenance free and have a capacity to supply sufficient output power to lamp loads and to exit sign emergency loads for a period of time in accordance with latest requirements of local governing building code but be a minimum of 30 minutes. Batteries to be designed for and guaranteed for at least 10 years of life expectancy.
- 2.3.5 Cabinets are constructed of No. 18 gauge steel, finished in white enamel. Front cover is removable to provide easy and full access to battery and charger connections. Knockouts are provided on top for lamp heads. Cabinet includes protective wire-guard, where required and/or where identified with "WG" designation on drawings.
- 2.3.6 Units include "PUSH-TO-TEST" switch, AC and high charge pilot lights and AC cordset.
- 2.3.7 Integral lamp heads are 6 W MR16 LED lamps, decorative design, high impact plastic, adjustable heads.
- 2.3.8 Provide remote lamp heads as scheduled in Schedule of Luminaires.
- 2.3.9 Include for manufacturer's authorized representative to perform on-site after installation inspection, testing, adjusting, and verification of equipment. Such work to be performed during premium after hours' time. Refer to Part 3 for additional requirements.
- 2.3.10 Acceptable manufacturers are:
- 2.3.1 Beluca (supplied by Omnilumen);
- 2.3.2 Emergi-lite;
- 2.3.3 Or approved equivalent.
- 2.4 EXIT SIGN UNITS**
- 2.4.1 Exit lights: to CSA C22.2 No. 141 and CSA C860.
- 2.4.2 Housing: cold rolled steel minimum satin aluminum enamel finish.
- 2.4.3 Lamps: - LED-2W, 347V
- 2.4.4 Downlight: white glass in bottom of unit.
- 2.4.5 Graphics: Green pictogram and white graphical symbol and directional arrows to ISO 3864-1. Dimensions to ISO 7010.
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2.4.6 Face plate to remain captive for relamping.

2.4.7 Acceptable manufacturers are:

2.4.7.1 Beluca (supplied by Omnilumen);

2.4.7.2 Or approved equivalent.

2.5 SELF-POWERED UNITS

2.5.1 Exit lights: to CSA C22.2 No. 141 and CSA C860.

2.5.2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish

2.5.3 Lamps: LED-2W

2.5.4 Downlight: white glass in bottom of unit.

2.5.5 Third lamp socket for emergency lamp lighting circuit.

2.5.6 Face plate to remain captive for relamping.

2.5.7 Supply voltage: 120 V, ac.

2.5.8 Output voltage: 24V dc.

2.5.9 Operating time: 2 hours minimum.

2.5.10 Recharge time: 12 hours

2.5.11 Battery: sealed, maintenance free.

2.5.12 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.

2.5.13 Solid state transfer circuit.

2.5.14 Signal lights: solid state, for 'AC Power ON' condition.

2.5.15 Lamp heads: integral on unit

2.5.16 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.

2.5.16.1 Removable or hinged front panel for easy access to batteries.

2.5.17 Auxiliary equipment:

2.5.17.1 Ammeter.

2.5.17.2 Voltmeter.

2.5.17.3 Lamp disconnect switch.

2.5.17.4 Test switch.

2.5.17.5 AC/DC output terminal blocks inside cabinet.

2.5.17.6 RFI suppressor.

2.5.17.7 Cord and single twist-lock plug connection for AC power supply

2.6 Acceptable manufacturers are:

2.6.1 Emergi-lite;

2.6.2 Lumacell;

2.6.3 Beluca (supplied by Omnilumen);

2.6.4 Or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 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.

3.1.2 Before placing luminaire orders:

3.1.1 verify quantity requirements;

3.1.2 thoroughly review ceiling types, finishes and construction details; verify ceiling types with latest Architectural Drawings; order luminaires to suit correct ceiling type;

3.1.3 ensure that required mounting assemblies, frames, rings and similar features are included;

3.1.4 confirm colours and finishes with Consultant.

3.1.3 Include for assembly and mounting of luminaires, complete with:

3.1.1 wiring and connections;

3.1.2 fittings and hangers;

3.1.3 aligners;

3.1.4 box covers;

3.1.5 other accessories required for a complete, safe and fully operational assembly.

3.1.4 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.

3.1.5 Cut holes for recessed luminaires to exact size so that gaps are not visible or luminaire trims cover gaps.

3.1.6 Mount surface ceiling luminaires perfectly level or plumb, tightly to ceiling without showing a space or light leak between frame and ceiling.

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- 3.1.7 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.
 - 3.1.8 Provide spacers for fixtures mounted on low density ceiling material.
 - 3.1.9 Provide plaster frames for recessed fixtures in plaster or gypsum board ceilings.
 - 3.1.10 Prepare fixtures, trim and poles and standards required to be painted.
 - 3.1.11 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.
 - 3.1.12 Splices:
 - 3.1.1 Minimize number of splices.
 - 3.1.2 Make with approved mechanical insulated steel spring type connectors, suitable for temperature and voltage conditions to which splices are to be subjected.
 - 3.1.3 Splices are not to be made unless properly terminated in accessible identified junction boxes.
 - 3.1.13 Support luminaires directly by ceiling slab structure and not to formed steel decking, ceiling hangers, ductwork, piping, cable trays, etc.
 - 3.1.14 Do not tighten wing nuts, bolts, or screws that allow fixture adjustment for recessed adjustable fixtures.
 - 3.1.15 Install spread lenses only where called out on Schedule of Luminaires and Specifications.
 - 3.1.16 Use cloth gloves when handling reflector cones, louvers, glass, sconces and all exposed surfaces of fixtures.
 - 3.1.17 Co-ordinate luminaire installation with work of other trades to ensure that necessary recessing depths and mounting spaces are provided.
 - 3.1.18 Install luminaires in accordance with applicable architectural drawing reflected ceiling plans and/or wall elevations and/or field instructions issued by Consultant. Confirm luminaire locations 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.
 - 3.1.19 Comply with requirements of local governing electrical code regarding support of luminaires in suspended ceilings.
 - 3.1.20 Independently suspend luminaires in suspended ceilings from ceiling slab. For each luminaire, provide minimum two (2) 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.
 - 3.1.21 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.
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- 3.1.22 Locate exit signs in final locations confirmed 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 Consultant's directions.
- 3.1.23 Notify Consultant immediately and relocate if necessary as directed by Consultant, if:
- 3.1.1 fixture placement is in conflict with a structural beam, mechanical duct, plumbing pipe, etc.;
- 3.1.2 space above ceiling is not sufficient;
- 3.1.3 any reason that a fixture cannot be located where it is dimensioned or shown on construction documents.
- 3.1.24 Concrete Bases:
- 3.1.1 Secure poles for pole mounted, exterior type luminaires to concrete bases as detailed.
- 3.1.2 Co-ordinate required work including excavation/backfilling/concrete work to provide bases as shown.
- 3.1.3 Provide anchor bolt covers and anchor bolt templates for proper positioning of anchor bolts in concrete.
- 3.1.4 Refer to concrete base detail found on drawings; this detail is for general requirements only.
- 3.1.5 Include costs for and engage Professional Structural Engineer licensed in Place of Work and with liability insurance, to review and endorse final base design work; review exact details with Consultant; grade levels may be different in various areas.
- 3.1.25 Extend ground conductors from metal parts of poles to building grounding provisions. Generally locate devices in locations on drawings, but base exact locations on coordination and review with Consultant and governing authorities. Confirm luminaires and pole finishes with Consultant prior to ordering. Run wiring in conduit.
- 3.1.26 Provide seismic restraints to suspended luminaires, in accordance with latest local governing building code requirements.
- 3.1.27 Ground and bond luminaires as per local governing electrical code requirements.
- 3.1.28 Test and adjust exterior luminaires at times after sunset, in presence of Consultant and at times acceptable to Consultant.
- 3.1.29 Prior to turn over of Work to Owner, clean luminaires in manner recommended by manufacturer and to satisfaction of Consultant.
- 3.1.30 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.2 INSTALLATION OF EMERGENCY LIGHTING UNITS

- 3.2.1 Provide emergency lighting battery units and lighting heads as specified herein and on Schedule of Luminaires, and mount where required. Connect battery units complete to dedicated emergency circuit of local power panels designated for this purpose or where identified on drawings, plug into designated adjacent receptacle. Provide wiring in conduit and connections to remote lamp heads and extend to central battery unit serving area.
- 3.2.2 Install units such that units to be automatically actuated upon failure of power supply to normal lighting in area covered by that unit equipment.
- 3.2.3 Connect exit signs to battery unit circuits in applications where exit signs require backup DC supply.
- 3.2.4 Install combination units in locations and connect complete.
- 3.2.5 Obtain required training from manufacturer's representative on any special installation procedures. Install units in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.2.6 Note that drawings identify location for battery units and generally identify circuiting of remote heads. In absence of direction of circuiting, provide wiring in conduit to feed remote heads and exit lights from nearest battery unit with sufficient capacity in area, in accordance with application requirements, manufacturer's requirements, and applicable codes. Multiple battery units may be required to accommodate connection of remote heads in some areas. Provide sufficient battery units to accommodate connected lamp loads and system design time of operation. Where more than one battery unit is installed in same immediate location, only one unit is required to be provided with integral lamp heads.
- 3.2.7 Where battery model number is noted, it is for general reference and exact capacity may be required to be increased to suit connected loads and required battery output time duration to suit local governing codes. Ensure that emergency lighting operates at lighting levels and for duration to meet local governing codes.
- 3.2.8 For units serving genset room, provide SPD unit to line side of power supply to battery unit and install and connect in accordance with manufacturer's instructions.
- 3.2.9 Provide remote mounting lamp heads as specified and refer to Schedule of Luminaires where additional requirements may be identified. Connect complete to battery units.
- 3.2.10 Provide wiring in conduit and install devices in accordance to manufacturer's instructions. Comply with local governing codes and authority requirements with regards to providing fire rated conductors (MI) for life safety applications.
- 3.2.11 When installation of emergency lighting equipment is complete, and in conjunction with manufacturer's authorized representative, inspect and test entire system, adjust as required, and certify in writing to Consultant that system is complete, have been tested, adjusted, and are in proper operating condition. The emergency lighting levels shall meet requirements of local building code requirements and applicable CSA Standards.
- 3.2.12 Provide minimum one hard bound copy and electronic copy of signed test report.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- 1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED REQUIREMENTS:

- 1.2.1 Section 26 05 26 - Grounding and Bonding for Electrical Systems
- 1.2.2 Section 27 05 00 – Common Work Results for Communications
- 1.2.3 Section 27 05 26 – Grounding and Bonding for Communications Systems
- 1.2.4 Section 27 11 00 – Communications Equipment Room Fittings
- 1.2.5 Section 27 13 00 – Communication Backbone Cabling
- 1.2.6 Section 27 15 00 – Communication Horizontal Cabling
- 1.2.7 Section 27 21 33 – Wifi Systems
- 1.2.8 Section 27 41 16 – Audio/Video Systems
- 1.2.9 Section 27 41 20 – Digital Signage Systems
- 1.2.10 Section 28 13 00 – Access Control System
- 1.2.11 Section 28 15 00 – Security Intercom System
- 1.2.12 Section 28 23 00 – Video Surveillance System
- 1.2.13 Section 28 24 00 – Resident Wandering System

1.3 SUMMARY

- 1.3.1 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the horizontal cable pathway system of non-continuous cable supports, conduit or cable tray as described in the drawings.
- 1.3.2 The drawings indicate the general route of the raceway system. Data presented on the drawings is as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions, routing, etc. is required.
- 1.3.3 Specifications and drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.3.4 Section Includes:

- 1.3.4.1 Metal conduits and fittings.
- 1.3.4.2 Nonmetallic conduits and fittings.
- 1.3.4.3 Cable pathways, supports and fittings.
- 1.3.4.4 Boxes, enclosures, and cabinets.

1.4 STANDARD AND CODES

- 1.4.1 ANSI/NFPA 70 – National Electrical Code (NEC) 2008
- 1.4.2 ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- 1.4.3 ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process
- 1.4.4 ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel
- 1.4.5 ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- 1.4.6 ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
- 1.4.7 ASTM A 580 – Standard Specification for Stainless Steel Wire
- 1.4.8 ASTM D 769 – Standard Specification for Black Oxide Coatings
- 1.4.9 NEMA VE 1-2002 – Metal Cable Tray Systems
- 1.4.10 NEMA VE 2-2006 – Cable Tray Installation Guidelines
- 1.4.11 UL Compliance – Provide products that are UL-classified and labeled
- 1.4.12 ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- 1.4.13 ANSI J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- 1.4.14 IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management
- 1.4.15 BICSI Telecommunications Distribution Methods Manual

1.5 DEFINITIONS

- 1.5.1 ARC: Aluminum Rigid Conduit.
- 1.5.2 EMT: Electrical Metal Tubing

1.5.3 Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams, and specifications.

1.5.4 GRC: Galvanized Rigid Conduit.

1.5.5 IMC: Intermediate Metal Conduit.

1.5.6 PVC: Polyvinyl Chloride Conduit

1.5.7 RMC: Rigid Metal Conduit.

1.6 DESCRIPTION

1.6.1 This system consists of empty raceways as shown on the drawings and described herein.

1.6.2 Horizontal pathways consist of structure that conceal, protect, support, and provide access to horizontal cables between the telecommunication outlet/connector at the work area and the horizontal cross-connect in the serving area.

1.6.3 Where ceiling areas are used as pathways for telecommunication cables and connecting hardware follow all applicable rules covering installations in both air plenums and non-plenum hollow-ceiling systems as found in the applicable electrical and building codes and standards.

1.7 RESPONSIBILITIES

1.7.1 Responsibility for providing all equipment and associated support, splice, terminating hardware, etc. as necessary to provide a complete and functional cable support system shall be as outlined below:

1.7.1.1 Conduit: Electrical Contractor

1.7.1.2 J-Hooks: Low Voltage Contractor

1.7.1.3 Wire Basket Tray/ Cable Basket Tray: Electrical Contractor

1.7.1.4 Ladder Rack: Low Voltage Contractor

1.7.2 The Electrical Contractor shall be responsible for providing all back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the extra low voltage systems

1.7.3 The contractor installing cable pathways shall be responsible for coordinating installation with general contractor and other trades on the job to ensure pathways are not impeding other systems.

1.8 ACTION SUBMITTALS

1.8.1 Product Data

1.8.1.1 Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.8.1.2 Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:

1.8.1.2.1 Continuous and non-continuous cable pathway and fittings

1.8.1.2.2 All boxes and enclosures.

1.8.1.3 All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

1.8.2 Shop Drawings:

1.8.2.1 For custom enclosures and boxes. Include plans, elevations, sections, and attachment details.

1.8.2.2 Cable pathway (continuous and non-continuous) layout, showing cable pathway route to scale, with relationship between the pathway and adjacent structural, electrical, and mechanical elements. Include the following:

1.8.2.2.1 Vertical and horizontal offsets and transitions.

1.8.2.2.2 Clearances for access above and to side of cable pathways.

1.8.2.2.3 Vertical elevation of cable trays above the floor or bottom of ceiling structure.

1.8.2.2.4 Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.9 INFORMATIONAL SUBMITTALS

1.9.1 Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from the applicable contractors involved:

1.9.1.1 Structural members in paths of pathway groups with common supports.

1.9.1.2 HVAC, plumbing, fire protection, and electrical items and architectural features in paths of conduit groups with common supports.

1.9.2 Source quality-control reports.

1.10 QUALITY ASSURANCE

1.10.1 Installer Qualifications: Low Voltage Contractor must have personnel certified by BICSI on staff.

1.10.1.1 Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.

1.10.1.2 Installation Supervision: Installation shall be under the direct supervision of ITS Registered Technician, who shall be always present when Work of this Section is performed at Project site.

1.10.1.3 Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.10.2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10.3 Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-B and BICSI's Telecommunications Distribution Methods Manual.

1.10.4 Grounding: Comply with NEC, the Authority Having Jurisdiction and ANSI-J-STD-607-A.

1.11 COORDINATION WITH OTHER TRADES

1.11.1 Coordinate the support of cable pathways support systems with the work of other trades.

1.11.2 Coordinate routing of cable pathways with the work of other trades to maintain adequate working clearances above, below and to the sides of cable pathways.

1.11.3 Coordinate with other contractors during the installation coordination meetings to provide input on shared hangers planned for use to support cable pathway systems.

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORT (J-HOOKS)

2.1.1 Acceptable Manufacturers

2.1.1.1 Chatsworth Products, Inc.

2.1.1.2 Cooper B-Line

2.1.1.3 ERICO

2.1.1.4 Panduit

2.1.2 General

2.1.2.1 J-hooks shall have flared edges to prevent damage while installing cables.

2.1.2.2 J-hooks shall have an electro-galvanized or G 60 finish and shall be rated for indoor use for non-corrosive environments.

2.1.2.3 J-hook cable supports shall provide a bearing surface of sufficient width to comply with the bend radii of high-performance cables.

2.1.3 Size

2.1.3.1 J-hooks shall have a minimum bearing surface of 1 ¾ inches.

2.1.3.2 Follow Manufactures recommendations for allowable fill capacity for each size J-hook cable support

2.1.4 Support

2.1.4.1 J-hooks mounted to studs and stud walls: When mounting j-hooks to stud walls the j-hook shall be connected directly to the stud, the j-hook shall not be supported by the wall covering/ finish alone.

2.1.4.2 J-hooks supported by threaded rod: Refer to manufacturer's suggested attachment method to attach J-hook to threaded rod using standard nuts.

2.1.4.3 J-hooks supported using beam attachments shall be:

2.1.4.3.1 Factory or jobsite assembled.

2.1.4.3.2 Hammer or Screw-On, C & Z Perlin, Concrete or Joist support type.

2.1.4.3.3 Use manufacturer approved attachment method.

2.2 WIRE BASKET SUPPORT SYSTEM

2.2.1 Acceptable Manufacturers

2.2.1.1 Cablofil

2.2.1.2 Chatsworth Products, Inc.

2.2.1.3 Cooper B-line

2.2.1.4 G S Metals

2.2.1.5 WBT, LLC

2.2.2 General

2.2.2.1 Provide wire basket of types and sizes indicated, with connector assemblies, clamp assemblies, connector plates and splice bars. Construct units with rounded edges and smooth surfaces and in compliance with applicable standards.

2.2.2.2 Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

2.2.2.3 Bond every section of cable tray to the adjoining tray as per manufacturer's specifications. Bond cable tray to ground at end of every run.

2.2.2.4 Provide cable drop out brackets at every location where cable exits the tray.

2.2.2.5 Material and finish specifications for each wire basket type are:

2.2.2.5.1 Electroplated Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTB B633 SC2.

2.2.2.5.2 Stainless Steel: Straight sections and accessories shall be made from AISI Type 304 Stainless Steel.

2.2.2.5.3 Pre-Galvanized Zinc: Straight sections, wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653. Materials must be cleaned after fabrication to remove any soot, manufacturing residue/oils, or metallic particles.

2.2.2.5.4 Electro-Galvanized Zinc: Straight sections, accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B SC1.

2.2.2.5.5 Paint: Straight sections shall be powder coated over electrodeposited zinc.

2.2.3 Size

2.2.3.1 Wire basket shall conform to the following nominal criteria:

2.2.3.1.1 Wire Basket Support System shall be constructed of a minimum of 0.195" (5mm) steel wire. Cross wire members shall be constructed with a shaped wire to provide a flat surface for cable support.

2.2.3.1.2 Mesh construction: 2 x 4 inches.

2.2.3.1.3 Straight section lengths of standard 8' and 10'.

2.2.3.1.4 Wire basket shall have standard depths of 2, 4 and 6 inches.

2.2.3.1.5 Wire basket shall have standard widths of 4, 6, 8, 12, 18 and 24 inches.

2.2.3.1.6 Fittings shall be field formed or factory fittings.

2.2.3.1.7 All section splices shall be made per manufacturer's standards.

2.2.4 Support

2.2.4.1 Wire basket supports shall be trapeze hangers or wall brackets.

2.2.4.2 Trapeze hangers shall be supported by 1/4 inch or 3/8-inch diameter rods.

2.2.4.3 Special accessories shall be furnished as required to protect, support, and install a complete wire basket support system.

2.2.5 Installation

- 2.2.5.1 Install wire basket as indicated in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical practices.
- 2.2.5.2 Coordinate wire basket with other electrical work as necessary to properly interface installation of wire basket raceway with other work.
- 2.2.5.3 Provide dedicated space encompassing wire basket to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.
- 2.2.5.4 Test wire basket support system to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test method.
- 2.2.5.5 The cross-sectional area of installed cables may not exceed 50% of the cross sectional area of the tray per National Electric Code per (Article 392.9 (B)). All wire basket tray shall be sized to provide a minimum of 50% growth once cable installation included in the scope of work of these documents is complete.

2.3 LADDER RACK SUPPORT SYSTEM

2.3.1 Acceptable Manufacturers

- 2.3.1.1 Cablofil
- 2.3.1.2 Chatsworth Products
- 2.3.1.3 Cooper B-line
- 2.3.1.4 G S Metals
- 2.3.1.5 Wiremold

2.3.2 General

- 2.3.2.1 Provide metal; ladder racking, of types, classes, and size indicated; with splice plates, bolts, nuts, and washers for connecting sections. Construct system maintaining rounded edges and smooth surfaces in compliance with the applicable standards. Ladder rack shall be installed according to the latest revision of NEMA VE-2.
- 2.3.2.2 Ladder tray shall consist of two longitudinal members (side rails) with transverse members (rungs) welded or mechanically fastened to the side rails.
- 2.3.2.3 Straight sections, fitting side rails, rungs and splice plates shall be extruded from aluminum (ASTM B 221 6063 alloy) or shall have stringers made of 16 gauge hot rolled steel tubing and cross members shall be made of 12-gauge cold rolled steel (ASTM A 569).

- 2.3.2.4 The ladder racking shall be available in black and gray painted finishes and clear anodized aluminum finish.
- 2.3.2.5 Bond the ladder rack to ground at end of every run.
- 2.3.2.6 Bond every section of cable rack to the adjoining section as per manufacturer's specification.
- 2.3.2.7 Provide cable drop out brackets at every location where cable exits the tray.
- 2.3.2.8 Provide plastic end caps on side rails ends.

2.3.3 Size

- 2.3.3.1 Ladder rack shall consist of two side rails with transverse rungs welded, or mechanically fastened to the side rails. Rungs shall be spaced at 9 inches on center and shall have a minimum width of 1" for cable laying.
- 2.3.3.2 Straight sections shall be supplied in standard 10-foot lengths.
- 2.3.3.3 Ladder Rack shall be available in 6, 9, 12, 18 and 24-inch widths (as indicated on the drawings).
- 2.3.3.4 All bends and elbows shall have a minimum radius of 12-inches
- 2.3.3.5 All section splices shall be made per manufacturer's standards.

2.3.4 Support

- 2.3.4.1 The ladder racking shall be supported by the side rails or trapeze support by a minimum 3/8 inch threaded rod and at intervals of no more than 5'.
- 2.3.4.2 Special accessories shall be furnished as required to protect support and install a complete ladder rack support system.
- 2.3.4.3 The ladder racking shall be capable of supporting 115 lb/ft when supported at 5' intervals.
- 2.3.4.4 The contractor shall provide manufacturer specific hardware for joining sections of ladder rack in straight lines and at right angles. Hardware shall be provided to mount and join the cable raceway in various configurations and attachment methods to walls, racks, and equipment.

2.3.5 Installation

- 2.3.5.1 Install ladder rack as indicated on drawings. Installation shall be in accordance with equipment manufacturer's instruction, utilizing recognized industry practices to ensure that ladder rack complies with requirements of NEC and applicable portions of NFPA 70B Reference NEMA-VE2 for general ladder rack installation guidelines.
- 2.3.5.2 Coordinate ladder rack installation with other electrical work as necessary to properly integrate installation with other work.

- 2.3.5.3 Provide dedicated space encompassing wire basket to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.
- 2.3.5.4 Ladder rack fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instruction.
 - 2.3.5.4.1 Test ladder rack to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

2.4 BOXES AND ENCLOSURES

- 2.4.1 Acceptable Manufacturers:
 - 2.4.1.1 Cooper Technologies Company; Cooper Crouse-Hinds.
 - 2.4.1.2 Hoffman; a Pentair company.
 - 2.4.1.3 Hubbell Incorporated; Killark Division.
 - 2.4.1.4 RACO; a Hubbell company.
 - 2.4.1.5 Wiremold / Legrand.
- 2.4.2 General Requirements for Boxes and Enclosures:
 - 2.4.2.1 Comply with ANSI/TIA-569-D.
 - 2.4.2.2 Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- 2.4.3 Sheet-Metal Boxes: Comply with NEMA OS 1 and UL 514A.
- 2.4.4 Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- 2.4.5 Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- 2.4.6 Typical Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep (119 mm square by 60 mm deep) unless otherwise noted.
- 2.4.7 Gangable boxes are prohibited.
- 2.4.8 Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- 2.4.9 Enclosures:
 - 2.4.9.1 Comply with UL 50 and NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

- 2.4.9.2 Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- 2.4.9.3 Nonmetallic Enclosures:
 - 2.4.9.3.1 Material: Plastic.
 - 2.4.9.3.2 Finished inside with radio-frequency-resistant paint.
- 2.4.9.4 Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- 2.4.9.5 Fully hinged door in front cover with flush latch and concealed hinge.
- 2.4.9.6 Keyed latch to match equipment racks/ cabinets.
- 2.4.9.7 Metal barriers to separate wiring of different systems and voltage.
- 2.4.9.8 Accessory feet where required for freestanding equipment.
- 2.4.9.9 Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 FLEXIBLE RACEWAY (INNERDUCT)

- 2.5.1 Acceptable Manufacturers
 - 2.5.1.1 CANTEX Inc
 - 2.5.1.2 Carlon Electrical Products.
 - 2.5.1.3 Pyramid Industries.
 - 2.5.1.4 Maxcell
- 2.5.2 Flexible Raceway shall be plenum rated.
- 2.5.3 The rating of the flexible raceway shall match the rating of the surrounding environment which it is installed.
- 2.5.4 Flexible raceway shall meet the requirements:
 - 2.5.4.1 NEC Articles 770 and 800 for Telecommunications Cables.
 - 2.5.4.2 Flexible raceway shall be UL Listed under UL 910 Standard for Plenum Application for Optical Fiber Raceway.
- 2.5.5 Flexible raceway shall be provided with a pull (mule) tape routed throughout the raceway containing footage markings.
- 2.5.6 Flexible raceway fitting and accessories shall be manufactured by the same manufacturer as the flexible raceway.

2.6 CONDUITS/SLEEVES

2.6.1 General

- 2.6.1.1 Conduit/sleeve shall be EMT grade metallic conduit schedule 5 or heavier.
- 2.6.1.2 Any conduit/sleeve installed for communication cabling shall have a coupler on each end with a plastic bushing for cable protection.
- 2.6.1.3 Terminate metal conduit using connectors with plastic bushings.
- 2.6.1.4 Provide nylon or plastic pull strings in all conduit runs.

2.6.2 Fire Wall Penetrations

- 2.6.2.1 Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- 2.6.2.2 Fire stop penetrations seal methods and materials shall be FM-approved and UL listed as applicable and as approved by the authorities having jurisdiction.
- 2.6.2.3 All sealing systems and methods shall be submitted to the engineer for review prior to installation and sealing.

PART 3 - EXECUTION

3.1 INSTALLATION

- 3.1.1 Pathways shall primarily be constructed from wall mounted J-hooks or J-hooks hung from dedicated communications ceiling wire installed with powder-actuated devices, wire basket trays supported by threaded rod or wall brackets, ladder rack supported by threaded rod or wall brackets, or conduit supported as per the NEC.
- 3.1.2 J-hooks shall not be attached to the any drop ceiling grid wiring.
- 3.1.3 In finished areas, provide concealed conduits and flush mount boxes.
- 3.1.4 Conduit installation shall be coordinated with their respective termination equipment layouts at each backboard location as required to provide adequate dedicated space for the mounting of equipment for each system identified on the plans.
- 3.1.5 Cable pathway systems shall be supported by support systems specifically designed and manufactured for the support of cable pathway systems. The cable pathway systems shall not be supported by other installed building systems.
- 3.1.6 Install all pathway systems as per manufacturers recommended practices and as per local governmental regulations and NEC, and BICSI regulations and practices.

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- 3.1.7 All cable pathway routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by the engineer prior to installation of the cabling.
- 3.1.8 Grounding and Bonding
- 3.1.8.1 Ground conduits at terminal boards with grounding bushings.
- 3.1.8.2 Wire basket tray shall be bonded directly to the TMGB or TGB in the telecommunications equipment room that the wire basket tray originates.
- 3.1.8.3 Provide and install a grounding conductor routed through the entire run of all wire basket tray. The grounding conductor shall be bonded to each individual piece of cable basket tray.
- 3.1.8.3.1 Any splices in the grounding conductor shall be protected, readably visible and accessible upon completion of the cable installation.
- 3.1.8.3.2 Refer to specification section "Grounding and Bonding for Communication Systems" for grounding conductor requirements and sizing.
- 3.1.8.4 Ladder rack shall be bonded directly to the TMGB or TGB within the telecommunications equipment room the ladder rack is located.
- 3.1.8.5 Provide a bonding jumper connecting each rail of each piece of ladder rack to one another to form a continuous grounding path.
- 3.1.9 Cable pathways
- 3.1.9.1 A dedicated pathway shall be provided for each Low Voltage communications cabling sub-system, included but not limited to structured cabling systems, security systems, audio visual systems and Low Voltage control systems.
- 3.1.9.2 Cable pathways supporting multiple Extra Low Voltage communications cabling sub systems shall be divided into dedicated sections for each cabling sub system.
- 3.1.9.3 Coordinate locations and sizes with each system's Low Voltage Contractor, Electrical Contractor, General Contractor, -----and the Owner's representative.
- 3.1.10 Non-Continuous Cable Pathways (J-Hooks)
- 3.1.10.1 Non-continuous cable support shall be located at intervals of four (4) feet maximum.
- 3.1.10.2 Non-continuous cable supports shall be installed such that all cable runs through them maintain the minimum clearance to all fluorescent lights and EMF sources as specified below. Any violations of this rule will be corrected at the contractor's Expense.
- 3.1.10.3 Horizontal cabling shall not lay on any ceiling or ceiling tile. All horizontal cabling shall maintain a minimum clearance of 6" above ceiling, ceiling tile and support channels.
- 3.1.10.4 Cable pathways shall not be strapped to or supported by any electrical conduits or any other building service equipment.
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3.1.11 Conduit/ Sleeves

- 3.1.11.1 Any section of conduit longer than 100 feet or containing more than 180 total degrees of bends shall have pull boxes. The contractor shall identify the pull box location(s) on submitted shop drawings for the Architect and Engineer to review.
- 3.1.11.2 Each conduit bend shall be a long sweep radius wherever possible. In no instance shall the inside radius or bend be less than six (6) times the internal diameter of the conduit for conduits that are 2" in diameter or less, for conduits larger than 2" the bend radius shall be no less than 10 (ten) times the inside diameter.
- 3.1.11.3 All communications sleeves shall be of a sized to accommodate the appropriate NEC fill ratios and comply with UL system requirements in rated penetration instances.
- 3.1.11.4 All sleeves shall be of a size as to not have more than 40% of the sleeve filled with Low Voltage cable at the completion of the installation. Provide a minimum of 50% capacity for future growth (minimum of one open sleeve) at each sleeve location.
- 3.1.11.5 All conduits/sleeves shall be secured and strapped to building surfaces per National Electric Code Article 358.30 (A) and (B).

3.1.12 Pull Boxes

- 3.1.12.1 All pull boxes installed in Low Voltage communications conduit runs shall be sized per NEC or Table 4.7 of the BICSI Telecommunications Distribution Methods Manual, which ever requirement results in a larger pull box.
- 3.1.12.2 Provide dedicated space encompassing pull box to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.

3.1.13 Firestopping

- 3.1.13.1 Comply with requirements in Division 07 Section "Penetration Firestopping" and ANSI/TIA-569-D.
- 3.1.13.2 Responsibility for sealing of opening around the exterior of the Low Voltage system sleeves shall be by the contractor as described below:
 - 3.1.13.2.1 Sleeves through fire rated and smoke walls created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
 - 3.1.13.2.2 Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - 3.1.13.2.3 Sleeves of openings between floors created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
 - 3.1.13.2.4 Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.

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- 3.1.13.3 Sealing of the space internal to all sleeves or openings specifically designated for telecommunications cabling shall be the responsibility of the Low Voltage Contractor.
 - 3.1.13.4 Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.
 - 3.1.14 Separation from EMI Sources:
 - 3.1.14.1 Comply with BICSI TDMM and TIA/EIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 3.1.14.2 Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 3.1.14.2.1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - 3.1.14.2.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - 3.1.14.2.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
 - 3.1.14.3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 3.1.14.3.1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - 3.1.14.3.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - 3.1.14.3.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 - 3.1.14.4 Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 3.1.14.4.1 Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 3.1.14.4.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - 3.1.14.4.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
 - 3.1.14.5 Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

3.1.14.6 Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.2 CLEARANCES AROUND CABLE PATHWAYS

- 3.2.1 Clearances shall be provided around all cable pathways to provide continuous access to the cable pathway during and following the installation process. Coordinate required clearances with all other trades prior to beginning work.
- 3.2.2 Provide a minimum clearance of 12" above the entire width of all cable basket tray and ladder tray.
- 3.2.3 Provide a minimum clearance of 6" to one side of all cable basket tray and ladder tray.
- 3.2.4 Provide a minimum clearance of 12" in front of all j-hook cable pathways for the entire height of the j-hook cable pathway.
- 3.2.5 Provide a minimum clearance of 6" above all j-hook cable pathways.
- 3.2.6 Provide a minimum clearance of 24" in front of each pull box location.

END OF SECTION

1 GENERAL

1.1 RELATED DOCUMENTS

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED REQUIREMENTS

Section 27 05 26 - Grounding and Bonding for Communications Systems

Section 27 05 28 – Pathways for Communications Systems

Section 27 11 00 – Communications Equipment Room Fittings

Section 27 15 00 - Communication Horizontal Cabling

1.3 SUMMARY

- .1 Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation and performance. Equipment catalog numbers are listed to establish this minimum.
- .2 Section Includes:
 - .1 UTP cable
 - .2 Fiber Optic Cable
 - .3 Cable connecting hardware, patch panels, and cross-connects.
 - .4 Cabling identification products.

1.4 SUMMARY OF WORK

- .1 Furnish and install complete with all accessories a communication backbone cable system. The backbone cable shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network between designated demarcation points and other locations as indicated on the contract drawings and described herein.
- .2 The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.
- .3 Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.
- .4 Cabling utilized for data and voice communications shall terminate in either wall mounted termination blocks, cabinets, or panels, in vertical free standing equipment racks, and/or enclosed equipment racks located at the Entrance Facility (EF), the Telecommunications Equipment Room (ER), the Main Cross-connect (MC), the Intermediate cross-connect (IC), and/or the Telecommunications Room (TR) location(s).

- .5 The communications backbone cabling system shall utilize a network of optical fiber, coaxial cabling and unshielded twisted pair riser and tie cables. Cables and terminations shall be provided and located as shown and, in the quantities, indicated on the drawings.
 - .1 Fiber cables shall terminate on fiber patch panels and/or modular patch panels located at demarcation and termination points shown on the drawings.
 - .2 All cables and terminations shall be identified and labeled per owner specifications at all locations.
 - .3 All cables shall be terminated in an alpha-numeric sequential order based on the originating location at all termination locations.
- .6 All cable and terminations shall comply with the rated performance and standard of the cabling and shall be tested per the requirements of this document.
- .7 Available and unused pairs shall be terminated, tested and shall be identified as spare at each location.

1.5 DEFINITIONS

- .1 Backbone cabling System: A Communication Backbone Cabling System is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity between entrance facilities, equipment rooms, main distribution frames, and intermediate distribution frames with the network file server or voice network/switch designated as the service point of the local area network.
- .2 Riser Backbone: The Riser Backbone subsystem links the main cross connect (MC) and telecommunications rooms (TR). The riser backbone consists of the transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.
- .3 Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning at the main cross connect in the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.
- .4 Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, main cross connect or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.
- .5 The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.
- .6 BICSI: Building Industry Consulting Service International.
- .7 Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- .8 EMI: Electromagnetic interference.

- .9 Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams, and specifications.
- .10 IDC: Insulation displacement connector.
- .11 LAN: Local area network.
- .12 RCDD: Registered Communications Distribution Designer.
- .13 UTP: Unshielded twisted pair.

1.6 ACTION SUBMITTALS

- .1 Material Provided
 - .1 The successful Low Voltage Contractor shall be certain that all correct parts are ordered per Products Section of this document and installed in accordance with manufacturers design and installation guidelines. Low Voltage Contractor shall submit complete parts list and part numbers to Engineer prior to installation of equipment for approval.
- .2 Product Data:
 - .1 Provide manufacturer's catalog information showing dimensions, colors, and configurations.
 - .2 Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
 - .1 All optical fiber, copper cable including patch cords, cross connect wire and cross connect cordage.
 - .2 All connectors and required tooling.
 - .3 All termination system components for each cable type.
 - .4 All building entrance protection surge suppression system components.
 - .3 For UTP copper cable, provide manufactures technical data sheet that includes the following installation data for each type used:
 - .1 Mutual Capacitance
 - .2 Impedance
 - .3 DC Resistance
 - .4 Attenuation (Insertion Loss)
 - .5 Return Loss
 - .6 Worst Pair-to-Pair Near End Crosstalk (NEXT)
 - .7 Power Sum Near End Crosstalk (PSNEXT)
 - .8 ELFEXT (ACRF)
 - .9 Power Sum ELFEXT (PSACRF)
 - .4 For optical fiber cable, provide manufactures technical data sheet that includes the following installation data for each type used:
 - .1 Maximum Attenuation
 - .2 Minimum LED Bandwidth
 - .3 Minimum Effective Modal Bandwidth
- .3 Shop Drawings:

- .1 System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
- .2 Cabling administration drawings and printouts including floor plans indicating telecommunication spaces (EF/ER/TR) , primary cable pathways and telecommunication outlets (with circuit ID's).
- .3 Wiring diagrams to show typical wiring schematics for patch panels and wiring blocks.
- .4 Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
- .5 Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - .1 Vertical and horizontal offsets and transitions.
 - .2 Required clearances for access above and to side of cable trays.
 - .3 Vertical elevation of cable trays above the floor or bottom of ceiling structure.
- .4 Pre-Qualification Certificate: Low Voltage Contractor shall submit the following documents with project proposal:
 - .1 Submit proof from manufacturer of the Low Voltage Contractor's good standing in the cabling manufacturer's qualification program.
 - .2 Submit training certificates for design, engineering and installation of the proposed products awarded to the Low Voltage Contractor's assigned project manager and installers. All installers working on this project shall be certified in the manufacturer's certified installers program.
- .5 Test Equipment
 - .1 Provide a complete list of the test equipment to be utilized, including part numbers.
 - .2 Provide certificates for the latest manufacturer calibration for each piece of test equipment to be utilized.
- .6 Warranty Documentation
 - .1 Complete documentation regarding the manufacturer's Extended Product Warranty and Application Assurance Program shall be submitted as part of the proposal. This shall include but is not limited to: a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
 - .2 A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

1.7 QUALITY ASSURANCE

- .1 The Low Voltage Contractor shall guarantee that all twisted pair copper and fiber optic cabling, cable pathways and associated components meet or exceed specifications (including installation) of ANSI/TIA/EIA-568.1-D, 568-C.2, 568.3-D and 569-D.
- .2 Testing Agency Qualifications: An NRTL.
 - .1 Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

- .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .4 Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Test all optical fiber cables upon receipt at Project site.
 - .1 Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set
 - .2 Test optical fiber cable while on reels.
 - .3 Visually inspect all cable upon delivery for damage during transport.
 - .4 Store cables in dry areas that are free of potential pre-installation damage.
- .2 Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 RESPONSIBILITY

- .1 The term Low voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.
- .2 The Low Voltage Contractor for this project shall be contracted by the Owner/General Contractor.

2 PRODUCTS

2.1 UTP COPPER CABLE

- .1 Approved Manufacturers
 - .1 Belden
 - .2 CommScope
 - .3 Panduit
 - .4 Leviton
- .2 UTP CMR/CMP Riser
 - .1 The CMR rated riser cable shall consist of solid copper conductors insulated with and covered by a polyolefin or PVC (polyvinyl chloride) flame retardant jacket.
 - .2 The CMP rated riser cable shall consist of solid copper conductor, 24 AWG, covered by a low smoke FR-PVC jacket.
 - .3 The sheath shall have improved frictional properties allowing it to be pulled through conduit without the use of lubricants.
 - .4 The cable shall be available in pair counts as indicated on drawings.
- .3 UTP Outside Plant Copper Cables (PE89, PE39, PE22 type)

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- .1 All voice grade wire and cable placed in the outside environment shall be solid, twisted pair, and multi-conductor.
 - .2 Buried and underground cable shall have a corrugated, copolymer coated, 8-mil aluminum tape with overlap applied longitudinally.
 - .3 The core assembly shall be filled with a gel compound completely filling the interstices between the pairs and under the core wrap.
 - .4 The cable shall be available in pair counts as indicated on drawings.
- .4 Description: 100-ohm, 24 AWG multi-pair UTP cable, formed into 25-pair binder groups covered with a gray thermoplastic jacket.
- .1 Comply with ICEA S-90-661 for mechanical properties.
 - .2 Comply with TIA/EIA-568-C.1 for performance specifications.
 - .3 Comply with TIA/EIA-568-C.2, Category 5e.
 - .4 Cables larger than 25 pairs shall be constructed with pairs separated into color-coded 25-pair sub-units per ICEA publication S-80-576. Cables up to 600 pairs shall be constructed with 25-pair binder groups combined into super units. Each super unit shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained at all cable splice locations.
 - .5 Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - .1 Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.
 - .2 Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
 - .3 Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.
 - .4 Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.
 - .5 Multipurpose: Type MP or MPG; or MPP or MPR.
 - .6 Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - .7 Multipurpose, Riser Rated: Type MPR or MPP, complying with UL 1666.
 - .6 All copper cabling shall bear the cable's rating and/or appropriate markings for the environment in which they are installed printed directly on the cable jacket.
 - .7 ISO 9001 Certified Manufacturer
- .5 Description: Outside Plant 100-ohm, 24 AWG multi-pair UTP cable, formed into 25-pair binder groups covered with a black thermoplastic jacket and overall metallic shield.
- .1 Comply with ICEA S-90-661 for mechanical properties.
 - .2 Comply with TIA/EIA-568-C.1 for performance specifications.
 - .3 Comply with TIA/EIA-568-C.2, Category 5e.
 - .4 Cables larger than 25 pairs shall be constructed with pairs separated into color-coded 25-pair sub-units per ICEA publication S-80-576. Cables up to 600 pairs shall be constructed with 25-pair binder groups combined into super units. Each super unit shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained at all cable splice locations.
 - .5 Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
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- .1 Communications, Outside Plant Rated: Type CMX (verify)
- .6 All copper cabling shall bear the cable's rating and/or appropriate markings for the environment in which they are installed printed directly on the cable jacket.
- .7 ISO 9001 Certified Manufacturer

2.2 COPPER CABLE PROTECTOR UNITS/ BUILDING ENTRANCE PROTECTION (BEP)

- .1 All copper circuits entering or exiting a building shall be provided with electrical over current protection.
- .2 Protector Panels
 - .1 Approved Protector Housings
 - .1 ADC
 - .2 Circa
 - .2 BEP panels shall meet and/or exceed the requirements outlined in UL497.
 - .3 Input and output terminations shall be 110 style IDC terminations.
 - .4 BEP panels shall accept industry standard 5-pin protector modules.
 - .5 BEP panels shall include an internal splice chamber for incoming and outgoing connections.
 - .6 Each BEP panel shall be equipped with an external two position ground lug that accepts 6 – 14 AWG ground wire.
 - .7 The protector shall be connected with a minimum #6 AWG copper bonding conductor between the protector ground lug and the TR ground point.
 - .8 BEP panels shall be wall and 19" EIA/TIA frame mountable.
 - .9 BEP panels do require a cover.
- .3 Protector Modules
 - .1 Approved Protectors
 - .1 ADC 4 Pair Protector
 - .2 Circa 4 Pair Protector
 - .2 Protector modules shall be standard five pin digital solid state protector modules.
 - .3 Protector modules shall feature nanosecond response time and an external failsafe mechanism that permanently grounds the module under sustained high current conditions.
 - .4 Solid state protector modules shall provide transient and power fault protection for voice or data line applications.
 - .5 Protector modules shall meet or exceed the following electrical specifications:
 - .1 DC Breakover (nominal) @ 100V/μsec: 240V
 - .2 Peak Pulse Current (maximum):
 - .1 @ 2 x 20 μsec: 250A
 - .2 @ 10 x 160 μsec: 150A
 - .3 @ 10 x 1000 μsec: 100A

- .3 Holding Current (minimum): 200 mA
- .4 Surge Life (minimum operations):
 - .1 10A, 10 x 1000 µsec: unlimited
 - .2 100A, 10 x 1000 µsec: >300
 - .3 1Arms, 1 sec: >60
 - .4 10Arms, 1 sec: > 20
- .5 Capacitance, 1 Vrms @ 1KHz, 50 VDC: <45 pf
- .6 Insulation Resistance @ 50VDC: >100 MΩ
- .7 Fail-Safe Operations:
 - .1 @ 1.0A: <50 sec
 - .2 @ 5.0A: <15 sec
 - .3 @ 20A: <10 sec
 - .4 @ 60A: <3 sec
- .8 Current Limiters
 - .1 Hold current @20 C: 145mA
 - .2 R (min)/ R (max): 4/6 Ω

2.3 110-WIRING BLOCK

- .1 Approved Manufacturers
 - .1 Belden
 - .2 CommScope
 - .3 Panduit
 - .4 Leviton
- .2 The wiring block shall facilitate cross connection and interconnection using either cross connect wire (voice only) or the appropriate category patch cords.
- .3 The wiring blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. The index strips shall be marked with five colors on the high teeth, separating the tip and ring of each pair, to establish pair location.
- .4 A series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips.
- .5 The wiring block shall accommodate 19- through 26-AWG conductors and shall be able to mount directly on wall surfaces with or without backboards or on a 19" free-standing frame.
- .6 Clear label holders with the appropriate colored inserts shall be provided with the wiring blocks. The insert labels shall contain vertical lines spaced on the basis of circuit size (3-, 4-, or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.

- .7 The wiring blocks shall be available in 100 and 300 pair sizes and shall be available with or without legs depending on the mounting.
- .8 The wiring block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10000 connections.
- .9 Jumper Trough
 - .1 Provide a horizontal trough for the routing of patch cords and/or cross connect wire.
 - .2 Provide a horizontal trough between each wiring block and top and bottom of each group of wiring blocks.
 - .3 Provide vertical cross-connect management with troughs integrated with the frame.

2.4 SPLICE CASES

- .1 Approved Manufacturers
 - .1 3M
 - .2 Preformed Line Products
 - .3 Tyco Electronics
- .2 Splice cases shall be un-pressurized.
- .3 Splice cases shall be rated for underground use.
- .4 Each splice case shall support a minimum of 2 input and 2 output ports.
- .5 Splice cases shall support straight splice configurations.
- .6 Splice cases shall support splices between 24 and 26 AWG UTP cables up to 1500 pairs.

2.5 PRODUCT WARRANTY AND APPLICATION ASSURANCE

- .1 The Structured Cabling System (SCS) shall be provided with an Extended Product Warranty and Application Assurance Program guaranteeing performance and operation of the SCS (including optical fiber and copper cabling).
- .2 Extended Product Warranty
 - .1 The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:
 - .2 The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use.
 - .3 All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3 standards and will

conform to the guaranteed minimum performance specifications published within the manufacturer's associated product data sheet and warranty platform documentation in effect at the time the Registration Certificate is issued for the duration of the extended warranty period.

.3 Term of Warranty

- .1 The Extended Product and Application Assurance Warranty shall span minimum 25 years from the date of issuance of the Registration Certificate or completion of installation, whichever is later.
- .2 The warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.
- .3 If the manufacturer repairs the product, the repair shall utilize only new replacement parts. Replacement of existing parts shall be with new parts of the same design meeting or exceeding the performance of the replaced parts. Any such repair or replacement shall include a warranty for either 90 days or the remainder of the original warranty period, whichever is longer.

2.6 OPTICAL FIBER CABLING

.1 General

- .1 The cable must meet the requirements of the National Electric Code (NEC) Section 770.
- .2 Plenum Applications - Applicable Flame Test: UL 910 (NFPA 262-1994)

.2 Optical Fiber Characteristics

.1 Acceptable Manufacturers

- .1 Belden
- .2 CommScope
- .3 Panduit
- .4 Leviton
- .5 Corning

- .2 All fibers must be useable and meet the required specifications. All optical glass shall be manufactured by Corning Optical Fiber Products or Sumitomo.
- .3 All fiber cables must be flame retardant and meet UL-1666 OFNR specification
- .4 All optical fibers shall be sufficiently free of surface imperfections and occlusions to meet the optical, mechanical, and environmental requirements of this specification
- .5 A silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD).
- .6 Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²). The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
- .7 The attenuation specification shall be a maximum value for each cabled fiber at $23 \pm 5^{\circ}\text{C}$ on the original shipping reel.
- .8 Single-mode and Multi-mode optical fiber cable shall be available in standard strand counts as indicated on drawings.
- .9 Inside plant cable (including indoor/outdoor rated cabling) shall be reinforced with Aramid yarn for superior strength.

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- .10 All plenum-rated cable shall meet or exceed the requirements of NFPA-262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces and are OFNP Listed with Underwriters Laboratory.
 - .11 All loose-tube constructed optical fiber cable shall meet the following requirements:
 - .1 The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
 - .2 The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
 - .3 The cable core shall be water blocked without the use of flooding compounds.
 - .12 Packing and Shipping
 - .1 The cable shall be packaged in cartons and/ or wound on spools or reels. Each package shall contain only one continuous length of cable with sufficient length for entire run without splicing. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
 - .2 Tests tails shall be at least 2 meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Tails shall be permanently marked with an identification number that it can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.
 - .3 Indoor/ Outdoor Riser-Rated Loose Buffered Optical Fiber Cable.
 - .1 Fiber bundles wrapped in water swellable yarns within loose tubes.
 - .2 Water swellable yarns routed between and surrounding the separate tubes
 - .3 Color-coded fibers and buffer tubes.
 - .4 Ripcord
 - .5 Dielectric strength members all surrounded in a UV-resistant/flame-retardant outer jacket.
 - .6 All-dielectric construction.
 - .7 Flexible buffer tubes.
 - .8 UL-listed OFNR (UL1600) and CSA-listed FT-4.
 - .4 Indoor/ Outdoor Plenum-Rated Tight Buffered Optical Fiber Cable.
 - .1 The cable shall be a totally dry tight buffered water-proof central core cable.
 - .2 The cable shall not contain any gel, filling or flooding compound, grease or other flammable water blocking fluids.
 - .3 The cable shall use aramid yarns for strength in conjunction with a glass reinforced polymer (GRP) central strength member (CSM).
 - .4 The aramid yarns shall specially be prepared with an agent that shall provide the water-proof attribute of the cable.
 - .5 The plenum-rated indoor/outdoor cable shall meet all Bellcore GR-409 requirements.
 - .6 The plenum-rated indoor/outdoor cable shall meet or exceed the requirements of NFPA-262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces and are OFNP Listed with Underwriters Laboratory.
 - .7 All cables must meet the mechanical and environmental requirements of Telcordia GR-20-CORE Issue 2 Generic Requirements for Optical Fiber and Optical Fiber Cable and ANSI/ICEA S-87-640 Standard for Optical Fiber Outside Plant Communications Cable.
 - .5 Optical Fiber Outside Plant (OSP) Cable
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- .1 This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
 - .2 The cable shall be armored with a corrugated polymer coated steel tape constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
 - .3 It shall be suitable for underground, aerial, direct buried, tunnel, or tray installations.
 - .4 Outside plant cabling shall be of loose tube construction.
 - .5 The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
 - .6 The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
 - .7 The cable core shall be water blocked without the use of flooding compounds.
 - .8 The cable shall be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
- .6 Pre-Terminated Optical Fiber Cable Assemblies
- .1 Pre-terminated optical fiber cable assemblies include trunk cables, equipment cords, cross-connect cords and ruggedized fan-outs.
 - .2 Cable Construction
 - .1 All cables shall be constructed with one or more subunits, each with 12 fibers surrounded by a jacket containing aramid yarn strength members.
 - .2 All cable used within the system shall be generally round in construction with the exception of 24-fiber, which shall be side-by-side 12-fiber subunits with a secondary jacket.
 - .3 Cables may not contain any splices of any kind.
 - .4 The lengths of the breakout sections shall be staggered for easy routing and handling of the cable assembly.
 - .5 Pulling socks shall be available that attach to one end of the cable to protect the connector terminations during installation.
 - .6 The cable shall include a ripcord beneath the outer jacket to allow for customization of the 12-fiber subunit breakout length after installation.
 - .7 All cables shall be available in Zero/Low Water Peak Single-Mode, Laser Optimized 50/125 Multimode fiber, with or without aluminum interlocking armor.

2.7 SINGLE-MODE OPTICAL FIBER

- .1 Single-Mode Optical Fiber in Tight Buffer Cables
 - .1 The single-mode fiber shall meet EIA/TIA-492CAAB, "Detail Specification for Class IV a Dispersion-Un-shifted Single-Mode Optical Fibers with Low Water Peak" and ITU-T G.652.C, "Characteristics of Single-Mode Optical Fiber Cable."
 - .2 The cladding diameter shall be $125.0 \pm 0.7 \mu\text{m}$. The cladding non-circularity shall be $\leq 0.7\%$
 - .3 The core-to-cladding concentricity shall be $\leq 0.5 \mu\text{m}$.
 - .4 The coating outside diameter shall be $245 \pm 5 \mu\text{m}$.
 - .5 The colored fiber nominal diameter shall be 253 – 259 μm .
 - .6 The mode field diameter at 1550 nm shall be $10.4 \pm 0.5 \mu\text{m}$.
 - .7 The fiber curl radius of curvature shall be $\geq 4.0 \text{ m}$.
 - .8 The optical fiber refractive index profile shall be graded. The numerical aperture shall be 0.200 ± 0.015 . $\geq 4.0 \text{ m}$.

- .9 The maximum cabled fiber attenuation shall be ≤ 1.0 dB/km at 1310 nm, ≤ 1.0 dB/km at 1383 ± 3 nm and ≤ 0.75 dB/km at 1550 nm.
- .10 The point of discontinuity shall be ≤ 0.5 dB at 1310 nm and ≤ 0.5 dB at 1550 nm.
- .11 The macro bend attenuation shall be ≤ 0.05 dB at 1550 nm at 1 turn around a mandrel with an OD of 32 ± 2 mm; ≤ 0.05 dB at 1310 nm and ≤ 0.10 dB at 1550 nm at 100 turns around a mandrel with an OD of 50 ± 2 mm; and ≤ 0.05 dB at 1550 nm and ≤ 0.05 dB at 1625 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm.
- .12 The cable cutoff wavelength (λ_{cct}) shall be ≤ 1260 nm.
- .13 The zero-dispersion wavelength (λ_0) shall be $1302 \leq \lambda_0 \leq 1322$ nm.
- .14 The zero-dispersion slope (S_0) shall be ≤ 0.089 ps/(nm²*km).
- .15 The total dispersion shall be ≤ 3.5 ps/(nm²*km) at 1285-1330 nm, ≤ 17.5 ps/(nm²*km) at 1550 nm and ≤ 21.5 ps/(nm²*km) at 1625 nm.
- .16 The cabled polarized mode dispersion shall be ≤ 0.2 (ps/ $\sqrt{\text{km}}$).
- .17 The optical fiber shall support IEEE 802.3 GbE - 1300 nm laser distances at 5000 m.
- .18 The water peak attenuation at 1383 ± 3 nm at ≤ 1.0 dB/km.
- .2 Single-Mode Optical Fiber in Bend Insensitive Tight Buffer Cables
 - .1 The single-mode Low Water Peak fiber utilized in the optical fiber cable shall meet EIA/TIA-492CAAB, "Detail Specification for Class IV a Dispersion-Un-shifted Single-Mode Optical Fibers with Low Water Peak" and ITU-T G.652.D, "Characteristics of Single-Mode Optical Fiber Cable," and ITU-T G.657, Table A, "Characteristics of a Bending Loss Insensitive Single Mode Optical Fiber for Access Networks."
 - .2 The cladding diameter shall be 125.0 ± 0.7 μm . The cladding non-circularity shall be $\leq 0.7\%$
 - .3 The core-to-cladding concentricity shall be ≤ 0.5 μm .
 - .4 The coating outside diameter shall be 245 ± 5 μm .
 - .5 The colored fiber nominal diameter shall be 253 – 259 μm .
 - .6 The mode field diameter at 1550 nm shall be 9.8 ± 0.5 μm .
 - .7 The fiber curl radius of curvature shall be ≥ 4.0 m.
 - .8 The maximum cabled fiber attenuation shall be ≤ 1.0 dB/km at 1310 nm, ≤ 1.0 dB/km at 1383 ± 3 nm and ≤ 0.75 dB/km at 1550 nm.
 - .9 The point of discontinuity shall be ≤ 0.5 dB at 1310 nm and ≤ 0.5 dB at 1550 nm.
 - .10 The macrobend attenuation shall be ≤ 0.05 dB at 1550 nm at 1 turn around a mandrel with an OD of 20 ± 2 mm; ≤ 0.05 dB at 1550 nm at 10 turns around a mandrel with an OD of 30 ± 2 mm; and ≤ 0.01 dB at 1625 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm.
 - .11 The cable cutoff wavelength (λ_{cct}) shall be ≤ 1260 nm.
 - .12 The zero-dispersion wavelength (λ_0) shall be $1302 \leq \lambda_0 \leq 1322$ nm.
 - .13 The zero-dispersion slope (S_0) shall be ≤ 0.089 ps/(nm²*km).
 - .14 The total dispersion shall be ≤ 3.5 ps/(nm²*km) at 1285-1330 nm, ≤ 18.105 ps/(nm²*km) at 1550 nm and ≤ 22.0 ps/(nm²*km) at 1625 nm.
 - .15 The cabled polarized mode dispersion shall be ≤ 0.2 (ps/ $\sqrt{\text{km}}$).
 - .16 The optical fiber shall support IEEE 802.3 GbE - 1300 nm laser distances at 5000 m.
 - .17 The water peak attenuation at 1383 ± 3 nm at ≤ 1.0 dB/km.

2.8 MULTI-MODE OPTICAL FIBER

- .1 OM4 Laser Optimized 50-Micron Multi-Mode Optical Fiber Cable (10Gb/s @ 550m)

- .1 Multimode fiber shall meet the following standards:
 - .1 EIA/TIA-492AAAD, "Detail Specification for 850-nm Laser-Optimized 50-mm Core Diameter/125-mm Cladding Diameter Class 1a, Graded-Index Multimode Optical Fibers."
 - .2 ISO/IEC 11801 type OM4 fiber
 - .3 IEC 60793-2-10 type A1a.3 fiber
- .2 Laser 50-Micron Optical Fiber Cable shall have the same specified performance as 50-Micron Optical Fiber Cable specified above except the following performance and geometry values.
- .3 The maximum cabled fiber attenuation shall be ≤ 2.5 dB/km at 850 nm and ≤ 1.0 dB/km at 1300 nm.
- .4 The cabled laser Effective Modal Bandwidth (EMB) shall be ≥ 4700 MHz/km at 850 nm and ≥ 500 MHz/km at 1310 nm.
- .5 The minimum bandwidth during Overfilled Launch (OFL) conditions shall be ≥ 3500 MHz/km at 850 nm and ≥ 500 MHz/km at 1310 nm.
- .6 The optical fiber shall support the following applications at the associated distances:
 - .1 10 Gigabit Ethernet (802.3ae)
 - .1 850 nm serial laser (10GBASE-SR & 10GBASE-SW): 550m
 - .2 1310 nm CWDM lasers (10GBASE-LX4): 300m
 - .2 1 Gigabit Ethernet
 - .1 850 nm serial laser (1000BASE-SX): 1040m
 - .2 1310 nm serial lasers (1000BASE-LX): 600m
 - .3 100 Megabit Ethernet
 - .1 850 nm serial LED (100BASE-SX): 300m
 - .2 1310 nm serial LED (100BASE-FX): 2000m
 - .4 10 Megabit Ethernet: 850 nm LED (10BASE-FL): 1250
 - .5 10 Gigabit Fibre Channel (10GFC Rev 3.0)
 - .1 850 nm serial laser (1200-M5E-SNS): 530m
 - .2 12010 nm WWDW lasers (1200-M5-LC3S): 300m
 - .6 1 Gigabit Fibre Channel: 850 nm serial laser (100-Mx-SNI): 970m
 - .7 10 Gigabit OIF OC-192 VSR
 - .1 850 nm serial (VSR-4-04): 505m
 - .2 850 nm 4x2.5 Gb/s parallel (VSR-4-03): 700m

2.9 OPTICAL FIBER CONNECTORS

- .1 General Connector Requirements
 - .1 Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of ANSI/TIA-604 and appropriate sub sections. Comply with ANSI/TIA-568.3-D.
 - .2 Multi-Mode fiber optic connectors shall be factory or field installed.
 - .3 Fiber optic connectors shall be quick-connect anaerobic or heat cure terminated connectors.
 - .4 Single-Mode fiber optic connectors shall duplex LC style connectors.
 - .5 Multi-Mode fiber optic connectors shall duplex LC style connectors.
 - .6 Fiber connectors shall have < 0.2 dB change after 500 re-matings.
 - .7 The connector operating temperature shall be -40 to 167°F (-4 to 75°C).
 - .8 Connectors shall have a temperature stability (-4°C to $+75^{\circ}\text{C}$) Insertion Loss Change of < 0.3 dB.
- .2 LC Optical Fiber Connectors

- .1 The fiber optic connector shall be one half the size (double density) of conventional ST and SC connectors.
- .2 The connector shall utilize ceramic tips.
- .3 The connector shall have an insertion release mechanism similar to the RJ-45 intuitive push/pull-style housing.
- .4 The connector shall be pull-proof to prevent momentary disconnect from axial loads with a cable retention rating of 2 lbs.
- .5 The connector possesses an anti-snag latch which facilitates routing of patch cords
- .6 The connector shall be field-mountable with minimal polish
- .7 The connector shall be polarized.
- .8 The connector shall be Bellcore, TIA/EIA and IEC compliant
- .9 LC type connectors shall have an average loss of 0.1dB for multi-mode cabling and 0.1dB (tuned)/ 0.15dB (untuned) for single mode cabling per mated pair. Connectors shall have a maximum return loss of -20 db for multi-mode cabling and -40 db for single mode cabling.

2.10 OPTICAL FIBER LINE/PATCH CORDS

- .1 All optical fiber line/patch cords shall be provided by Low Voltage Contractor.
- .2 Fiber optic line/patch cords shall be manufactured by the same manufacturer as the optical fiber distribution system.
- .3 All line/patch cords shall be factory terminated. Field terminated line/patch cords shall not be accepted.

2.11 OPTICAL FIBER HOUSINGS

- .1 All optical fiber hardware shall be manufactured by the same manufacturer as the optical fiber cabling unless specified otherwise.
- .2 General Optical Fiber Housing Requirements
 - .1 Optical fiber housing shall be available for cross-connection or inter-connecting purposes. The units shall provide for direct connectorization and pigtail splicing. All connector housings shall be meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.
 - .2 Each optical fiber housing shall accept a labeling scheme that complies with ANSI/TIA-606-A.
 - .3 Each optical fiber housing shall include clamshell-type clamping mechanisms to provide cable strain relief. Each cable clamp shall accept one cable with an OD of 9.5 – 28.6 mm. Each cable clamp shall also handle multiple small fiber count cables when used with the multiple cables insert; these clamps shall have a capacity of five cables with an OD of ≤ 10.2 mm. Cable clamps shall be provided as required be the panel/ module loading of the connector housing.
 - .4 Optical fiber housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity. Housings shall be finished with a wrinkled black powder coat for durability.
- .3 Connector Housings

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- .1 Connector housings shall be mountable in an EIA-310 compatible 19" rack. Housing shall be a minimum of 1RU and be available in 2RU, 3RU and 4RU heights. Connector housing shall not exceed a depth of 12".
 - .2 Connector housings shall be modular in nature with separate splicing, jumper management and combination connector/ splicing housings available.
 - .3 Connector housings shall be available in 2, 4, 6, 8, and 12 connector panel configurations.
 - .4 The connector housing shall include jumper/ patch cord routing guides to allow a transition and segregation point for cords exiting the front and back of the housing.
 - .5 Feeder cable entries shall have a grommet installed to minimize dust/ water intrusion.
 - .6 Connector housings doors shall meet the following requirements:
 - .1 Shall have removable hinged front and rear doors.
 - .2 The front and rear doors shall be manufactured from tinted polycarbonate with slide latches.
 - .3 The front and rear doors shall be lockable.
 - .7 Connector housings shall include provisions for mounting fiber fan-out devices and factory installed cable stubs for multiple cable and connector types.
- .4 Combination Connector/ Splice Housings
- .1 Connector/ splice housings shall be mountable in an EIA-310 compatible 19" rack. The connector/ splice housing shall not exceed a depth of 12".
 - .2 Combination connector/ splice housings shall be modular in nature, providing the ability to splice inside the same housing as the connectorized fiber with a splicing compartment and a termination compartment located in a single housing.
 - .3 Splice tray mounting shall allow individual trays to be accessed without disturbing adjacent trays or fibers.
 - .4 Splice tray shall be retained in the splice tray holder by a hook and loop strap.
 - .5 Connector/ splice housings shall include fiber jumper/ patch cord routing guides that allow a transition and segregation point for jumpers exiting either side of the connector/ splice housing.
 - .6 Connector/ splice housings shall include an open top panel which shall allow fiber jumper/ patch cord routing through the top of the housing. A separate jumper/ patch cord management panel shall be provided for cabling routed through the top of the housing. A separate cover shall be provided to close this opening if top routing is not utilized.
 - .7 Splice capacity shall include a minimum of either four 5.1 mm tall splice trays or two 10.2 mm tall splice trays.
 - .8 Connector/ splice housings doors shall meet the following requirements:
 - .1 Shall have removable hinged front and rear doors.
 - .2 The front and rear doors shall be manufactured from tinted polycarbonate with slide latches.
 - .3 The front and rear doors shall be lockable.
 - .9 Connector/ splice housings shall include provisions for mounting fiber fan-out devices and factory installed cable stubs for multiple cable and connector types.
- .5 Splice Housings

- .1 Splice housings shall be mountable in an EIA-310 compatible 19" rack. Housing shall be available in a 1RU through 5RU heights.
- .2 The splice housing shall provide access to individual splice trays with minimal disturbance to neighboring trays and fibers.
- .3 Splice shall be retained in the splice tray holder by a hook and loop strap.
- .4 The splice housing shall include fiber routing guides that allow slack storage for jumpers exiting the housing.
- .5 Splice housings shall utilize a slide-out tray for splice tray access. The tray shall contain a spring-loaded plunger to prevent accidental over-extension of the sliding tray.
- .6 Splice housings shall accept splice trays from industry standard splice types and store slack for these trays.
- .7 Splice housing shall include cable routing guides that allow a transition and segregation point for fibers existing the top and bottom of the housing. Cable entries shall have a grommet installed to minimize dust/ water intrusion.
- .8 Front access housing shall include metal front and rear doors with jumpers/ patches that are routed out of the sides of the housing.
- .9 Front and rear doors on splice housings shall be hinged and removable. The front door shall utilize swell latches.
- .10 Front and rear doors on all splice housing shall be lockable.
- .11 Splice housings shall include internal fiber routing to connector panels without having to route fibers outside of the housings.

2.12 CONNECTOR PANELS AND MODULES

.1 Connector Panels

- .1 Connector panels shall be manufactured by the same manufacturer as the connector housing.
- .2 Connector panels shall utilize a single mounting footprint.
- .3 Connector panels shall be available in three, four, six, eight, and twelve connector adaptor configurations.
- .4 Connector panels shall be attached to the connector housing with a minimum of two push-pull style latches.
- .5 Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including LC.
- .6 Unused spaces/opening in each housing shall be populated with connector panels matching the utilized connector panel configuration.
- .7 Connector panels shall be manufactured from 16-gauge cold rolled steel or injection molded polycarbonate.

.2 Connector Modules

- .1 The connector module shall be a modular removable case containing optical fiber connector adapters and provisions for strain-relief, slack storage, and the furcation of fiber optic cables.
- .2 Connector modules shall be manufactured by the same manufacturer as the connector housing.
- .3 Connector modules shall consist of a panel incorporated into a protective case with a removable cover for access to the interior connectors and fibers.
- .4 Connector modules shall include a fiber retaining spool for managing slack fiber.
- .5 Connector modules shall utilize a single mounting footprint.
- .6 Connector modules shall be available in three, four, six, eight, and twelve connector adaptor configurations.

- .7 Connector modules shall be attached to the connector housing with a minimum of two push-pull style latches.
- .8 Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including SC duplex, ST compatible, MTRJ and LC.
- .9 Connector modules shall be manufactured from 16-gauge cold rolled steel or injection molded polycarbonate.
- .10 Connector modules shall be available in the following configurations: adapter modules, pigtail modules, and pre-terminated system modules.

3 EXECUTION

3.1 WORKMANSHIP

- .1 Components of the backbone cabling system shall be installed in a neat, workmanlike manner.
- .2 Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.
- .3 Identification markings and systems shall be uniform.
- .4 The Low Voltage Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of and any charges resulting in the repair surfaces including painting shall be included as necessary.

3.2 ADMINISTRATION

- .1 The administration subsystem shall consist of wiring blocks and or patch panels for termination of copper cables or optical fibers. All wall field layouts to be as detailed on drawings or as approved by Engineer prior to installation.
- .2 Fields: Separate termination fields shall be created for voice and data applications if both are wall mounted.
- .3 Termination blocks: Termination blocks/panels that require rotation after connection of horizontal/vertical wiring shall not be allowed.
- .4 Cross-connect wire, patch cords
 - .1 Low Voltage Contractor shall provide cross-connect wire, copper and fiber patch cords for cross connection and inter-connection of termination blocks.
 - .2 Jumper type: The type of jumper cables shall depend on ANSI/EIA/TIA copper applications, or fiber application and the termination block used, i.e. a punch panel or a patch panel termination block and be part of the manufacturers total channel solution.

3.3 INSTALLATION

- .1 The Low Voltage Contractor shall ensure that all recommended cable pulling tensions and pulling bending radius are not exceeded. Any cable damaged (bent or kinked to a radius less than the recommended dimension) shall not be installed. Any cable that is bent or kinked to a radius less than the recommended dimension during installation shall be replaced by the Low Voltage Contractor at no additional cost to the project.
- .2 Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.

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- .3 The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.
 - .4 All installation shall be done in conformance with ANSI/TIA 568-B standards, federal and local standards and the cable manufacturers Installation guidelines.
 - .5 The Low Voltage Contractor shall make provisions so that all cabling is stored within a temperature-controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.
 - .6 Low Voltage Contractor shall terminate all wires, conductors, and fibers in accordance with the manufacturer's instructions.
 - .7 All cabling shall be run in and supported by cable pathways that are installed solely for the purpose of supporting extra low voltage communications cabling.
 - .8 Riser Backbone
 - .1 Low Voltage Contractor shall supply and install the transmission media and terminating hardware to provide interconnection between the MC and each TR in a star topology.
 - .2 All cable routes shall be approved by Engineer prior to installation.
 - .3 All fibers shall be run in inner duct or conduit and terminated in the ER/TR's with sufficient panels, couplers and jumper storage shelves to terminate and secure all fibers. Optical fiber cabling constructed with interlocking armor may be run in approved cable raceways without inner duct.
 - .4 All riser backbone cabling shall be installed with a minimum service loop of 10'-0" at each point of termination.
 - .5 The Low Voltage Contractor shall maintain the copper UTP cable twist rate for each pair in the backbone cabling to within 0.5-inches of the termination.
 - .6 The Low Voltage Contractor shall adhere to the manufacture's recommendations and specifications with regard to the bending radius and pulling strength requirements of all backbone cables during handling and installation.
 - .9 Bonding and Grounding
 - .1 The Low Voltage Contractor shall be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
 - .2 All bonding conductors shall consist of #6 AWG or larger (As required) copper wire and shall be supplied from an approved building ground bus that is bonded to the main electrical ground in accordance with the NEC and ANSI-J-STD-607.
 - .3 Grounding must be in accordance with the NEC, NFPA and all local codes and practices.
 - .10 Electrical Protection
 - .1 Low Voltage Contractor shall supply over current protectors and wires used to ground the equipment.
 - .2 Each protector panel shall be provided with one five (5) pin plug-in solid state protector modules for each copper cable pair terminated on the panel.
 - .3 The electrical protection devices supplied by the Low Voltage Contractor shall be in multi-pair form.

- .4 For small pair count applications, Low Voltage Contractor shall supply electrical protection devices which consist of a mounting panel for a series of solid-state protector units and a wiring block. The wiring block shall be used for input and output cable terminations. Insertion of the protector units into the mounting block will complete the circuit.
- .11 Power Separation: The Low Voltage Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. All SCS equipment and terminations must maintain proper separation from sources of EMI as per ANSI/TIA 569-D and BICSI installation practices.
- .12 Separation from EMI Sources:
 - .1 Comply with BICSI TDMM and TIA/EIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - .2 Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - .2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - .3 Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - .3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - .2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - .3 Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - .4 Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - .2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - .3 Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - .5 Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - .6 Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
- .13 Miscellaneous Equipment: The Low Voltage Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (MC & TR locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the System.
- .14 Special Equipment and Tools: It shall be the responsibility of the Low Voltage Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
 - .1 Tools for terminating cables,

- .2 Testing and splicing equipment for copper/fiber cables,
- .3 Communication devices,
- .4 Jack stands for cable reels,
- .5 Cable wrenches.
- .15 Identification
 - .1 Identify system components, wiring, and cabling complying with TIA/EIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - .1 Project Administration Class as defined by the latest version of the TDMM.
 - .2 Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
 - .2 Paint and label colors for equipment identification shall comply with TIA/EIA-606-C for the appropriate administration class level of administration.
 - .3 Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.
 - .4 Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 - .5 Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, grounding buses and pathways, equipment grounding conductors and fire stopped penetrations.
 - .6 Cable and Wire Identification:
 - .1 Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - .2 Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plug covers or each service.
 - .7 Labels shall be pre-printed or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-C. Use flexible laminated vinyl or polyester labels that flex as cables are bent.
- .16 Cable Records: The Low Voltage Contractor shall maintain conductor polarity (tip and ring) identification at the main equipment room (switch room) and risers in accordance with industry practices.
- .17 As Built Documentation
 - .1 Upon completion of the project, Low Voltage Contractor is to prepare "As Built" documentation showing actual site conditions and installation as constructed.
 - .2 Provide copies of such documentation to the Owner as mentioned below.

- .1 Upon completion of system installation, Low Voltage Contractor shall provide to Owner for its records the following:
 - .1 MC, TR and EF Diagrams which shall include:
 - .1 Cable routing
 - .2 Position of all components and
 - .3 Detailed layout of the wall field
 - .4 Labeling plan.
 - .2 Riser Distribution Plan
 - .3 Campus Distribution Plan
 - .4 Fire Stop Penetrations and System ID
- .2 Documentation shall be in the following format:
 - .1 Four (4) copies of all diagrams and drawings matching the bid documents in size and format.
 - .2 One (1) copy of electronic plans, drawings and diagrams provided in both PDF format and the latest version of AutoDesk AutoCAD (or Revit if applicable) on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.
 - .3 One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.
- .18 Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Low Voltage Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for both copper and fiber cables.

3.4 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

- .1 Prior consent: The Low Voltage Contractor shall make no penetration of floors, walls, or ceiling without the prior consent from the Engineer.
- .2 Coordination: Coordinate the fire proofing manufacturer, product and specific sealing detail to be utilized on penetrations with other contractors to ensure that fire proofing seals are UL compliant.
- .3 Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
 - .1 Where penetrations through acoustical walls or other walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.
 - .2 Where penetrations through fire-rated walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.5 TESTING / WARRANTY

.1 Copper Cable testing

- .1 Testing of all copper wiring shall be performed prior to system acceptance.
- .2 One hundred percent of the permanent installed links shall be tested for conformance to the manufacturers guaranteed performance levels as specified in the manufacturer's Extended Product Warranty platform.
 - .1 Any pairs not meeting or exceeding the requirements of the guaranteed performance levels shall be brought into compliance by the contractor, at no charge to the owner.
 - .2 All cabling shall exceed the specifications of ANSI/TIA-568-C.2 (specific to the Category standards the cabling is manufactured to) by the margins (headroom) specified in the manufacturer's Extended Product Warranty platform.
- .3 One hundred percent of the backbone cabling pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
- .4 All test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.
- .5 All test equipment shall include valid proof of calibration within 6 months of the testing date. The calibration shall utilize the manufacturer's recommended calibration practices.
- .6 Backbone/riser cables rated above Category 5e shall be tested according to test set manufacturer's instructions utilizing the latest firmware and software.
 - .1 Testing shall include all of the electrical parameters.
 - .2 The detailed test results shall include the following:
 - .1 Wire Map
 - .2 Length
 - .3 Insertion loss
 - .4 Near-End Cross Talk (NEXT)
 - .5 Power Sum Near-End Crosstalk (PSNEXT)
 - .6 Equal-Level Far End Crosstalk (ELFEXT)
 - .7 Power Sum Equal-Level Far-End Crosstalk (PSELFEXT)
 - .8 Return Loss
 - .9 Propagation delay
 - .10 Delay skew
- .7 Complete, end to end, test results must be submitted to Engineer for review.

.2 Optical Fiber Cable Testing

- .1 All fiber testing shall be performed on all fibers in the completed end to end system.
- .2 Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61 or a bidirectional end to end power meter test performed per EIA/TIA 455-53A. Optical Certification testers may be used if approved in advance by the engineer of record.
- .3 The system loss measurements shall be provided at (850 and 1310 nanometers for multimode fibers) and (1310 and 1550 for single mode fibers).
- .4 Pre-installation cable testing

- .1 The Low Voltage Contractor shall test all fiber cable prior to the installation of the cable and provide the Engineer, with those test results prior to installation.
- .2 The Low Voltage Contractor shall assume all liability for the replacement of the cable should it be found defective.
- .5 Loss Budget
 - .1 Fiber links shall have a maximum loss of: Allowable cable loss per km)(km of fiber in link) + (.4dB)(number of connectors) = maximum allowable loss
 - .2 A mated connector to connector interface is defined as a single connector.
 - .3 Any link not meeting the requirements of the standard shall be brought into compliance by the Low Voltage Contractor, at no charge to Owner.
 - .4 Documentation shall be provided in both hard copy and Compact Disk to the point of contact.
- .6 Complete, end to end, test results must be submitted to the Engineer for review (provide both PDF format and native tester file format).
- .3 Extended Product Warranty Work
 - .1 Under the Extended Product the manufacturer shall replace all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.
 - .2 The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the owner.
 - .3 The Extended Product Warranty shall include a minimum two (2) year installation warranty for the premises copper and optical cabling to correct all installation related problems/ issues at no cost to the owner.

3.6 COMPLETION OF WORK

- .1 At the completion of the work, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.
- .2 All clean up, restoration, and removal noted above shall be by the Low Voltage Contractor and at no additional cost.
- .3 If the Low Voltage Contractor fails in its duties under this paragraph, Owner may upon notice to the Low Voltage Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Low Voltage Contractor.

3.7 INSPECTION

- .1 On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high-quality manner and the overall appearance shall be clean, neat and orderly.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- 1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 27 05 26 – Grounding and Bonding for Communications Systems
- 1.2.2 Section 27 05 28 – Pathways for Communications Systems
- 1.2.3 Section 27 11 00 – Communications Equipment Room Fittings
- 1.2.4 Section 27 13 00 – Communication Backbone Cabling

1.3 SUMMARY

- 1.3.1 Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation, and performance. Equipment catalog numbers are listed to establish this minimum.
- 1.3.2 Section Includes:
 - 1.3.2.1 UTP cabling
 - 1.3.2.2 Cable connecting hardware, patch panels, and cross-connects.
 - 1.3.2.3 Telecommunications outlet/connectors.
 - 1.3.2.4 Cabling system identification products.
 - 1.3.2.5 Cable management system.

1.4 SUMMARY OF WORK

- 1.4.1 Furnish and install complete with all accessories a horizontal Structured Cabling System (SCS). The SCS shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network from designated demarcation points to outlets located at various desks, workstation and other locations as indicated on the contract drawings and described herein.
- 1.4.2 The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.
- 1.4.3 Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.
- 1.4.4 Wiring and cabling utilized for data and voice communications shall originate at patch panels mounted in vertical freestanding equipment racks, and/or enclosed wall mounted vertical equipment racks located at the telecommunications Equipment Room (ER), the Main Cross-connect (MC), the Intermediate cross-connect (IC), and/or the Telecommunications Room (TR) location(s). Wiring and cabling shall be routed to Telecommunication Outlets (TO) at the workstation or device being served. All connectivity, wiring, terminations and patch bays between these designated demarcation points and outlet locations designated on the plans shall be considered part of the contract and shall be furnished, wired and installed by the SCS Low Voltage Contractor.
- 1.4.5 The system shall utilize a network of riser, tie and station cables. Cables and terminations shall be pro-

vided and located as shown and, in the quantities, indicated on the drawings.

1.4.5.1 Fiber cables shall terminate on fiber patch panels located at demarcation and termination points shown on the drawings.

1.4.5.2 All cables and terminations shall be identified and labeled at all locations.

1.4.5.3 All cables shall be terminated in a sequential order based on the originating location at all termination locations wherever possible.

1.4.6 All copper cable terminations shall comply with and be tested to ANSI/TIA 568-D standards for Category Cable installations.

1.5 DEFINITIONS

1.5.1 Structured Cabling System (SCS): A SCS is defined as all required equipment and cabling including but not limited to hardware, termination blocks, telecommunication outlets, work area cords, UTP and fiber optic cable installed and configured to provide computer data, voice connectivity and video between the ER/ EER/EE and each telecommunications outlet.

1.5.2 Work Area: The connection between the information outlet and the station equipment in the work area consists of cords, adapters, and other transmission electronics.

1.5.3 Horizontal Cabling: The horizontal cabling subsystem provides connections from the horizontal cross connect to the Telecommunication Outlets (TOs) in the work areas. It consists of the horizontal transmission media, the associated connecting hardware terminating this media and TOs in the work area. Each floor of a building is served by its own Horizontal Subsystem.

1.5.3.1 Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector unless specifically identified in the contractor drawing or approved in writing by the owner/ engineer.

1.5.3.2 Bridge taps and splices shall not be installed in the horizontal cabling.

1.5.3.3 Splitters shall not be installed as part of the optical fiber cabling.

1.5.4 Riser Backbone: The Riser Backbone subsystem links the main cross connect (MC) and telecommunications rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.

1.5.5 Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning at the main cross connect in the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.

1.5.6 Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, main cross connect or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.

1.5.7 The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.

1.5.8 Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

1.6 ACTION SUBMITTALS

1.6.1 Product Data

- 1.6.1.1 Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- 1.6.1.2 Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
 - 1.6.1.2.1 All connectors and required tooling.
 - 1.6.1.2.2 All termination system components for each cable type.
 - 1.6.1.2.3 All grounding and building entrance protection surge suppression system components.
- 1.6.1.3 For UTP copper cable, provide manufactures technical data sheet that includes the following installation data for each type used:
 - 1.6.1.3.1 Mutual Capacitance
 - 1.6.1.3.2 Impedance
 - 1.6.1.3.3 DC Resistance
 - 1.6.1.3.4 Attenuation (Insertion Loss)
 - 1.6.1.3.5 Return Loss
 - 1.6.1.3.6 Worst Pair-to-Pair Near End Crosstalk (NEXT)
 - 1.6.1.3.7 Power Sum Near End Crosstalk (PSNEXT)
 - 1.6.1.3.8 ELFEXT (ACRF)
 - 1.6.1.3.9 Power Sum ELFEXT (PSACRF)

1.6.2 Shop Drawings:

- 1.6.2.1 System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
- 1.6.2.2 Cabling administration drawings and printouts.
- 1.6.2.3 Wiring diagrams to show typical wiring schematics, including the following:
 - 1.6.2.3.1 Cross-connects.
 - 1.6.2.3.2 Patch panels.
 - 1.6.2.3.3 Patch cords.
 - 1.6.2.3.4 Coaxial splitters, taps, and amplifiers (with calculated dB losses per leg).
- 1.6.2.4 Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

1.6.3 Warranty Documentation

- 1.6.3.1 Complete documentation regarding the manufacturer's Extended Product Warranty and Application Assurance Program shall be submitted as part of the proposal. This shall include but is not limited to: a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
- 1.6.3.2 A systems application assurance manual documenting the vendor supported applications and

application guidelines shall be provided as part of the submittals.

1.7 INFORMATIONAL SUBMITTALS

- 1.7.1 Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1.7.1.1 Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 - 1.7.1.2 Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 1.7.1.3 Field Inspector: Currently registered by BICSI as ITS Registered Technician to perform the on-site inspection.
 - 1.7.1.4 Testing Supervisor: Currently certified by BICSI as an ITS Registered Technician to supervise on-site testing.
- 1.7.2 Maintenance Data: For splices and connectors to include in maintenance manuals.
- 1.7.3 Certificate of current calibration on all test equipment.

1.8 CLOSEOUT SUBMITTALS

- 1.8.1 As-Built Documentation: As specified in Section 3.9.
- 1.8.2 Test Results: Test results shall be submitted in both PDF form and in the native electronic file format of the test equipment.
 - 1.8.2.1 As specified in Section 3.8.
 - 1.8.2.1.1 Copper Cabling Test Results
 - 1.8.2.2 Test equipment firmware and software versions.
 - 1.8.2.3 Test equipment proof of calibration documentation.

1.9 QUALIFICATIONS

- 1.9.1 The Low Voltage Contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein at the time of bid.
- 1.9.2 The Low Voltage Contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- 1.9.3 The Low Voltage Contractor shall be in compliance with all federal, provincial, and local statutes regarding qualifications of firms.
- 1.9.4 The Low Voltage Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic copper premise distribution systems.
- 1.9.5 The Low Voltage Contractor shall submit a resume of qualification with the vendor's proposal indicating the following:
 - 1.9.5.1 A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 1.9.5.2 A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
 - 1.9.5.3 A technical resume of experience for the Low Voltage Contractor's Project Manager and on-site installation supervisor who will be assigned to this project.

- 1.9.5.4 A list of technical product training attended by the Low Voltage Contractor's personnel that will install the SCS system.
- 1.9.5.5 Any Sub-Contractor, who will assist the SCS Low Voltage Contractor in performance of this work, shall have the same required training and certification as the Low Voltage Contractor.

1.10 QUALITY ASSURANCE

- 1.10.1 The Low Voltage Contractor shall guarantee that all twisted pair copper cabling, fiber optic cabling, cable pathways and associated components meet or exceed specifications (including installation) of ANSI/TIA/EIA-568.1-D, 568.2-D, 568.3-D and 569-D.
- 1.10.2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 1.10.3 Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D and BICSI's Telecommunications Distribution Methods Manual.
- 1.10.4 Grounding: Comply with ANSI-J-STD-607-C and ANSI/TIA-942.

1.11 DELIVERY, STORAGE, AND HANDLING

- 1.11.1 Test cables upon receipt at Project site.
 - 1.11.1.1 Visually inspect all cable upon delivery for damage during transport.
 - 1.11.1.2 Store cables in dry areas that are free of potential pre-installation damage.
- 1.11.2 Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 RESPONSIBILITY

- 1.12.1 The term Low Voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

PART 2 - PRODUCTS

2.1 HORIZONTAL STRUCTURED CABLING SYSTEM

- 2.1.1 Horizontal cabling shall be Category 6A 4-pair unshielded twisted pair (UTP) cabling that meets the channel requirements.
- 2.1.2 The horizontal structured cabling system specified in this specification shall be manufactured by a single manufacturer capable of providing the extended warranty outlined above. Including:
 - 2.1.2.1 4-Pair UTP Cabling
 - 2.1.2.2 Modular 8-Position, 8-Conductor
 - 2.1.2.3 Modular Faceplates
 - 2.1.2.4 Patch Panels
 - 2.1.2.5 Patch/ Station Cords
- 2.1.3 Acceptable Horizontal Structured Cabling System Manufacturers:
 - 2.1.3.1 Belden

- 2.1.3.2 CommScope
- 2.1.3.3 Panduit
- 2.1.3.4 Leviton

2.2 HORIZONTAL CABLING

- 2.2.1 Description: 100-ohm, four-pair UTP cable.

- 2.2.1.1 Comply with ANSI/TIA-568.2-D Category 6A.
- 2.2.1.2 All horizontal cabling shall be listed, labeled and rated for plenum use.

2.3 PRODUCT WARRANTY AND APPLICATION ASSURANCE

- 2.3.1 The Structured Cabling System (SCS) shall be provided with an Extended Product Warranty and Application Assurance Program guaranteeing performance and operation of the SCS (including optical fiber and copper cabling).

- 2.3.2 Extended Product Warranty

- 2.3.2.1 The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:
- 2.3.2.2 The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use.
- 2.3.2.3 All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of ANSI/TIA-568.1-D, ANSI/TIA-568.2-D, ANSI/TIA-568.3-D and exceed ISO/IEC 11801 standards and will conform to the guaranteed minimum performance specifications guaranteed head room published within the manufacturer's associated product data sheet and warranty platform documentation in effect at the time the Registration Certificate is issued for the duration of the extended warranty period.

- 2.3.3 Application Warranty

- 2.3.3.1 The Application Warranty shall cover failure of the SCS to operate all applications which the system was designed to support and all future applications which are developed to operate over ANSI/TIA-568-D permanent link/ channels.
- 2.3.3.2 The manufacturer shall warrant that the registered SCS solution will be free from failures which prevent operation of the specific applications for which the original SCS was designed.
- 2.3.3.3 Applications introduced in the future by recognized standards or user forums that utilize ANSI/TIA-568-C or ISO/IEC 11801 components and link/channel specifications for cabling shall be covered by the Application Warranty.

- 2.3.4 Term of Warranty

- 2.3.4.1 The Extended Product and Application Assurance Warranty shall span minimum 20 years from the date of issuance of the Registration Certificate or completion of installation, whichever is later.
- 2.3.4.2 The warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.
- 2.3.4.3 If the manufacturer repairs the product, the repair shall utilize only new replacement parts.

Replacement of existing parts shall be with new parts of the same design meeting or exceeding the performance of the replaced parts. Any such repair or replacement shall include a warranty for either 90 days or the remainder of the original warranty period, whichever is longer.

2.4 GUARANTEED CHANNEL PERFORMANCE

2.4.1 Category 6A 10 Gigabit Guaranteed Channel Performance

- 2.4.1.1 The Category 6A, 4 pair UTP channel shall consist of all cable and components with up to four connections that comprise the full 100-meter (328 feet) length circuit from the Hub/Server/LAN Electronics port located in the ER and/or TR to the device port located at the User Workstation.
- 2.4.1.2 All copper cable and apparatus shall exceed the Category 6A/Class D Channel Performance Specification.
- 2.4.1.3 The Category 6A cable and components shall be electrically compatible with future networks and backward compatible with existing Category 3, 5e and 6. Components of the Category 6A channel shall be engineered and manufactured to compensate for any Category 3, 5e or 6 component crosstalk and shall provide at least Category 3, 5e or 6 performance in all the customer's existing installed base of voice/data/video. The Category 6A cable and components shall be physically compatible with existing installed base of equipment.
- 2.4.1.4 The Category 6A cable and components shall not require special cords, specialty tools or special installation requirements.
- 2.4.1.5 The Category 6A, 4 pair UTP channel shall be capable of providing stable and continual performance from 0 MHz to 500 MHz over the entire swept frequency range.
- 2.4.1.6 All copper cable and apparatus shall conform to IEEE and TIA standards for 10Gb/s performance including specifications for alien crosstalk and ANSI/TIA-568-C.2 addendum 10 draft standard and the draft IEEE 802.3an for 10GBase-T standard.
- 2.4.1.7 The channel performance (including Alien Crosstalk performance) shall be guaranteed for the worst-case six-around-one channel configuration, where the entire 90m permanent link length is in a structured (combed) bundle.
- 2.4.1.8 The channel performance shall have >625 MHz of usable bandwidth and a Shannon capacity of >18 Gb/s up to 500 MHz.
- 2.4.1.9 The Delay Skew on the 100-meter channel shall not exceed 50 ns.
- 2.4.1.10 Each installed channel (consisting of cable, cords and up to four connections) shall provide the following performance above (margin/ headroom) the ANSI/TIA-568-C.2 standard for a Category 6A four connector channel over the entire swept frequency range from 0 MHz to 500 MHz:
 - 2.4.1.10.1 Insertion Loss: 2.0%
 - 2.4.1.10.2 NEXT (Near End Crosstalk): 1.0 dB
 - 2.4.1.10.3 PSNEXT (Power Sum Near End Crosstalk): 2.5 dB
 - 2.4.1.10.4 ACRF/ ELFEXT (Attenuation to Crosstalk Ratio (Far End)/ Equal Level Far End Crosstalk): 4.0 dB
 - 2.4.1.10.5 PSACR (Power Sum Attenuation to Crosstalk Ratio): 6.5 dB
 - 2.4.1.10.6 PSACRF/ PSELFEXT (Power Sum Attenuation to Crosstalk Ratio (Far End)/ Power Sum Equal Level Far End Crosstalk): 6.0 dB

2.4.1.10.7 PSANEXT (Power Sum Alien Near End Crosstalk): 2 dB

2.4.1.10.8 Return Loss: 1.0 dB

2.4.2 Outdoor Category 6A cable

2.4.2.1 Shall be Unshielded Twisted Pair (UTP), contains 4 pairs twisted pair cable, internal water-proof layer design.

2.4.2.2 Shall meet or exceed applicable requirements of ISO/IEC "11801 Class EA channel specifications" up to a minimum of 500MHz for all four (4) pairs.

2.4.2.3 Shall meet or exceed TIA-568.2-D standard for Category 6A cable for all four (4) pairs.

2.4.2.4 Shall support 1GBASE-T to a minimum of 100 meters on all four (4) pairs.

2.4.2.5 Cable jacket shall be PE material, black color.

2.4.2.6 Shall support direct burial installation.

2.4.2.7 Operation Temperature: -40°C~+70°C.

2.5 OUTLETS

2.5.1 Faceplates

2.5.1.1 General Requirements

2.5.1.1.1 Faceplates shall be available in single, duplex, triplex, quadplex, and sixplex arrangements in a single gang configuration.

2.5.1.1.2 The outlets shall be capable of being installed in any modular faceplate, frame, flush mounted box or surface-mounted box avoiding the need for special faceplates.

2.5.1.1.3 Faceplate outlet openings shall be numbered on both sides for installation and maintenance identification.

2.5.1.1.4 Faceplate shall be installed with the number of ports as required by the designated outlet. Each unused port shall contain a blank insert matching the color of the faceplate.

2.5.1.2 Modular Flush Mounted Faceplates

2.5.1.2.1 Faceplates shall be High-impact, flame retardant, UL-rated 94V-0 thermoplastic.

2.5.1.2.2 The standard faceplate color for back-of-house areas shall be White

2.5.1.2.3 Refer to the plans for individual front-of-house faceplate colors by location.

2.5.1.3 Metal Modular Faceplates

2.5.1.3.1 Metal faceplates shall be available in stainless steel.

2.5.1.3.2 Painted steel faceplate colors shall be available in custom colors. Refer to the plans for individual faceplate colors by location.

2.5.1.4 Modular Furniture Faceplates

2.5.1.4.1 Modular faceplates shall be available in double, triplex, and quadplex configurations.

2.5.1.4.2 Modular faceplates shall be designed and manufactured to support applications and connectivity within Modular Furniture. Refer to the Architectural Interiors

plans for modular furniture details and information.

2.5.2 Category 6A outlet

- 2.5.2.1 All Category 6A outlets shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA-568.2-D Commercial Building Telecommunication Cabling Standard and be part of the UL LAN Certification and Follow-up Program.
- 2.5.2.2 The Category 6A outlets shall be backward compatible with Category 6, 5e, 5 and 3 cords and cables.
- 2.5.2.3 Category 6A 8P8C jacks shall be:
 - 2.5.2.3.1 8-position/ 8-conductor modular outlets.
 - 2.5.2.3.2 Terminated utilizing insulation displacement.
 - 2.5.2.3.3 Equipped with T568A and T568B universal wiring labels.
- 2.5.2.4 The outlet shall accept either the TT568A or T568B wiring configurations. The T568B wiring scheme shall be used.

2.6 MODULAR PATCH PANELS

- 2.6.1 The Category 6A modular jack panels shall meet or exceed the Category 6A standards requirements in ISO/IEC 11801 (2002), CENLEC EN 50173 (2002) and ANSI/TIA-569.2-D and shall be UL Listed.
- 2.6.2 The Category 6A modular patch panels shall support system performance up to and beyond pending 10GBase-T standards and shall satisfy ANSI/TIA-568-.2-D.
- 2.6.3 The panel shall be capable of accepting either T568A or T568B wiring configurations.
- 2.6.4 The panel shall accept standard modular 8-position, 8-conductor jacks.
- 2.6.5 The jack panels shall be 19-inch rack mountable.
- 2.6.6 The patch panel shall be available in 12, 24 and 48 port configurations.
 - 2.6.6.1 12 and 24 port patch panels shall mount in a single RU space.
 - 2.6.6.2 48 port patch panels shall mount in a two RU space.
- 2.6.7 The patch panel shall ensure alien crosstalk performance.
- 2.6.8 Each patch panel shall include a rear mounted metal strain relief bar.
 - 2.6.8.1 Strain relief bars shall be mounted to the rear of the equipment rack, directly behind the patch panel.
 - 2.6.8.2 Strain relief bars shall have a smooth, contoured bearing surface to alleviate point pressure on the cabling, maintain cable bend radius and to allow securing of cable ties.
- 2.6.9 Provide horizontal wire management containing patch cord organizers between each group of modular patch panels
 - 2.6.9.1 Each horizontal wire manager shall have horizontal routing via molded plastic fingers to manage cable bend radius and a dual hinged cover.
 - 2.6.9.2 Horizontal wire managers shall include rear facing molded plastic cable management fingers with a dual hinged cover.
 - 2.6.9.3 Each horizontal wire manager shall mount in a two RU space.

2.7 110-WIRING BLOCK

- 2.7.1 Approved Manufacturers
 - 2.7.1.1 Belden
 - 2.7.1.2 CommScope
 - 2.7.1.3 Panduit
 - 2.7.1.4 Leviton
- 2.7.2 The wiring block shall facilitate cross connection and interconnection using either cross connect wire (voice only) or the appropriate category patch cords.
- 2.7.3 The wiring blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. The index strips shall be marked with five colors on the high teeth, separating the tip and ring of each pair, to establish pair location.
- 2.7.4 A series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips.
- 2.7.5 The wiring block shall accommodate 19- through 26-AWG conductors and shall be able to mount directly on wall surfaces with or without backboards or on a 19" free-standing frame.
- 2.7.6 Clear label holders with the appropriate colored inserts shall be provided with the wiring blocks. The insert labels shall contain vertical lines spaced on the basis of circuit size (3-, 4-, or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.
- 2.7.7 The wiring blocks shall be available in 100 and 300 pair sizes and shall be available with or without legs depending on the mounting.
- 2.7.8 The wiring block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10000 connections.
- 2.7.9 Jumper Trough
 - 2.7.9.1 Provide a horizontal trough for the routing of patch cords and/or cross connect wire.
 - 2.7.9.2 Provide a horizontal trough between each wiring block and top and bottom of each group of wiring blocks.
 - 2.7.9.3 Provide vertical cross-connect management with troughs integrated with the frame.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- 3.1.1 Components of the SCS system shall be installed in a neat, workmanlike manner.
- 3.1.2 Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.
- 3.1.3 Identification markings and systems shall be uniform.

3.2 WIRING METHODS

- 3.2.1 Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- 3.2.2 Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- 3.2.3 Provide a minimum 10'-0" of service loop/ figure eight at the telecommunications rooms for each permanent link.

- 3.2.4 Provide a minimum of 3'-3" of service loop/ figure eight in the ceiling above the telecommunications outlet for each channel.
- 3.2.5 Provide a minimum of 8" slack of cable at each copper UTP outlet location for jack termination.
- 3.2.6 Provide a minimum of 3'-3" of cable at each fiber optic outlet for connector termination.
- 3.2.7 The Low Voltage Contractor shall ensure that all recommended cable pulling tensions and pulling bending radius are not exceeded. Any cable damaged (bent or kinked to a radius less than the recommended dimension) shall not be installed. Any cable that is bent or kinked to a radius less than the recommended dimension during installation shall be replaced by the Low Voltage Contractor at no additional cost to the project.
- 3.2.8 Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 REQUIREMENTS FOR CABLE ROUTING AND INSTALLATION

3.3.1 Cabling

- 3.3.1.1 All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes.
- 3.3.1.2 All UTP copper cabling shall bear CMP (Plenum Rated) and/or appropriate markings for the environment in which they are installed.
- 3.3.1.3 All fiber optic cabling shall bear OFNP (Plenum Rated) and/or appropriate markings for the environment in which they are installed.

3.3.2 Cable Pathway

- 3.3.2.1 In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, the Low Voltage Contractor shall bundle, in bundles of 50 or less, station wiring with fabric cable ties snug. The ties shall be snug but not deforming the cable geometry.
- 3.3.2.2 Cable bundles not located in cable tray shall be supported via "J" hooks attached to the existing building structure and framework at intervals of four (4) feet average with a maximum separation of five (5) feet.
- 3.3.2.3 Plenum rated cable ties shall be used in all appropriate areas.
- 3.3.2.4 The Low Voltage Contractor shall adhere to the manufacturers' requirements for bending radius and pulling tension of all data and voice cables.
- 3.3.2.5 All cabling shall be run in and supported by cable pathways that are installed solely for the purpose of supporting low voltage communications cabling.
- 3.3.2.6 Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
- 3.3.2.7 Cables shall not be attached to or supported by fire sprinkler heads or delivery systems, or any environmental sensor located in the ceiling air space.
- 3.3.2.8 Cables shall maintain adequate separation from EMI and heat sources such as lighting fixtures etc.
- 3.3.2.9 Coordinate the support of cable pathways support systems with the work of other trades.
- 3.3.2.10 Coordinate routing of cable pathways with the work of other trades to maintain adequate working clearances above, below and to the sides of cable pathways.
- 3.3.2.11 Coordinate with other contractors during the final BIM coordination meetings when shared

hangers to support cable pathway systems are used.

3.3.3 Penetrations of Walls, Floors and Ceilings

- 3.3.3.1 Prior consent: The Low Voltage Contractor shall make no penetration of floors, walls or ceiling without the prior consent from the Engineer.
- 3.3.3.2 Coordination: Coordinate the fire proofing manufacturer, product, and specific sealing detail to be utilized on penetrations with other contractors to ensure that fire proofing seals are UL compliant.
- 3.3.3.3 Sealing penetrations: The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
- 3.3.3.4 Where penetrations through acoustical walls or other walls for cableways that have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.

3.3.4 Fire Stopping

- 3.3.4.1 Responsibility for sealing of opening around the exterior of the low voltage system sleeves shall be by the contractor as described below:
 - 3.3.4.1.1 Sleeves through fire rated and smoke walls created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
 - 3.3.4.1.2 Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - 3.3.4.1.3 Sleeves of openings between floors created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
 - 3.3.4.1.4 Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
- 3.3.4.2 Sealing of the space internal to all sleeves or openings specifically designated for telecommunications cabling shall be the responsibility of the Low Voltage Contractor.
- 3.3.4.3 Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.

3.3.5 Horizontal Cabling

- 3.3.5.1 The Low Voltage Contractor shall supply horizontal cables to connect each information outlet to the backbone subsystem on the same floor.
- 3.3.5.2 Unless otherwise noted on the floor plans or within this document, the type of horizontal cables used for each work location shall be 4-pair unshielded twisted pair (UTP).
- 3.3.5.3 The 4-pair UTP cables shall be run using a star topology format from the administration subsystem (Electronic Equipment Room/Electronic Enclosure) on each floor to every individual Telecommunication Outlet.
- 3.3.5.4 All cable routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by Engineer prior to installation of the cabling.
- 3.3.5.5 The length of each individual run of horizontal cable from the administration subsystem (Telecommunications Closet) on each floor to the Telecommunication Outlet shall not exceed 295 ft (90 m).

- 3.3.5.6 Conduit runs installed by the Low Voltage Contractor should not exceed 100 feet or contain more than two 90 degree sweeping bends without utilizing appropriately sized pull boxes.
- 3.3.5.7 The Low Voltage Contractor shall adhere to the manufacture's recommendations and specifications with regard to the bending radius and pulling strength requirements of the 4-pair UTP cable during handling and installation.
- 3.3.5.8 The Low Voltage Contractor shall maintain the horizontal UTP cable twist rate for each pair in the cable to within 0.5-inches of the cable termination or to the manufacturer's termination instructions, whichever is more stringent. The cable jacket shall be removed only to the extent required to make the termination.
- 3.3.5.9 Each run of cable between the termination block and the information outlet shall be continuous without any joints or splices.
- 3.3.5.10 In suspended ceiling and raised floor areas where walker duct, cable trays or conduit are not available, the Low voltage Contractor shall bundle station wiring with Velcro type cable ties at appropriate distances.
- 3.3.5.11 The Low Voltage Contractor shall conceal horizontal distribution wiring internally within the walls. If obstructions exist, the Low Voltage Contractor shall secure approval by Engineer prior to the use of an alternate method.
- 3.3.5.12 Every effort will be made to schedule the requirements under this Contract in such a manner so as to complete all above ceiling work prior to ceiling tile installation. In the event the Low Voltage Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid and must be coordinated with the General Contractor.

3.4 ADMINISTRATION

- 3.4.1 Fields: Separate termination fields shall be created for voice and data applications if both are wall mounted.
- 3.4.2 Termination blocks: Termination blocks that require rotation after connection of horizontal/vertical wiring shall not be allowed.
- 3.4.3 Cross-connect wire, patch cords: The Owner shall provide cross-connect wire, copper and fiber patch cords for cross connection and inter-connection of termination blocks, patch panels, and fiber cabinets.

3.5 SOURCE QUALITY CONTROL

- 3.5.1 Testing Agency: Engage a qualified testing agency to evaluate cables.
- 3.5.2 Factory test UTP cables on reels according to ANSI/TIA-568.1-D.
- 3.5.3 Test UTP cables according to ANSI/TIA-568.2-D.
- 3.5.4 Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- 3.5.5 Cable will be considered defective if it does not pass tests and inspections.
- 3.5.6 Prepare test and inspection reports.

3.6 INSTALLATION

- 3.6.1 The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals, shop drawings and as-built drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.

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- 3.6.2 Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.
- 3.6.3 All installation shall be done in conformance with ANSI/TIA-568 standards, federal and local standards and the SCS manufacturer Design and Installation guidelines.
- 3.6.3.1 The Low Voltage Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Low Voltage Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation at no additional cost to the owner. This shall also apply to any and all damages sustained to the cables by the Low Voltage Contractor during the implementation.
- 3.6.3.2 The Low Voltage Contractor shall make provisions so that all cabling is stored within a temperature-controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.
- 3.6.4 Bonding and Grounding
- 3.6.4.1 Comply with requirements in Division 27 Section "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- 3.6.4.2 Comply with ANSI-J-STD-607-A and ANSI/TIA-942 Grounding and Bonding Standards.
- 3.6.4.3 Grounding must be in accordance with the NEC, NFPA and all local codes and practices.
- 3.6.4.4 The Low Voltage Contractor shall be responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to any existing facilities.
- 3.6.4.5 The Low Voltage Contractor shall be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
- 3.6.5 Power Separation: The Low Voltage Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. All SCS equipment and terminations must maintain proper separation from sources of EMI as per ANSI/TIA 569-D and BICSI installation practices.
- 3.6.6 Separation from EMI Sources:
- 3.6.6.1 Comply with Article 800.52 of ANSI/NFPA 70, BICSI TDMM and ANSI/TIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
- 3.6.6.2 Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
- 3.6.6.2.1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
- 3.6.6.2.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
- 3.6.6.2.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
- 3.6.6.3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
- 3.6.6.3.1 Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
- 3.6.6.3.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
- 3.6.6.3.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

- 3.6.6.4 Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 3.6.6.4.1 Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 3.6.6.4.2 Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3.6.6.4.3 Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 3.6.6.5 Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- 3.6.6.6 Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
- 3.6.7 Miscellaneous Equipment: The Low Voltage Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (ER & EER/EE locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the SCS system.
- 3.6.8 Special Equipment and Tools: It shall be the responsibility of the Low Voltage Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
 - 3.6.8.1 Tools for terminating cables,
 - 3.6.8.2 Testing and splicing equipment for copper/fiber cables,
 - 3.6.8.3 Communication devices,
 - 3.6.8.4 Jack stands for cable reels,
 - 3.6.8.5 Cable winches.

3.7 IDENTIFICATION/ LABELING

- 3.7.1 The Low Voltage Contractor shall be responsible for generating and placing printed labels for all cables and cords, distribution frames, and outlet locations at the time of delivery.
- 3.7.2 Adhere to existing owner standards for identification/labeling.
- 3.7.3 All horizontal cables shall be labeled within 4" of terminations on each end.
- 3.7.4 Labels shall not be written by hand.
- 3.7.5 Identification:
 - 3.7.5.1 Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 3.7.5.1.1 Project Administration Class as defined by the latest version of the TDMM
 - 3.7.5.1.2 Color-code cross-connect fields. Apply colors to voice and data service back-boards, connections, covers, and labels.
 - 3.7.5.2 Paint and label colors for equipment identification shall comply with TIA/EIA-606-C for the appropriate administration class level of administration
 - 3.7.5.3 Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

- 3.7.5.4 Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-C. Furnish electronic record of all drawings, in software and format selected by Owner.
- 3.7.5.5 Cable and Wire Identification:
 - 3.7.5.5.1 Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 3.7.5.5.2 Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 3.7.5.5.2.1 Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - 3.7.5.5.2.2 Label each unit and field within distribution racks and frames.
 - 3.7.5.5.3 Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- 3.7.5.6 Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-C.
- 3.7.6 Cable Records: The Low Voltage Contractor shall maintain conductor polarity (tip and ring) identification at the equipment, risers, and station connecting blocks in accordance with industry standards and practices.
- 3.8 TESTING / WARRANTY**
 - 3.8.1 Copper Cable testing
 - 3.8.1.1 Testing of all copper wiring shall be performed prior to system acceptance.
 - 3.8.1.2 One hundred percent of the permanent installed links shall be tested for conformance to the manufacturers guaranteed performance levels as specified in the manufacturer's Extended Product Warranty platform.
 - 3.8.1.2.1 Any pairs not meeting or exceeding the requirements of the guaranteed performance levels shall be brought into compliance by the contractor, at no charge to the owner.
 - 3.8.1.2.2 All cabling shall exceed the specifications of ANSI/TIA-568-C.2 (specific to the Category standards the cabling is manufactured to) by the margins (headroom) specified in the manufacturer's Extended Product Warranty platform.
 - 3.8.1.3 One hundred percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition, and presence of AC voltage.
 - 3.8.1.4 Test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.
 - 3.8.1.5 All test equipment shall include valid proof of calibration within 6 months of the testing date. The calibration shall utilize the manufacturer's recommended calibration practices.
 - 3.8.1.6 One hundred percent of horizontal cables shall be tested according to the manufacturer's in-

structions utilizing the latest firmware and software.

3.8.1.6.1 Testing shall include all of the electrical parameters.

3.8.1.6.2 The detailed test results shall include the following:

3.8.1.6.2.1 Wire Map

3.8.1.6.2.2 Length

3.8.1.6.2.3 Insertion loss

3.8.1.6.2.4 Near-End Cross Talk (NEXT)

3.8.1.6.2.5 Power Sum Near-End Crosstalk (PSNEXT)

3.8.1.6.2.6 Equal-Level Far End Crosstalk (ELFEXT)

3.8.1.6.2.7 Power Sum Equal-Level Far-End Crosstalk (PSELFEXT)

3.8.1.6.2.8 Power Sum Alien Near End Cross Talk (PSANEXT)

3.8.1.6.2.9 Return Loss

3.8.1.6.2.10 Propagation delay

3.8.1.6.2.11 Delay skew

3.8.1.7 Complete, end to end, test results shall be submitted to Engineer for review.

3.8.2 Extended Product and Application Assurance Warranty Work

3.8.2.1 Under the Extended Product and Application Assurance Warranty, the manufacturer shall replace any and all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.

3.8.2.2 The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the owner.

3.8.2.3 The Extended Product Warranty shall include a minimum two (2) year installation warranty for the premises copper and optical cabling to correct all installation related problems/ issues at no cost to the owner.

3.9 AS-BUILT DOCUMENTATION

3.9.1 Upon completion of the project, Low Voltage Contractor shall prepare "As-Built" documentation showing actual site conditions and installation as constructed.

3.9.2 Provide copies of such documentation to Owner as mentioned below.

3.9.2.1 Upon completion of system installation, Low Voltage Contractor shall provide to Owner for its records the following:

3.9.2.1.1 EF, ER and EER/EE Diagrams which shall include:

3.9.2.1.1.1 Cable routing.

3.9.2.1.1.2 Position of all components.

3.9.2.1.1.3 Detailed layout of all wall fields.

3.9.2.1.1.4 Labeling plan.

3.9.2.1.2 Work Area Floor Plans which shall Include:

3.9.2.1.2.1 Detailed cable routes

3.9.2.1.2.2 Firestop penetrations (with UL system number).

3.9.2.1.2.3 Approved labeling plan for all work areas.

3.9.2.1.3 Cable Tray, Conduit, and Raceway Plans

3.9.2.2 Documentation shall be in the following format:

3.9.2.2.1 Four (4) copies of all diagrams and drawings matching the bid documents in size and format.

3.9.2.2.2 One (1) copy of electronic plans, drawings and diagrams provided in both PDF format and the latest version of AutoDesk AutoCAD (or Revit if applicable) on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.

3.9.2.2.3 One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.

3.9.3 Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Low Voltage Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for both copper and fiber cables.

3.10 COMPLETION OF WORK

3.10.1 At the completion of the System, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

3.10.2 All clean up, restoration, and removal noted above shall be by the Low Voltage Contractor and at no additional cost.

3.10.3 If the Low Voltage Contractor fails in its duties under this paragraph, Owner may upon notice to the Low Voltage Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Low Voltage Contractor.

3.11 INSPECTION

3.11.1 On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high-quality manner and the overall appearance shall be clean, neat and orderly.

3.11.2 Upon completion of the project, the engineer representative will perform a final inspection of the installed cabling system with a Low Voltage Contractor's representative. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package.

END OF SECTION

PART 1 - GENERAL

1.1 APPLICATION

- 1.1.1 Functional and output specifications for the Wi-Fi System, herein also referred to as the 'wireless system'.

1.2 REFERENCES

- 1.2.1 This section shall be read in conjunction with and in the context of all other sections of the contract documents

1.3 SUBMITTALS

- 1.3.1 Design Documents:
- 1.3.1.1 Equipment information, including catalogue sheets;
 - 1.3.1.2 A Wi-Fi site survey of the entire coverage envelope, in stages as described;
 - 1.3.1.3 Wi-Fi topology (physical and logical) and interconnect drawings;
 - 1.3.1.4 Other design materials outlining:
 - 1.3.1.4.1 Design redundancy and channel capacity;
 - 1.3.1.4.2 Design number and concentration of user devices
 - 1.3.1.4.3 Receive Strength Signal Indicator (RSSI) based planning
 - 1.3.1.5 Assigned rack/cabinet elevation drawings;
 - 1.3.1.6 The commissioning plan.
- 1.3.2 As-built Documents (catalogue of all information documenting the design and products as delivered at time of hand-over):
- 1.3.2.1 All design documentation, updated as applicable;
 - 1.3.2.2 Instructions for storage, handling, protection, operation, and installation of all provided equipment and products whether hardware or software;
 - 1.3.2.3 Complete schedule of equipment and software including as appropriate:
 - 1.3.2.3.1 Manufacturer/vendor information;
 - 1.3.2.3.2 Date part acquired;
 - 1.3.2.3.3 Model and version numbers;
 - 1.3.2.3.4 Warranty information;
 - 1.3.2.3.5 All license information.

1.4 SCOPE OF WORK

- 1.4.1 Contractor shall implement a fully configured Wi-Fi solution, coordinated with the Owner's requirements, providing enterprise class wireless coverage throughout the facility, including but not limited to the following:
- 1.4.1.1 All levels, including utility areas (Mechanical and Electrical Rooms etc.);
 - 1.4.1.2 Elevator cabs;
 - 1.4.1.3 Exit/Emergency corridors and staircases;

1.4.1.4 Rooftop AHU's

1.4.2 The entire solution shall be defined, designed, and installed as an end-to-end system, closely coupled and integrated with the wired LAN.

1.4.3 Deployment:

1.4.3.1 Provide in all designated locations, required Wi-Fi System equipment including all associated devices, modules, interfaces, patch cabling and terminations to meet the requirements of this and other relevant sections;

1.4.3.2 Wireless Access Points shall be installed in accordance with manufacturer recommendations and as permissible by applicable building and fire codes.

1.4.4 Wi-Fi Coverage Surveys:

1.4.4.1 Contractor shall conduct Wi-Fi coverage by various means during the course of the project, including computer generated models and live radio frequency measurement data, represented in graduated heat map formats;

1.4.4.2 During the design stage, Contractor shall provide an initial computer modelled site survey to determine optimal coverage and signal strength based upon proposed floor plan layouts and selected construction materials, when the information becomes available. This initial survey shall also take into account high user density areas, and will ultimately determine the initial quantity and location of the horizontal distribution cables and the network ports required to service the Wi-Fi system;

1.4.4.3 During the construction stage, Contractor shall conduct at minimum two walk-through radio frequency site surveys in order to iteratively adjust and optimize the design, coordinated with other disciplines as applicable. Upon completion of each survey Contractor shall provide survey information documenting WAP location changes and the new heat map information;

1.4.4.4 Prior to occupation of the facility, a baseline frequency analysis shall be performed, and results documented;

1.4.4.5 Owner will conduct annual checks in order to identify frequency conflicts. Contractor shall coordinate with the facility and take appropriate actions to resolve any related performance issues.

1.4.5 Wi-Fi Performance Testing:

1.4.5.1 W-Fi specific end-to-end testing and validation shall, but not be limited to:

1.4.5.1.1 Coverage and signal strength;

1.4.5.1.2 Extreme sensitivity performance (low to high power devices);

1.4.5.1.3 Signal to noise ratio and noise tolerance;

1.4.5.1.4 Bandwidth availability;

1.4.5.1.5 Traffic prioritization;

1.4.5.1.6 Hand-off and roaming performance;

1.4.5.1.7 System and WAP load balancing.

1.4.6 Configuration:

- 1.4.6.1 Configure all network equipment as required and as coordinated with Owner, interfacing vendors and contractors, to satisfy network service requirements. Such network configuration and provisioning shall include but not be limited to:
 - 1.4.6.1.1 IP addressing;
 - 1.4.6.1.2 VLAN assignments;
 - 1.4.6.1.3 Routing provisions;
 - 1.4.6.1.4 Network Security;
 - 1.4.6.1.5 Quality of Service;
 - 1.4.6.1.6 Network Management;
 - 1.4.6.1.7 Logging, trending, monitoring and alerting.

1.4.7 Quality Assurance:

- 1.4.7.1 Contractor shall retain an accredited Wi-Fi communications network vendor with a documented experience and delivery success in projects of comparable complexity and scope.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION AND DESIGN

2.1.1 Network Topology

- 2.1.1.1 The new network shall be designed with a redundant AP controllers located in the Main Computer Room and redundant back up in the Secondary Computer Room within the facility;
- 2.1.1.2 Wireless Access Points shall be powered via PoE, and connected directly to the network access switches located in the Telecom Rooms;
- 2.1.1.3 The overall logical design shall be closely coordinated with Owner and shall be implemented such as to provide transparent service availability across the entire facility WAN environment.

2.1.2 General Performance

- 2.1.2.1 The solution shall provide component and system level resiliency in order to ensure uninterrupted system operation. Critical duty equipment shall be equipped with resilient processing and power supply systems.
- 2.1.2.2 Failure of any of the core locations, whether at a system or a component level, shall not impact any of the network services. Failover between systems or components shall be imperceptible to the network users and shall take no more than 100ms to achieve steady state.
- 2.1.2.3 The coverage for all the required 802.11ac/ax standards, at all ratified frequency bands as applicable, shall be achieved at no greater than 50% radio power levels, and measured characteristics within the coverage areas shall be:
 - 2.1.2.3.1 Signal strength no lower than -65dBm;
 - 2.1.2.3.2 Signal to Noise Ratio greater than 20dB;
- 2.1.2.4 Should an access point fail, adjacent access points shall temporarily compensate by automatically boosting their power output levels.
- 2.1.2.5 Configure the Wi-Fi solution as coordinated with Owner, and in a manner that will ensure continuous, reliable service availability for:
 - 2.1.2.5.1 Authorized and secure access to corporate resources for Owner.

- 2.1.2.6 Wi-Fi guest access to the Internet, in a manner that does not compromise corporate LAN resources.

2.2 REFERENCE STANDARDS

- 2.2.1 All hardware, installation materials and workmanship shall meet applicable building codes and fire codes and shall be subject to compliance review by Authority Having Jurisdiction.
- 2.2.2 The design and implementation shall observe and follow current state standards as required to deliver this project. In addition to the most current standards required, the network may require support for older standards.
- 2.2.3 The network hardware shall comply with the following general IEEE Request for Comments (RFC) standards:
 - 2.2.3.1 802.11 A, B, G, N, AC, AX (or newer);
 - 2.2.3.2 802.11e – Quality of Service;
 - 2.2.3.3 802.11i – Security;
 - 2.2.3.4 In addition to the base IEEE 802 compliance as required to meet the functional and performance requirements, the solution shall also support and follow ISO/IEC 17799 Security Practice Standards.

2.3 WAP CONTROLLERS

- 2.3.1 WAP controllers shall each be located in the Data Centre and in the secondary Core Room. Each WAP controller shall at minimum meet the following functional and output specifications:
 - 2.3.1.1 Stand-alone or integrated into the core (modules), as coordinated with Owner at time of design;
 - 2.3.1.2 Redundant 208Vac power supplies (if standalone controller option is selected);
 - 2.3.1.3 Capable to support and manage all access points within the facility such as to ensure non-blocking data transport;
 - 2.3.1.4 The controller shall interface with the wired LAN over redundant, load balancing 10 Gb/s connections, or better;
 - 2.3.1.5 QoS for layers 2 through 7.

2.4 WIRELESS ACCESS POINTS

- 2.4.1 Access points shall be lightweight type and shall support, at minimum, the following:
 - 2.4.1.1 Indoor use, for use in plenum spaces where may be required;
 - 2.4.1.2 Most recent IETF CAPWAP recommendations;
 - 2.4.1.3 Support a minimum of 16 Service Set Identifiers (SSID).
 - 2.4.1.4 Simultaneous 802.11a, b, g, n , ac and ax non-blocking operation;
 - 2.4.1.5 Support for 802.11ac/ or latest standards at time of implementation. The system shall be ready/upgradeable, or fully configured if available at time of deployment;
 - 2.4.1.6 Support for 802.11ax
 - 2.4.1.7 Support Cisco Compatible Extensions.

- 2.4.1.8 Multiple Gigabit port for connection to the wired network;
- 2.4.1.9 Capability of being powered via 802.3at (PoE+) and a 120V power source.
- 2.4.1.10 QoS for layers 2 through 7.

2.5 WI-FI SECURITY

- 2.5.1 Network security solution shall be resilient such as not to impede secure network operation in an event of a system or component level failure.
- 2.5.2 The Wi-Fi communications shall be logically isolated from all other LAN (wired) communications, such as to make the wired LAN inaccessible from the wireless network.
- 2.5.3 Generally, the following wireless network security mechanisms shall be implemented as coordinated with the Owner's security policy:
 - 2.5.3.1 802.11i – WPA, WPA2, WPA3 (PSK and TKIP) and WEP;
 - 2.5.3.2 802.1x – EAP, EAP-TLS, PEAP, TLS, MSCHAP v2;
 - 2.5.3.3 Multiple SSID and SSID broadcast control;
 - 2.5.3.4 Rogue WAP detection;
 - 2.5.3.5 SSH Protocol support;
 - 2.5.3.6 AAA integration.
- 2.5.4 The wireless network shall have rogue device detection and RF suppression mechanisms to prevent unauthorised access points and other RF devices from interfering in Owner wireless network services.
- 2.5.5 Network security mechanisms and their implementation shall be coordinated with the Owner's security policy.

2.6 QUALITY OF SERVICE

- 2.6.1 Real time applications such as VoIP and IP Video shall be prioritised such as to provide reliable, quality service, without adversely affecting overall network performance for all other applications.
- 2.6.2 In order to ensure appropriate quality of service for real time and critical applications, the system performance shall ensure the following:
 - 2.6.2.1 There shall be no packet loss;
 - 2.6.2.2 End-to-end round-trip delay shall not exceed 100ms;
 - 2.6.2.3 Hand-off between access point for roaming devices shall not exceed 100ms;
 - 2.6.2.4 Network jitter, as reported by VoIP applications, shall not exceed 5%.
- 2.6.3 At minimum, the following QoS mechanisms shall be supported and implemented, as required.
 - 2.6.3.1 Type of Service (ToS) and Cost of Service (CoS)
 - 2.6.3.2 DiffServ;
 - 2.6.3.3 Wi-Fi Multimedia (WMM).

2.7 MANAGEMENT AND MONITORING

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- 2.7.1 Contractor shall provide a new management platform and tools to monitor and manage the wireless network at the facility.
 - 2.7.2 All access points shall be full managed using a single management platform.
 - 2.7.3 The wireless network shall use auto-RF or Remote Monitoring Management (RMM) and dynamic channel assignment to adapt to changes in the RF environment.

2.8 COMPUTERS

- 2.8.1 All system servers and workstations shall be certified for such use by the application system vendor.

PART 3 - EXECUTION

3.1 WI-FI ACCESS POINT INSTALLATION

- 3.1.2 The contractor shall provide all required mounting hardware for any selected mounting configuration, including above ceiling, below ceiling, vertical surface mount or pole/mast; and patch cables.
- 3.1.3 Access points shall be installed in concealed locations wherever possible, including above the ceiling, whether tiled or solid. The contractor shall coordinate all access point locations with the client and ensure that any areas of specific concern are adequately provisioned such that:
 - 3.1.3.1 Wi-Fi performance levels are met and recorded as part of initial coverage survey.
 - 3.1.3.2 Architectural design integrity is maintained;
- 3.1.4 Where necessary, and as coordinated with the client, access points located inside resident rooms shall be housed within CSA-C22.2 compliant enclosures.
- 3.1.5 Locations with concealed access points shall be identified with a locator label. The type and exact location of the labels shall be coordinated with the client and the Architect as necessary.

End of Section

PART 1 - GENERAL

1.1 Section Includes

1.1.1 This section includes a general description of the technical Scope of the Work and requirement surrounding the implementation of Telephone Systems:

1.1.1.1 Unified Communications System (UCS); and

1.1.1.2 Contingency Telephone System (CTS).

1.2 REFERENCES

1.2.1 Section 27 05 28 – Pathways for Communications Systems

1.2.2 Section 27 08 00 – Commissioning of Communications Systems

1.2.3 Section 27 11 00 – Communications Equipment Room Fittings

1.2.4 Section 27 13 00 – Communication Backbone Cabling

1.2.5 Section 27 15 00 – Communication Horizontal Cabling

1.3 SUBMITTALS

1.3.1 Design Documents (materials that require the client's review):

1.3.1.1 Equipment information (catalogue sheets);

1.3.1.2 System topology (physical and logical) and interconnect drawings;

1.3.1.3 Assigned rack/cabinet elevation drawings

1.3.1.4 The commissioning plan

1.3.2 As-built Documents (catalogue of all information documenting the design and products as delivered at time of hand-over):

1.3.2.1 All design documentation, updated as applicable;

1.3.2.1.1 Call flow diagrams;

1.3.2.1.2 Dial plans;

1.3.3 Instructions for storage, handling, protection and operation and installation of all provided equipment and products whether hardware or software;

1.3.4 Complete schedule of equipment and software including as appropriate:

1.3.4.1 Manufacturer/vendor information

- 1.3.4.2 Date of acquisition
- 1.3.4.3 Model and version numbers
- 1.3.4.4 Warranty information
- 1.3.4.5 All license information

1.4 SCOPE OF THE WORK

- 1.4.1 The contractor shall be responsible for the fully coordinated design and implementation of the system. All design and implementation activities shall be coordinated with the client.
- 1.4.2 Provide design, engineering and implementation services, necessary equipment, hardware, materials and all associated configuration for all components of the Network System.
- 1.4.3 Unified Communications System (UCS)
 - 1.4.3.1 The entire solution shall be defined, designed and installed as an end-to-end system, closely coupled and integrated with the Network System.
 - 1.4.3.2 UCS shall be an enterprise class communications system, fully integrated with the client's existing VoIP communications platform.
 - 1.4.3.3 The UCS shall form a logical extension of the client's existing VoIP system cluster such as to provide overall system resiliency and to make the client's existing voice applications available across the new system.
- 1.4.4 Contingency Telephone System (CTS)
 - 1.4.4.1 CTS shall be a business class TDM system that shall provide telephone services to strategic locations within the facility in the event of a catastrophic UCS failure.
 - 1.4.4.2 The solution shall be a current technology platform at the time of implementation.
 - 1.4.4.3 The solution shall not depend on the IP network for its operation. It shall integrate with UCS using SIP in order to make the two systems communicate seamlessly during normal conditions.
- 1.4.5 The system and all its components shall be supplied, installed, configured and commissioned by the contractor to ensure complete end-to-end interoperability and compatibility of all component subsystem, including:
 - 1.4.5.1 Passive and active devices;
 - 1.4.5.2 Interfaced networks and systems;
 - 1.4.5.3 Communication protocols;
 - 1.4.5.4 Associated cabling and connectors;
- 1.4.6 Deployment

- 1.4.6.1 Provide in all designated locations, required telephone system components and equipment, including:
 - 1.4.6.1.1 Head end system, associated devices, their licenses, modules, interfaces, patch cabling and terminations to meet the requirements of this and other relevant sections;
 - 1.4.6.1.2 Telephone sets and related accessories, in accordance with a coordinated station review;
- 1.4.6.2 Conduct detailed telephone station review to determine the final quantity, type, features and placement of all telephone sets, whether IP or TDM.
- 1.4.6.3 Station review shall consist of a log/record and floor plans that shall include, as a minimum, the following information for each set/device:
 - 1.4.6.3.1 Location;
 - 1.4.6.3.2 Type of device;
 - 1.4.6.3.3 Feature selection;
 - 1.4.6.3.4 Coordinated DID or extension number;
- 1.4.6.4 Install telephone patch cables as coordinated with the client.

1.4.7 Configuration

- 1.4.7.1 Configure the telephone systems as required and as coordinated with the client. Such configuration and provisioning shall include but not be limited to:
 - 1.4.7.1.1 Dial Plan;
 - 1.4.7.1.2 Call Flows;
 - 1.4.7.1.3 IP addressing scheme;
 - 1.4.7.1.4 VLAN architecture;
 - 1.4.7.1.5 Quality of Service;
 - 1.4.7.1.6 Network and Set Security;
 - 1.4.7.1.7 Others as needed;

PART 2 - Products

2.1 VENDOR COMPLIANCE

2.1.1 Network Topology

- 2.1.1.1 The client has invested significant effort and capital in existing Cisco Systems telephone infrastructure, and in developing related expertise and operational efficiencies. In order for the client to continue to capitalise on this investment, the new Unified Communications System solutions at the facility shall be based on technologies from Cisco Systems.
- 2.1.1.2 The client would be open to suitable vendor options for the deployment of the Contingency Telephone System. The client will consider solutions from the following reputable enterprise vendors:
 - 2.1.1.2.1 Avaya;
 - 2.1.1.2.2 Cisco Systems;
 - 2.1.1.2.3 NEC
- 2.1.1.3 Maximum use shall be made of Commercial-Off-The-Shelf products, technologies, and modular designs.

2.2 REFERENCE STANDARDS

- 2.2.1 All hardware, installation materials and workmanship shall meet applicable building codes and fire codes and shall be subject to compliance by Authority Having Jurisdiction.
- 2.2.2 The design and implementation shall observe and follow current standards as required to deliver this project. In addition to the most current standards required, the network may require support for older standards.
- 2.2.3 In addition to the base IEEE 802 compliance as required to meet the functional and performance requirement, the solution shall also support and follow ISO/IEC 17799 Security Practice Standards.

2.3 SYSTEM DESCRIPTION AND DESIGN

- 2.3.1 Unified Communications System (UCS)
 - 2.3.1.1 This section describes high level requirements for mission critical unified communications platform based on solution and technologies from Cisco Systems supporting all IP based voice and Cisco applications. The unified communications system should as a whole include the following key components:
 - 2.3.1.1.1 Cisco Unified Computing Systems for UM Servers
 - 2.3.1.1.2 Cisco Voice Gateways
 - 2.3.1.1.3 Interface cards and voice modules
 - 2.3.1.1.4 Web sphere management tools
 - 2.3.1.1.5 Cisco CIMCS manage tools
 - 2.3.1.1.6 Cisco Ops Manager tool
 - 2.3.1.1.7 Specifically interconnect cabling

2.3.1.1.8 Contact Centre recording tool or applications

2.3.1.2 The USC solution shall be based on a Cisco UCS Call Manager subscriber pair and a Cisco UCCX, all installed on a VMware platform. The subscriber pair and Cisco UCCX shall be configured as part of the client's existing cluster.

2.3.1.3 The solution topology shall provide redundancy by locating core components across diverse physical locations. Primary location shall be MCR1, and the secondary location shall be MCR2

2.3.1.4 The solution shall be designed with diverse, resilient and survivable elements as necessary to ensure around the clock, year-round continuity of system operation.

2.3.1.5 All equipment shall be provided with two hot-swap power supplies and redundant Ethernet interfaces (1000 Mbps, or as appropriate) for redundant connections to the network.

2.3.1.6 Failure of any one component within the system, and consequent fail-over, shall be imperceptible to user. No calls shall be dropped due to such failure.

2.3.1.7 UCS shall support analogue endpoints, such as telephones, faxes and point of sale devices, including any specific DTMF features and capabilities.

2.3.1.8 UCS solution shall include installing, configuring one Cisco Ops manager applications on a virtual server to provide monitoring for all Cisco components, voice integration with main system.

2.3.2 Contingency Telephone System (CTS)

2.3.2.1 CTS shall be a stand-alone TDM platform supporting digital and analogue telephone sets and shall have an independent connection to the service provider circuit.

2.3.2.2 The system shall be integrated for communication with UCS during normal conditions, and shall be transparent to users, i.e. access between the systems. Dial plan details shall be coordinated with the client.

2.3.2.3 Location of the system shall be coordinated with the client but shall generally be in a location not shared with the UCS.

2.3.3 Common Requirements

2.3.3.1 The following connectivity options shall be supported. The contractor shall coordinate actual requirements:

2.3.3.1.1 Digital Trunks

2.3.3.1.2 T1/E1;

2.3.3.1.3 Rate Access (PRI);

2.3.3.1.4 Basic Rate Access (BRI).

2.3.3.1.5 ISDN Connectivity

2.3.3.1.6 IP Networking Connectivity

2.3.4 Telephone Sets

2.3.4.1 The client will provide telephone sets and licenses for use by the client.

2.3.4.2 The contractor shall provide telephone sets and licenses for its own use on the client's IP telephone system. Telephone sets (models) shall be subject to review with the client.

2.4 CONFIGURATION AND INTEGRATION

2.4.1 Configure the new UCS solution as a logical extension of the client's existing voice architecture.

2.4.2 Provide services to bring basic system features and functions at the facility, including but not limited to:

2.4.2.1 General calling with extended features;

2.4.2.2 Conferencing with extended features;

2.4.2.3 External calling using local provider services;

2.4.2.4 Fail-over mechanisms;

2.4.2.5 Voicemail;

2.4.2.6 Contact Centre;

2.4.2.7 Recording server or application for contract centre agent calls

2.4.2.8 VoIP system monitoring using Cisco Ops Manager tool

2.4.3 Provide integration and related configuration and services as coordinated with the client, to bring voice applications systems and features to production states at the facility. These may include the client's existing telephony applications and services:

2.4.3.1 Cisco Unified Messaging;

2.4.3.2 Contact Centre application; including recording of call entire agent calls

2.4.3.3 Voice recognition;

2.4.3.4 Directory Services;

2.4.3.5 IP phone paging and notification;

2.4.3.6 Billing systems;

2.4.3.7 Call Detail Recording;

2.4.3.8 Voice recording;

2.4.3.9 Extension

2.4.3.10 Corporate Fax solution

2.4.3.11 Telephone System Monitoring

2.4.3.12 Others as may be necessary.

2.4.4 The scope of the configuration and the integration components shall include:

2.4.4.1 Coordination with the client's and its system vendors for voice communication requirements;

2.4.4.2 Participation in any integration design workshops and sessions as may be necessary;

2.4.4.3 Driving the process of collecting and defining necessary network communications requirements necessary for implementation.

2.4.5 The contractor shall provide all firmware and software components for the project to be of the latest, published, stable release up to 30 days prior to the scheduled system commissioning. Firmware and software shall be maintained with updates during the course of the warranty and term agreements per terms of the Project Agreement.

2.5 PROJECT IMPLEMENTATION

2.5.1 The contractor shall assign a certified experience Project Manager to manage the delivery of the Network System. The project Manager shall be well versed in all relevant technical areas applicable to the scope of the project, and have a minimum five (5) year experience in the delivery of converged network communications, both wired and wireless

2.5.2 The contractor shall ensure that the technical and engineering staff assigned to the project shall be certified by the proposed technology Vendors/Manufacturers to design, engineer, configure and maintain the proposed equipment.

2.5.3 The contractor shall ensure that pre-approved technical and engineering staff originally assigned to the project remains available to the project for the entire duration, and minimum 30 days after commissioning.

2.5.4 Design submittals shall be provided to the client for review as per individual system specifications. Maintain and update all drawings as required. Updating drawings shall be made available to the client upon request, with clearly identified quantity, design, and implementation changes, as well as dated document revision.

2.5.5 Adhere to the change control process and procedures established with the client. The contractor shall not affect any actions that may result in change to scope, schedule, quality and formally agreed upon design.

2.6 TRAINING

2.6.1 The contractor shall develop a training program for review by the client. Once approved, the contractor shall provide the following training to the client, for all delivered system

2.6.1.1 Installation and maintenance;

2.6.1.2 Configuration and management; and

2.6.1.3 End user training

- 2.6.2 At least 30 days prior to commencing training, the contractor shall submit to the client for review three (3) draft copies of training course outlines and training manuals.
- 2.6.3 The contractor shall provide on-site classroom-based training for system administrators and for the system users.
- 2.6.4 The training scope shall include all aspects of the solution being delivered. Timing of the training shall be at the client's choosing and will be coordinated with the contractor.
- 2.6.5 The training program must be completed 20 days prior to Substantial Performance.

2.7 WARRANTY AND SUPPORT

- 2.7.1 All system components shall include an extended warranty and on-site maintenance agreement, with a maximum 4-hour response time, year-round on a 24x7 basis, for the entire lifetime of all equipment.
- 2.7.2 The contractor shall provide assurance that all system direct-replacement components shall be available for a minimum of five (5) years from the date of Final Performance of the construction contract. The assurance may be in the form of documentation from the Manufacturer, confirming component and support availability for the required time period.
- 2.7.3 Warranty shall cover replacement or repair within 4 hours of any mission critical defective component, assembly, or sub-system that malfunctions or fails while operating for the purpose intended by the manufacturer. Warranty replacement and repair shall include all shipping, handling and materials, if and as required.
- 2.7.4 All delivered and implemented Network System hardware, software and firmware shall become the property of the client, in that the software, firmware and any associated licenses delivered shall not expire or require the client to incur additional costs to maintain them in any way.

2.8 SPARE PARTS

- 2.8.1 The contractor shall submit a recommended list of spare parts including a detailed listing and description of all components including a reference to room data schedules.
- 2.8.2 The parts list shall include the following information:
- 2.8.2.1 Name of the part;
 - 2.8.2.2 Complete description of the part;
 - 2.8.2.3 Each specific location that the listed part is used in the system(s);
 - 2.8.2.4 Total number of parts in the system(s);
 - 2.8.2.5 Manufacturer of part;
 - 2.8.2.6 Manufacturer's part number;
 - 2.8.2.7 Source of supply;

- 2.8.2.8 Price per unit;
- 2.8.2.9 Lead time for availability of part;
- 2.8.2.10 Estimated Spare Part List required for first year of operation;
- 2.8.2.11 Mean time Between Failure (MTBF) and Mean Time To Repair (MTTR)

2.8.3 The client and the contractor will provide the list of spare parts on contract signing.

2.9 GENERAL REQUIREMENTS

2.9.1 All equipment and hardware provided by the contractor shall be new and unblemished. After installation, each item of equipment and hardware shall be cleaned by qualified staff following manufacturers recommended procedures.

2.9.2 A thorough and professional installation shall be provided. The contractor shall utilize only skilled labour familiar with the work at hand. Unsafe practices, poor workmanship, incomplete submissions and documentation shall be rejected.

2.9.3 Continuity of Services

2.9.3.1 The contractor shall not take any action that will interfere with or interrupt, the client's services or systems unless previous arrangement have been made with the client. All activities shall be subject to Change Advisor Board review/approval. Refer to FMOS technical section.

2.9.3.2 Should services be inadvertently interrupted due to action by the contractor, the contractor shall immediately furnish labour, including overtime, material, and equipment necessary for prompt restoration of the interrupted services at no cost to the client.

2.9.3.3 All activities having potential for the disruption to the client's infrastructure or system shall be strictly coordinated with the client.

2.9.4 Material Guarantee

2.9.4.1 Ensure that all correct parts are ordered and installed. Maintain records and submit as part of the as-build package part numbers for all installed equipment.

2.9.5 Manufacturer's Instructions

2.9.5.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

2.9.5.2 Notify the client in writing of any conflict between these specifications and manufacturer's instructions. The client will designate which document shall be followed.

2.9.6 Conformance

2.9.6.1 When materials or products are specified by a Standard, Perspective or Output Specifications, the conformance of delivered materials or products must be verifiable by means of documentation published by vendor or an independent recognized testing authority.

2.9.7 Documentation

- 2.9.7.1 All submittal documentation shall be provided in electronic format and in hardcopy. Each of the three (3) required copies of the hardcopy submittals shall include a cover page, clearly identifying:
 - 2.9.7.1.1 Contract No.;
 - 2.9.7.1.2 Title;
 - 2.9.7.1.3 Revision ID, date and author;
 - 2.9.7.1.4 Summary outlining context and purpose;
 - 2.9.7.1.5 Revision history, showing issue date, author and change summary for each revision;
 - 2.9.7.1.6 Noted as "For Comments", "For Approval" or "For Information"
 - 2.9.7.1.7 Noted as "Response Requested By: YYYY-MM-DD" if applicable.
- 2.9.7.2 Electronic submittal documents shall be in PDF (compatibility mode). These documents shall be made available upon request in native, editable format, and shall include, as applicable:
 - 2.9.7.2.1 Microsoft Office 2010 (or newer) documents;
 - 2.9.7.2.2 Microsoft Visio, Microsoft Project documents (2010 or newer);
- 2.9.7.3 The contractor shall manage a library consisting of all documents developed under this agreement, including specifications, design documents, test reports and others.
- 2.9.7.4 The contractor shall implement and manage a Configuration Management Plan in order to:
 - 2.9.7.4.1 Document and monitor changes that effect scope, schedule, and costs.
 - 2.9.7.4.2 Supervise approval and delivery status of proposed changes.

2.9.8 Substitutions

- 2.9.8.1 No Substitution shall be permitted without prior review by the client.
- 2.9.8.2 Substitution Proposal will be considered if:
 - 2.9.8.2.1 Materials specified are not available;
 - 2.9.8.2.2 Delivery date of materials specified would unduly delay completion of contract;
 - 2.9.8.2.3 Such substitutions and justification are identified in the Project Agreement;
- 2.9.8.3 Should proposed substitution(s) be accepted either in part or in whole; the contractor shall be responsible for all consequential work and associated cost.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE

- 3.1.1 All equipment shall be installed in accordance with the equipment manufacturer's requirements and recommendations, and in location coordinated with the client.
- 3.1.2 The contractor shall engage an accredited network systems vendor in order to deliver the Network System as described.

3.2 WORKMANSHIP

- 3.2.1 All work shall be performed to applicable standards and industry best practices.
- 3.2.2 Patch cabling shall be neatly routed in cableways as required and as recommended in applicable standards.

3.3 INSTALLATION

- 3.3.1 Equipment shall be mounted in accordance with manufacturers recommended/supplied hardware and fasteners by staff deemed to be qualified by the manufacturer.

3.4 PROTECTION

- 3.4.1 Protect equipment not yet installed by storing it in original packaging and in secure area. Secure storage spaces, as well as transport of equipment to and from that area are the sole responsibility of the contractor.

3.5 CLEAN-UP

- 3.5.1 Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.
- 3.5.2 Clean up all areas around system equipment and ensure that internal equipment component area is free from debris.

END OF SECTION

Part 1 - General

1.1 Submittals

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

1.2 WARRANTY AND MAINTENANCE

- 1.2.1 The System Supplier to provide manufacturer's standard warranty on the system which is to include necessary labour and equipment to maintain the system(s) in full operation for a period of two (2) years from the date of Substantial Performance of the Work of the entire project.
- 1.2.2 Installation of system upgrade software to be by the system supplier and to be covered under this warranty.
- 1.2.3 System firmware / software upgrades to be downloaded to the system by data connection. Upgrades to be accomplished system-wide from a single point of connection.
- 1.2.4 Systems requiring local programming of individual network components / sub-systems at multiple physical locations, or which do not allow for remote download of component firmware, or which require the exchange of components, will not be accepted.

1.3 SOFTWARE NOMENCLATURE REPROGRAMMING

- 1.3.1 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 the 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 Consultant. The software revisions to incorporate final room names/area names/building names and equipment identification.

Part 2 - PRODUCTS

2.1 GENERAL

- 2.1.1 The existing system is an obsolete Nurse Call (NC) system Rauland Responder III.
- 2.1.2 New standalone Rauland Responder 5 system will be provided for the area of renovation.
- 2.1.3 The system to be based on provision of an IP based visual Nurse Call (NC) system. The system to be a multiplexed solid-state microprocessor based networked system. Provide equipment, accessories and material required for the installation of system in accordance with the specifications and drawings. Any material and/or equipment necessary for the proper operation of the system not specified or described herein is to be deemed part of this specification. The equipment described and provided under these specifications to be the standard product of one manufacturer.
- 2.1.4 The system to include, but not be limited to the following:
- 2.1.4.1 area control units, floor control stations, PC terminals and remote annunciators;

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- 2.1.4.2 software programming;
 - 2.1.4.3 activity reporting terminal;
 - 2.1.4.4 washroom stations;
 - 2.1.4.5 staff stations;
 - 2.1.4.6 emergency stations;
 - 2.1.4.7 bed stations;
 - 2.1.4.8 shower stations;
 - 2.1.4.9 corridor dome lights;
 - 2.1.4.10 Staff Communication DECT R4- digital cordless telecommunication system
 - 2.1.4.11 wiring and required ancillary devices, as recommended by system manufacturer.
- 2.1.5 Components and system as a whole to meet or exceed the minimal standards issued by CSA, EEMAC and ULC. The system to also be compliant with requirements of UL-1069. Each major component to bear the manufacturer's name, catalogue number, place of manufacture and CSA/ULC label. NC Network devices to be UL-1069 listed. This includes routers, hubs, switches, and room control devices. Field wiring to be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an fiber backbone (when distances exceed normal copper Ethernet limitations). Station equipment to use plug on connectors and switches, routers and controllers to utilize standard RJ-45 modular connections. Remote devices utilizing standard structured cabling to be capable of PoE (Power over Ethernet) or power supplied within the CAT 5E or CAT 6 cable jacket. Wiring to be capable of either being installed in conduit or cable trays, where required. NC Communications cabling to be separated out from any high voltage AC or DC wiring that exceeds 90 volts, or which violates any national or local electrical code. The network serving the NC communication response system to be dedicated only to the NC system, unless otherwise approved in writing by Owner.
- 2.1.6 The system to be UL 1069 listed as a NC Network. The system to be capable of interconnecting with the hospital's LAN (Local Area Network).
- 2.1.7 Components and the system as a whole to meet or exceed the minimal standards issued by CSA, EEMAC and ULC. Work in conjunction with this installation to meet the provisions of the local governing electrical code, edition of CSA Z32 enforced by local governing authority and any applicable local codes.
- 2.1.8 Each major component to bear the manufacturer's name, catalogue number, place of manufacture and CSA/ULC label.
- 2.1.9 System to be capable of supporting in excess of 500 resident stations (greater than 1,000 beds) and 5,000 peripheral stations. System to support networking of up to three systems of this size.

- 2.1.10 The system head end equipment and software to also be capable of handling an additional minimum 20% future expansion. Include for sufficient cabinet/panel/rack spaces, sufficient power supplies, and sufficient space for future zone/device connection modules and include in system software programming to easily accommodate future expansion requirements.

2.2 GENERAL SYSTEM FEATURES

- 2.2.1 The system to consist of a central control assembly with power supply, consoles with displays, resident stations, emergency stations, shower stations, exterior emergency stations, corridor lights, zone lights, duty stations, interconnections to other systems and required system cabling. Stations to be flush wall mounting into recessed backboxes.
- 2.2.2 The system to be compatible and include provisions to integrate fully to systems such as resident wandering systems such that the central station display annunciates and displays alarm information available from each integrated system, such as the unique address of alarm transmitter, exact location of alarm, resident's bed number, etc. In addition the system performs required responses to alarms, system alarm resets, and basic controlling features of the integrated systems. Features and functions to be programmable to suit Owner's specific requirement. Include selectively programmable system features as confirmed with Owner's Project Manager in writing prior to system programming.
- 2.2.3 In addition to staff emergency, lavatory/shower/emergency, resident emergency, resident priority, cord out, resident normal, and staff normal, priority levels to be assignable to each resident station and/or to each bed. Each level to be indicated at the staff master and duty stations.
- 2.2.4 Priority level names to be displayed as alpha characters, and the room numbers to be user-programmable.
- 2.2.5 The room numbers to be numeric with alpha characters for descriptions.
- 2.2.6 Visible annunciation to be by corridor and zone lights associated with each call.
- 2.2.7 System to use multiplex technology, requiring no unique wiring on a per station basis.
- 2.2.8 System to have automatic supervision of associated bedside resident stations, emergency stations, exterior emergency, shower stations, staff stations, zone lights, dome lights and consoles, with an indication at the console of which station or stations failed.
- 2.2.9 System to provide for transfer of one or more individual or groups of stations from one console to another without mechanical switches or additional predetermined wiring of the stations.
- 2.2.10 System to be configurable by call priority level to allow the attendant to set any levels of staff reminder on a manual basis.
- 2.2.11 System user features and programmable access to make system changes to be password protected to ensure that only authorized personnel can make changes.
- 2.2.12 The system to contain built-in diagnostics to monitor and diagnose system operation.

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- 2.2.13 The system to have the capability to program/create a list of staff, for the purpose of individual assignment to each resident/bed as a primary or alternate caregiver. Once assigned by shift, calls placed by the resident may be automatically directed to the assigned staff currently on duty, alerting them of the pending call and subsequent care givers if necessary.
 - 2.2.14 Ability to program individual staff to resident assignments easily from workstation terminal at the beginning of each shift by selecting the staff's name and changing their personal assignment screen. The staff-to-resident assignments are established directly using the resident's room and bed. Additionally the staff may receive all call priorities or only a selected subset of call priorities.
 - 2.2.15 Capabilities for the staff follow feature to be included. The basic staff follow function, when activated from the master station, to allow a staff member to leave the master station and be notified of a call at a designated room and bed.
 - 2.2.16 An automatic emergency call to be placed to the master station if the cordset is inadvertently pulled out of the receptacle on any resident station.
 - 2.2.17 The system to be provided with the activity reporting and management system interface software program to record all resident calls and related time-based activities and to provide for recall, summary reporting and printing of statistical information from a computer station provided with system. System software to perform automatically daylight-saving time adjustments to the Eastern Time Zone.
 - 2.2.18 The system to be of modular construction. Components used in signal control to be plug-in for easy replacement and maintenance. A solid-state plug-in flasher to be incorporated to provide the steady and interrupted alerting tones and indicating lights.
 - 2.2.19 The normal and emergency call tones generated at the console and duty stations to be preprogrammed at different rates for easy identification. The alerting tones to be electronically generated. Tone level to be adjustable or turned off as required during night hours.
 - 2.2.20 Resident stations, emergency stations, exterior emergency stations, shower stations and staff/duty stations to be installed into standard electrical backboxes.
 - 2.2.21 Devices located within areas where abuse can occur such as the Behaviour Unit areas, to be constructed with vandal-proof and shatter resistant features and tamperproof access/mounting screws.
 - 2.2.22 The system sequence of operation to be confirmed with Owner. This sequence is generally for pricing purposes and exact sequence of operation to be programmable to suit Owner's exact requirements. Confirm exact sequence with Owner and Consultant, in writing prior to start of work.
 - 2.2.23 Staff communication is also provided via Digital Enhanced Cordless Telecommunication system (DECT R4). DECT R4 is using the IP LAN to provide an IP based cordless telephony and messaging system. DECT R4 comprise if multiple external arial IP base stations. The IP base stations are powered by POE and are connected to IP DECT digital gateway.

2.3 SYSTEM FIRMWARE / SOFTWARE MAINTENANCE

- 2.3.1 System firmware/software upgrades to be downloaded to the system by data connection. Upgrades to be accomplished system-wide from a single point of connection.

- 2.3.2 Systems requiring local programming of individual network components/sub-systems at multiple physical locations, or which do not allow for remote download of component firmware or which require the exchange of components, are not acceptable.

2.4 ACTIVITY REPORTING SOFTWARE

- 2.4.1 Activity Reporting Software to be provided with the system to allow for recording and reporting of system activity. The centralized Reporting Software to be installed on a server to be located as directed by Owner.
- 2.4.2 Reporting Software to support real time system activity display as follows:
- 2.4.2.1 real time call waiting display with the ability to filter by call types and areas. Call information to be displayed and call-in tones to be sounded;
 - 2.4.2.2 real time NC Communications Network service reminder display and staff locations.
- 2.4.3 Reporting Software to allow users to generate/print reports on system activity. Access to reports to be controlled based on username and password. Reports to be capable of indicating call priority, room number and resident information, call placed time, service reminder set, staff registration and following:
- 2.4.3.1 detailed analysis of Call Data by area;
 - 2.4.3.2 analysis of Call Data by area;
 - 2.4.3.3 analysis of Call Data by room/bed;
 - 2.4.3.4 analysis of Call Data by resident.
- 2.4.4 Reporting Software to support a networked operation in which the Management Software server is connected to the hospital LAN. Users with access to the LAN can then generate reports from local workstations.
- 2.4.5 The software to include capacity to accommodate future expansions as previously noted.

2.5 CHASSIS FAULT, POWER MONITOR AND SUPERVISED CODE

- 2.5.1 Provide a separate chassis short / power fault monitor-to-monitor integrity of network wiring for short(s) to earth ground and to notify staff of loss of power. An audible alert tone to sound if short or loss of power is detected. Provide test button to test operation.

2.6 SYSTEM DIAGNOSTICS

- 2.6.1 The system to provide continuous self-diagnostics. The system to also support advanced computer diagnostics by local or remote technical personnel.
- 2.6.2 Components in the system to be continuously supervised for both power and signal to ensure proper operation and in the case of system faults to aid in troubleshooting.

2.6.3 The system to have the ability to diagnose all network active components, controllers, control stations, and sub-station operation from any designated network data interface location, on or off site. Network administrator to be able to review system faults reported (i.e. station failure).

2.6.4 The system to provide the ability to automatically notify maintenance personnel via pocket page in the event of a system trouble or failure.

2.7 NETWORK EQUIPMENT AND HEAD-END CONTROL EQUIPMENT

2.7.1 Control equipment to be IP-based and utilizes gateways/hub controllers for connection to room devices. These devices to make up a UL 1069 Listed Nurse Call LAN/WAN. The control equipment to mount in a standard 19" rack or wall mounted. The control equipment to have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment are not acceptable.

2.7.2 Provide as needed in each area, a NC communication, and IP DECT for staff communications network gateway/controller. Each hub controller to support the consoles for the rooms of the designated areas.

2.7.3 Network controller is capable of acting as standalone controller in event of loss of network communication.

2.7.4 Various system modules to be provided for control, monitoring, supervising and interfacing functions of the centralized system.

2.7.5 Power Supplies – Provide power supplies including integral back-up uninterruptible power supplies for control equipment, consoles, resident stations, sub-stations, and corridor lamps. System power supplies to be CSA approved and UL1069 listed as an integral part of the core system.

2.7.6 Review locations for the head end equipment and cabinets/panels for adequate ventilation. Where ventilation is not to system manufacturer's minimum requirements for the equipment, provide sufficient ventilation in manner to be proposed to consultant for review and approval prior to start of work. Include for providing proper ventilation.

2.7.7 Where head end equipment is located in designated closets, provide EIA 19" racks for mounting of head end equipment, patch panels and associated devices. Racks and patch panels to be as typically specified in Section entitled Structural Cabling System.

2.7.8 Capacities for head end equipment must include for future requirements as previously specified.

2.8 SERVERS AND PC TERMINALS

2.8.1 Unless otherwise directed by Owner and/or Consultant, provide server(s) for system applications and which meet Owner's IT approval. Minimum requirements to include but not limited to following:

2.8.1.1 Gateway, Application and Integration Server:

2.8.1.1.1 Hardware:

2.8.1.1.1.1 Quad Core Intel Xeon CPU @ 2.83 GHz or greater.

- 2.8.1.1.1.2 4GB Memory or greater.
- 2.8.1.1.1.3 Minimum of 10G disk space.
- 2.8.1.1.1.4 Dual 1 GB Network ports.
- 2.8.1.1.1.5 CD/DVD RW optical drive.
- 2.8.1.1.1.6 RS-232 Serial Port.

2.8.1.1.2 Software:

- 2.8.1.1.2.1 Window Server 2003 R2 (32 bit, Standard\Enterprise, SP2).
- 2.8.1.1.2.2 MSMQ (bundled with Windows Server 2003).
- 2.8.1.1.2.3 NET Framework 2.0 or higher.
- 2.8.1.1.2.4 NET Framework 2.0 or higher.
- 2.8.1.1.2.5 IIS Version 6.0 (bundled with Windows Server 2003).
- 2.8.1.1.2.6 W3SVC (World Wide Web Publishing) Service installed.
- 2.8.1.1.2.7 IIS installed and configured prior to installing .NET 2.0.
- 2.8.1.1.2.8 SQL Server 2005 (32-bit, Standard, SP2).

- 2.8.2 Supply of PC terminal workstations at each staff station to be responsibility of Owner. Coordinate exact requirements with Owner's IT to load system software on to terminals.

2.9 CALL ROUTING / PROCESSING

- 2.9.1 Call Routing – The system to support the routing of resident calls to any console, pager, phone or other annunciating device anywhere in the facility or to any combination of the above regardless of the location of the calling station. Calls may be routed and processed based on location, priority, or combination.
- 2.9.2 The system to support the ability to swing any individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within hospital staff/resident communications network.
- 2.9.3 The system to allow a console to capture an individual nursing unit, selected units, or all units in hospital by touching single custom labelled touch point.
- 2.9.4 Call Priorities – The system to support a minimum of 200 unique, user-definable call priorities.
- 2.9.5 Each call priority to be reported via a user-defined mnemonic of up to 14 alphanumeric characters;
- 2.9.6 Selectable call-in tone type, level, and corridor light behaviour for each type of call priority.

2.10 SERVICE REQUIREMENTS

2.10.1 The system to support service requirement reminders. Staff members may, by pressing a button on the console, initiate a service requirement reminder.

2.10.1.1 Service Requirements to be indicated on the corridor lamp by a flashing lamp.

2.10.1.2 Users may review the location of service requirements using the workstation terminal.

2.10.1.3 If a service requirement remains unanswered for a pre-determined period of time, an overtime call to automatically be initiated.

2.11 CONSOLES

2.11.1 Desk-mounted base, master NC communication response consoles to be provided, complete with screen with multiple touch buttons, a dial pad, and a combination of a hands-free operated speaker/microphone, volume control, and telephone handset. The station to include water resistant (spill proof) provisions of the controls and display and console construction to be of high impact flame retardant plastic. The operation of the console to be as per manufacturer's base operation, but modified to suit Owner's requirements, as confirmed with Owner.

2.11.2 The console features include but are not limited to the following:

2.11.2.1 alpha-numeric display with bed, call priority, call waiting timer and room number;

2.11.2.2 VGA colour screen display;

2.11.2.3 multiple unique user-definable call priorities;

2.11.2.4 selectable call-in tone type and level for each type of call priority;

2.11.2.5 user-configurable function keys;

2.11.2.6 monitor interface for remote display of calls;

2.11.2.7 automatic answer of highest priority call or selective answer of the displayed calls;

2.11.2.8 microprocessor-controlled operation;

2.11.2.9 optional tone mute of calls in progress;

2.11.2.10 ability to block all loudspeaker paging to facilitate a low noise resident environment. Password protection can be enabled to only allow authorized access to audio paging;

2.11.2.11 ability to swing an individual room or any group of rooms by pushbutton. Room(s) and consoles may be located anywhere within NC communications network;

2.11.2.12 ability to capture an individual nursing unit,

2.11.2.13 push-to-talk key for taking control of speech path;

- 2.11.2.14 digital inter-hub controller audio;
 - 2.11.2.15 desk or wall-mountable;
 - 2.11.2.16 feature keys capable of any present or future user-definable features. Manufacturer's default function keys may be re-labelled or removed to create easy to use, custom console for each staff unit;
 - 2.11.2.17 ability to program remotely from a computer interface all console functions, touchpoints, and priorities;
 - 2.11.2.18 direct dial to pocket page with messaging;
 - 2.11.2.19 ability to send customized "tag" messages to pocket pager of resident's assigned staff member(s). Each pocket page tag message must be programmable for a multi-character message and will set a service requirement for the appropriate staff level. At the console operator's discretion, the pocket page "tag" messages may be directed to any of the up to three levels of staff responsible for the resident depending on the type of staff attention required by the resident;
 - 2.11.2.20 complete with cord and connector and matching receptacle, flush mounted on single gang wall plate.
- 2.11.3 It must be possible to remove and/or replace console(s) while system is operational without the loss of any calls, damage to any system components, or reprogramming of console attributes. The consoles may be plug-in interchangeable without the need to re-program.

2.12 BEDSIDE RESIDENT STATIONS

- 2.12.1 Single bed control stations complete with following features and capability of the following functions:
- 2.12.1.1 receptacle(s) for call cord. All resident stations to be able to use standard push-button call cords and specialty geriatric call cords;
 - 2.12.1.2 reset Button to cancel pending calls;
 - 2.12.1.3 red LED(s) to indicate call placement from one or both of the call points;
 - 2.12.1.4 removing a call cord places a Cord Out call;
 - 2.12.1.5 Cord Out calls may be cancelled locally using the Cancel Button. No Dummy Plugs are required;
- 2.12.2 Smoke detectors, having maintained normally open dry contacts, to be connected to the room auxiliary input of the resident station and to provide a secondary alarm through the system. The devices to also be connected to its primary system for which it was designed and its intended use per all existing codes.

2.13 WATERPROOF EMERGENCY STATIONS

- 2.13.1 Pull cord stations to be IP68 rated waterproof with a 3 m (10') PVC (poly-vinyl chloride, not nylon) pull-cord, membrane reset button and covered call assurance LED. Stations to be of waterproof and is completely sealed to prevent water/fluid intrusion into the station. Pull cord length to be custom cut to length to suit specific applications. Unit may utilize remote cancel button for ease of staff cancel when pull cord station is mounted in inaccessible location (e.g. ceiling or too high on the wall for easy reset by staff).
- 2.13.2 Stations to include features to allow for wash down spraying for easy cleaning and disinfecting.
- 2.13.3 Stations can be programmed to have one station cancelled by another where multiple stations are located in same shower area.

2.14 STAFF CONTROL/ASSIST STATIONS

- 2.14.1 Staff stations provide network interface for sub-stations and be equipped with following:

- 2.14.1.1 Push button for call placement;
- 2.14.1.2 reset Button to cancel pending calls;
- 2.14.1.3 green LED to indicate that audio to the station is active;
- 2.14.1.4 red LED(s) to indicate call placement;
- 2.14.1.5 modular connectors;
- 2.14.1.6 features to service Stations without removing power from the system.

2.15 DOME LIGHTS AND ZONE LIGHTS

- 2.15.1 Dome lights and zone light units to utilize multiple RGB LED's for high visibility, long life and low maintenance. Units to serve as the hub for all room wiring. All field wire connections to be accomplished using modular connectors. Unit types are as follows:
 - 2.15.1.1 resident room dome lights (located over doors) – minimum four distinct coloured section units; colours selected from manufacturer's standard selection of seven (7) choices;
 - 2.15.1.2 zone lights (located on ceilings) – minimum four distinct coloured section units; colours selected from manufacturer's standard selection of seven (7) choices;
 - 2.15.1.3 zone lights and chimes – similar to standard zone lights but with integration to sound chimes.
- 2.15.2 The unit to make use of multiple colours and programmable flash rates and patterns to distinguish system calls, indicate pending calls, service requirements and staff presence.
- 2.15.3 Any unit to be able to function as a zone light that visually annunciates calls from assigned rooms / stations without the use of a controller.
- 2.15.4 The unit to be equipped with a heart-beat LED (visible to service personnel) to indicate that the unit is functioning properly.

- 2.15.5 The unit to accommodate a paper label to indicate the room number. The manufacturer to provide, at no cost, laser-printing template software to create custom room labels.
- 2.15.6 Units to be integrated to resident room smoke detectors enabling redundant visual annunciation upon activation of smoke detector. Additionally, a secondary alarm to be provided through the NC communication system and annunciate on the local staff console providing location where smoke detector was activated.
- 2.15.7 The number of lamps and colour requirements to be confirmed on drawings and with Owner.

2.16 POCKET PAGE INTEGRATION (CAPABILITY)

- 2.16.1 The system to be capable of fully integrating to the in-house pocket pager system. This integration to allow calls from residents to automatically send text messages to their assigned caregiver(s). The pager display must show the caregiver the bed number of the call, the call type/priority, and the unit's name or resident name.
- 2.16.2 The pocket pager integration to allow no less than three levels of staff, plus a charge staff and a "group", to be assigned to each resident/bed or call priority. These assignments to be performed via the client-based assignments software. The rollover time from the primary staff member to the secondary, tertiary and charge staff to be definable by the facility.
- 2.16.3 The call escalation manager to manage automatic messaging to the pocket pagers. The call escalation manager to also provide group page functions that allow any defined group of devices to receive any selected call type(s). The call escalation manager to also provide the ability to transmit a Call Cancel in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.
- 2.16.4 The pocket pager integration to allow device failures in the NC communication system to generate an automatic page to a Biomed device.
- 2.16.5 Semi-automatic Mode Operation – The system to support Semi-automatic Mode Operation. In this mode, a console operator may answer resident call, determine the resident need and then dispatch an appropriate staff member. Dispatching the staff member to be accomplished by establishing a service requirement. The page will then be sent to the pager of the designated staff member. It is not necessary to enter pager numbers to route the page message. When sent by Semi-automatic mode, the page message to include the room number, bed number; call priority plus an indication that a Service Requirement has been set.
- 2.16.6 Pagers to be able to run in both Automatic Mode and Semi-automatic Mode simultaneously.
- 2.16.7 Equipment Trouble Pagers – The system to support up to 10 pagers that receive a message whenever there is trouble in the system such as a console off-line or station off-line.

2.17 WIRED / WIRELESS TELEPHONE / PBX INTEGRATION

- 2.17.1 The NC System to be integrated with the facility PBX telephone system to provide connectivity with wired and / or wireless telephones. The PBX units to be provided complete with ports to accommodate required interconnections. The wireless system provisions is future integration requirements.

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- 2.17.2 The NC network to be capable of being equipped with an SIP compatible device that has analog trunk ports for connection to PBX extension ports. For initial Bid Pricing, assume VoIP telephone system requirements and future IEEE 802.11b/g wireless telephone standards.
 - 2.17.3 The telephone gateway to provide access to wired telephones that are connected to the hospitals telephone system. Gateway allows wired or wireless telephones to communicate using standard telephone protocols.
 - 2.17.4 The telephone gateway to be programmable via any PC that is connected to the network, either onsite or remotely. Each gateway to support up to four voice paths. The gateway to accept multiple inputs and outputs to connect to multiple Systems on site.
 - 2.17.5 Telephone interface to provide ability for staff to automatically receive assigned resident calls via wireless telephone. Upon answering the call, the staff may converse with the resident in a semi-private conversation.
 - 2.17.6 The integrated system to provide ability for the staff to review room number, bed number, and priority of incoming calls on wireless telephones via telephone display.
 - 2.17.7 Wireless telephone is able to signal that another call is incoming while staff member is in communication with a room.
 - 2.17.8 The ability on a per staff member basis to filter only selected call priorities to route to the wireless telephones, is included at each staff station.
 - 2.17.9 Supply of telephones are not included under this Division of the Work.

2.18 SYSTEM INTEGRATION

- 2.18.1 Integrate system to:
 - 2.18.1.1 fire alarm system;
 - 2.18.1.2 security system;
 - 2.18.1.3 Phone System.
- 2.18.2 Include for fire alarm system manufacturers to provide necessary fire alarm devices and interconnections of resident room smoke detectors to the Nurse Call communication system dome lights. Provide required interconnecting wiring in conduit from Nurse Call communication dome light to room smoke detector, and for coordination of work.
- 2.18.3 Notify Owner and Consultant if any fire alarm circuit in part or in whole or entire fire alarm panel is bypassed. Notify Owner and Consultant before and after work is performed and be provided of status of end of each day.
- 2.18.4 Integrate system work to fire alarm system work and ensure that system verification includes for the integrated functions of the systems. The work to include for provision of necessary system programming, testing and verification of the integration work.

2.19 EQUIPMENT ENCLOSURES

- 2.19.1 Equipment panels and enclosures to be CSA approved for application and in climate controlled areas, be rated minimum NEMA 1 with sprinkler proof provisions including gasketing of doors and openings and ventilation; louvers designed to prevent egress of water from activated sprinklers from contacting live components. Surface mounted panels to be equipped with drip shield manufactured by system manufacturer.
- 2.19.2 Equipment panels and enclosures located in non-climate controlled areas to be outdoor weatherproof rated NEMA 4X and equipped with heaters as required.

2.20 SYSTEM WIRING

- 2.20.1 System wiring and equipment installation to be provided in accordance with practices as established by the EIA and the local governing electrical code. Wiring to meet local electrical code requirements. System to employ a structured cable system consisting of standard 4-pair Category 5e/6 cable to service corridor lamps and consoles. Wiring to be CSA approved and ULC listed for the application and be FT- 6 rated.
- 2.20.2 Confirm cable colour with consultant prior to ordering. Wiring to be of colour consistent throughout to differentiate from other system(s) wiring.
- 2.20.3 Terminate wiring with manufacturer-approved connectors. Do not use wire nuts. Wiring to test free from all grounds and shorts. Do not splice wiring.
- 2.20.4 Do not run system wiring in the same conduit with other systems.
- 2.20.5 Exterior cabling or cabling run underground to be of type suitable for such applications as recommended by system manufacturer.

2.21 MANUFACTURER'S SITE SERVICES

- 2.21.1 Manufacturer's representative to provide following on site work:
 - 2.21.1.1 assist Contractor on required installation requirements;
 - 2.21.1.2 programme system head end;
 - 2.21.1.3 inspect installation and perform required final equipment connections;
 - 2.21.1.4 adjust, test, start-up and certify system.

2.22 ACCEPTABLE MANUFACTURERS

- 2.22.1 AATEL RAULAND RESPONDER 5

Part 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

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- 3.1.1 Coordinate work of each trade for scheduling, demolition, rough-in, power and conduit requirements, installation and testing. Refer to Section entitled Basic Electrical Materials and Methods for additional general installation requirements.
 - 3.1.2 Provide specified various Nurse Call communication response systems components in areas as shown and as required. Programme system on servers/terminals. Obtain Owner's approval of room nomenclature prior to start of programming. Customize software to suit Owner's specific applications. Program sequence of operation and user information as required. Include for system manufacturers authorized representative to program systems. Programme exact programming requirements as confirmed with consultant and/or Owner in writing prior to start of Work. Utilize manufacturer's 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.
 - 3.1.3 Locate head end equipment, terminal cabinets, racks, patch panels, UPS, and central computer terminal in locations as shown and/as directed by consultant. Locate equipment in electrical or telecom closets or as noted. Provide terminal cabinets/panels as required and locate in electrical or telecom closets as approved by consultant. Do not locate in ceiling spaces or public/resident areas, corridors, stairways or offices. Ventilate areas as required for proper equipment performance. Comply with EIA/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. Install devices in strict accordance with system manufacturer's instructions and recommendations.
 - 3.1.4 Provide central computer station/terminal for activity reporting software in specified locations or as directed by consultant. Locate equipment on racks as typically specified for network cabling systems of Section. Provide power receptacles, feeders, data jack/drop as required. Exact locations to be confirmed with consultant prior to roughing-in. Coordinate work of all trades.
 - 3.1.5 Provide dedicated conduit feeder(s) into the equipment cabinets and UPS units. Generally, required sizing of breakers, feeders and conduits to be as noted on drawings, 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. Dedicated circuit breakers to be used 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 communication System". These electrical circuits to be connected to the facility's essential power circuits of panels serving the area of work. Connect all network system power supplies and equipment cabinets to a common earth ground utilizing copper conductors as required. Comply with local governing electrical code requirements. Provide required data drops.
 - 3.1.6 Provide control units and stations and install into locations. Install components at the mounting heights as noted on drawings and as required and confirmed with consultant. Generally, wall mounted devices onto recessed boxes. Provide suitable conduits and backboxes to accommodate device installations. Confirm back box requirements with system vendor prior to roughing-in.
 - 3.1.7 Generally, install dome lights located between doorframe and underside of suspended ceiling. Interconnect resident room smoke detectors to dome lights and remote communicators. 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. Confirm colours for dome lights with consultant prior to ordering.

- 3.1.8 Provide system wiring. Wiring to be copper conductor, colour coded, and in accordance with the system manufacturer's recommendations and instructions. Connect equipment in accordance with the system manufacturer's certified wiring diagrams and instructions and under direct supervision of the manufacturer. Provide and arrange for authorized system manufacturer's representative to make all final equipment connections. Run conductors in conduit or in cable tray, as identified on drawings. Use of cable hangers' system such as J hooks are not acceptable unless approved in writing from consultant and/or unless such use is specifically noted on drawings.
- 3.1.9 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.
- 3.1.10 Confirm locations of devices with consultant prior to roughing-in.
- 3.1.11 Perform system integration connections to various systems as required. Include costs for systems service vendors to perform required integration and programming requirements.
- 3.1.12 Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- 3.1.13 Provide a lamacoid identification nameplate for each enclosure. Confirm wording of identification nameplates and colour finishes of devices with Owner prior to ordering.
- 3.1.14 When work is complete, arrange for attendance at the site of the system manufacturer's authorized representative to make final equipment connections and provide inspection, testing, adjusting and verification requirements.
- 3.1.15 Turn over to Consultant/Owner, specified loose accessories.

3.2 SYSTEM TRAINING, INSTRUCTIONS AND TRAINING UNIT

- 3.2.1 Provide to Owner's designated staff, onsite training sessions to Owner's designated personnel on the operation and maintenance procedures with regards to the system. Each session may be held on different days and locations, at Owner's discretion. Exact times and dates to be coordinated with and approved by Owner.
- 3.2.2 The following are required from Nurse Call communication System supplier, one week before each training session:
 - 3.2.2.1 an easy-to-read manual describing the features, providing trouble-shooting guidelines;
 - 3.2.2.2 one mobile training unit to be able to be transported to sites for training purposes.
- 3.2.3 Schedule
 - 3.2.3.1 Training on the operation of the Nurse Call communication System for Maintenance staff:
 - 3.2.3.1.1 Two sessions, 1 hour duration for up to ten (10) people each session.

- 3.2.3.1.2 There should be enough copies of printout regarding repair of parts, for each participant.
 - 3.2.3.2 Training on the operation and managing software for Staff Managers, Program Service Managers, Program Director, Operations Directors, VP Programs, Director of Organizational effectiveness and Risk Management and designate, Program Assistant:
 - 3.2.3.2.1 Two sessions, 1 hour duration for up to ten (10) people each session.
 - 3.2.3.2.2 There should be enough copies of handouts on summary of training, for each participant.
 - 3.2.3.3 Training for Staffs will be for the operation only. Allow for four (4) training days. At each training day, the training schedule to include:
 - 3.2.3.3.1 minimum four (4) 1-hour sessions spread out over the day at times directed by Owner;
 - 3.2.3.3.2 the number of staffs to be accommodated to be as later directed.
 - 3.2.3.4 Provide training/coordination on access and networking issues for Owner's computer network for one session, one hour duration for up to 8 people. There should be enough copies of handouts for technical information for networking and edit access.
- 3.2.4 Include for professional recording of and copying onto CD/ DVD digital video disk of operation and maintenance procedures.
- 3.2.5 For the duration of the Work, provide mobile training unit of the Nurse Call communication system, including typical consoles, bed stations, staff stations and wireless telephones. The unit will be set up to allow the users to train and familiarize themselves with the system, outside of the designated times for the training sessions. The unit to be easily transportable to designated areas for training purposes. System supplier to be responsible for transporting and set-up as required by Owner's schedule.

End of Section

PART 1 - GENERAL

1.1. SUBMITTALS

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

1.2. SOFTWARE NOMENCLATURE REPROGRAMMING

- 1.2.1. 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.

1.3. SYSTEM SUPPLIER/INSTALLER QUALIFICATIONS

- 1.3.1. 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.
- 1.3.2. Supplier/installer to be a valid authorized distributor for product/system proposed with full manufacturer's warranty privileges.
- 1.3.3. Supplier/installer to employ technicians who have attended and successfully completed manufacturer's technical certification training for proposed system.
- 1.3.4. 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.

PART 2 - PRODUCTS

2.1. MASTER WIRELESS GPS CLOCK SYSTEMS

- 2.1.1. Primex Wireless, GPS (Global Positioning System) type wireless system that continually synchronizes clocks throughout facility using GPS technology to provide atomic time. Features include:
- 2.1.2. clock readouts in multiple time zones;
- 2.1.3. automatic adjustment for Daylight Savings Time;
- 2.1.4. analogue clocks synchronized to within 10 milliseconds 6 times per day;
- 2.1.5. internal oscillator maintains plus or minus one second per day between synchronizations, so clock accuracy does not exceed plus or minus 0.2 seconds;
- 2.1.6. internal clock reference so that failure of GPS signal does not cause clocks to fail in indicating time;
- 2.1.7. fail-safe design so that failure of any component does not cause failure of system; upon restoration of power or repair of failed component, system to resume normal operation without need of resetting system or any component thereof;

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- 2.1.8. clocks are portable;
 - 2.1.9. system operates in accordance with a "Technical Acceptance Certificate" issued by Industry Canada and Ministry of Industry; license granted to and held by end user (Owner).
 - 2.1.10. System manufacturer to make payments and to provide required documents and technical information to Industry Canada and other governing local authorities, for approval.
 - 2.1.11. Include for provision of following:
 - 2.1.12. XR series, 5/30 watt master transmitters with GPS receiver/ antennae, rack, surge protector, UPS back-up system;
 - 2.1.13. XR series, 5/30 watt master transmitters with NTP interface, rack, surge protector, UPS back-up system;
 - 2.1.14. satellite transmitters with receiver switch, rack, surge protector, UPS back-up system;
 - 2.1.15. external outdoor antennae;
 - 2.1.16. exterior weatherproof coaxial antennae cabling; antennae/receiver cable to be provided in length to suit installation location on rooftop;
 - 2.1.17. standard round, 317 mm (12.5") satellite clocks with 12/24 hour display and complete with long life maintenance free batteries, high impact polycarbonate frame and lens, and clock lock; face to include Owner logo; exact clock dial face, logo and finish to be confirmed with and approved by Consultant prior to ordering; optional 120 VAC power supply operation; synchronized from master or satellite transmitter;
 - 2.1.18. digital time clocks: 63 mm (2.5") x 6 digit, 7 segment LED display with user configurable alternating time and date; 12 or 24 hour display, 120 Vac power supply; synchronized from master or satellite transmitter; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;
 - 2.1.19. digital time clocks with elapsed timer; clocks: 63mm (2.5") x 6 digit, 7 segment LED display unit of hours, minutes and seconds, that start and stop with push of a button and counts up or down until stopped; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; synchronized from master or satellite transmitter; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;
 - 2.1.20. Code Blue Timer: 65mm (2.5") x 6 digit, 7 segment LED display unit of hours, minutes and seconds, to indicate elapsed time during Code Blue event that integrates with Code Blue system and also operates through remote control unit; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; remote switch control allows user to run, hold or reset timer and consists of 3 pushbuttons mounted on stainless steel faceplate complete with required interconnection cable and connectors;
 - 2.1.21. clock lock feature;

- 2.1.22. protective wireguards;
- 2.1.23. mounting hardware and ancillary devices as required for full installation;
- 2.1.24. system wiring as per system manufacturer's requirements;
- 2.1.25. system software programme;
- 2.1.26. Industry Canada licence.
- 2.1.27. Engage system manufacturer to review documents prior to submission of pricing before close of Bids. Ensure that equipment selection proposed meets requirements of Work and that signal strength and clock coverage areas are adequate to give proper system performance throughout.
- 2.1.28. Final selection of clocks to be as directed by Owner at a later date.
- 2.1.29. Manufacturer's representative to provide following on site work:
- 2.1.30. programme system head end;
- 2.1.31. inspect installation;
- 2.1.32. adjust, test, start-up and certify system;
- 2.1.33. instructions on system operating and maintenance.
- 2.1.34. Base Bid manufacturer/supplier is Primex Wireless Canada (1-800-330-1459). Other manufacturers may be accepted subject to following (submit proof with shop drawings):
- 2.1.35. that system features and performance at least match base specified system;
- 2.1.36. systems are CSA approved and ULC listed and labelled, as applicable;
- 2.1.37. system has been installed and operating in other Canadian facilities for at least past three (3) years;
- 2.1.38. system products and parts are stocked and serviced by a Canadian distributor/vendor within Province of install.

2.2. MASTER WIRELESS NETWORK CLOCK SYSTEMS

- 2.2.1. Primex Wireless, SNS (Synchronous Network System) type wireless system that continually synchronizes and automates management of clocks throughout facility using 802.11 wireless network.
- 2.2.2. System features wireless network connected clocks with network time protocol (NTP) synchronization, data collection, data backup, and user access from anywhere in world. SNS clocks are synchronized by signals from network Gateway SNS Applications Management Platform (AMP) server over an 802.11b/g wireless network or 10/100 Base T Ethernet system. Time signals originate from local Network Time Protocol (NTP) server, keeping clocks in synch with time shown on network computers.

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- 2.2.3. SNS clock incorporates automated monitoring, alerting, and reporting firmware. Clock firmware performs diagnostics on battery life, time accuracy, and strength of wireless connection, and sends this data to AMP Gateway server. SNS AMP Gateway server also receives and stores event logs showing time and date records from Elapsed Timers. These logs, backed up on central server, are available to authorized users on AMP and can be e-mailed to assigned staff.
 - 2.2.4. System operates over building WIFI system. Clocks are controlled from signals transmitted over WIFI system or through wired network cabling to local RJ45 jacks. Coordinate work with structured network cabling work section.
 - 2.2.5. Additional system features include:
 - 2.2.6. clock readouts in multiple time zones;
 - 2.2.7. automatic adjustment for Daylight Savings Time;
 - 2.2.8. clocks continue to indicate accurate time within plus or minus 0.35 seconds in 24 hours;
 - 2.2.9. internal clock reference so that failure of NTP system signal does not cause clocks to fail in indicating time;
 - 2.2.10. fail-safe design so that failure of any component does not cause failure of system; upon restoration of power or repair of failed component, system to resume normal operation without need of resetting system or any component thereof;
 - 2.2.11. clocks are portable;
 - 2.2.12. system operates in accordance with a "Technical Acceptance Certificate" issued by Industry Canada and Ministry of Industry; license granted to and held by end user (Owner).
 - 2.2.13. System manufacturer to make payments and to provide required documents and technical information to Industry Canada and other governing local authorities, for approval.
 - 2.2.14. Include for but not be limited to provision of following:
 - 2.2.15. SNS applications management platform system software;
 - 2.2.16. round, 317 mm (12.5") SNS clocks with 12/24 hour display and complete with long life maintenance free batteries, high impact polycarbonate frame and lens, and clock lock; face to include Owner logo; exact clock dial face, logo and finish to be confirmed with and approved by Consultant prior to ordering; optional PoE or 120 VAC power supply operation; synchronized from master or satellite transmitter;
 - 2.2.17. SNS digital time clocks: 63 mm (2.5") x 6 digit, 7 segment LED display with user configurable alternating time and date; 12 or 24 hour display, 120 Vac power supply; synchronized from wired Ethernet connection or wireless WiFi; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; optional PoE powered;

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- 2.2.18. SNS digital time clocks with elapsed timer; clocks: 63 mm (2.5") x 6 digit, 7 segment LED display unit that start and stop with push of a button and counts up or down until stopped; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; synchronized from wired Ethernet connection or wireless WiFi; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;
 - 2.2.19. SNS Code Blue Timer: 63 mm (2.5") x 6 digit, 7 segment LED display unit to indicate elapsed time during Code Blue event that integrates with Code Blue system and also operates through remote control unit; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; remote switch control allows user to run, hold or reset timer and consists of 3 pushbuttons mounted on stainless steel faceplate complete with required interconnection cable and connectors;
 - 2.2.20. clock lock feature;
 - 2.2.21. protective wireguards;
 - 2.2.22. mounting hardware and ancillary devices as required for full installation and integration to network system (include programming of transmitter and system devices as required);
 - 2.2.23. system wiring as per system manufacturer's requirements;
 - 2.2.24. gateway server: standard 19-inch-wide single rack unit that synchronizes clocks over network with signals from NTP server, stores and forwards system information from clocks;
 - 2.2.25. Industry Canada licence;
 - 2.2.26. SNS temperature sensor;
 - 2.2.27. SNS humidity sensor;
 - 2.2.28. SNS vibration sensor;
 - 2.2.29. synchronous crash car kit.
 - 2.2.30. Engage system manufacturer to review documents prior to submission of pricing before close of Bids. Ensure that equipment selection proposed meets requirements of Work and that signal strength and clock coverage areas are adequate to give proper system performance throughout.
 - 2.2.31. Final selection of clocks will be as directed by Owner at a later date.
 - 2.2.32. Manufacturer's representative to provide following on site work:
 - 2.2.33. programme system head end;
 - 2.2.34. inspect installation;
 - 2.2.35. adjust, test, start-up and certify system;

- 2.2.36. instructions on system operating and maintenance.
- 2.2.37. Base Bid manufacturer/supplier is Primex Wireless Canada (1-800-330-1459). Other manufacturers may be accepted subject to following (submit proof with shop drawings):
- 2.2.38. that system features and performance at least match base specified system;
- 2.2.39. systems are CSA approved and ULC listed and labelled, as applicable;
- 2.2.40. system has been installed and operating in other Canadian facilities for at least past three (3) years;
- 2.2.41. system products and parts are stocked and serviced by a Canadian distributor/vendor within Province of install.

PART 3 - EXECUTION

3.1. INSTALLATION OF MASTER WIRELESS CLOCK SYSTEM

- 3.1.1. Provide specified master clock system. Include for and arrange for system manufacturers authorized representative to program system and to integrate to other low voltage systems. Connect complete. Provide wiring in conduit and/or in cable trays where noted. Provide suitable recessed backboxes for mounting of clocks.
- 3.1.2. 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.
- 3.1.3. Size transmitters and of quantity to provide coverage of areas throughout complex, as per manufacturer's recommendations.
- 3.1.4. Locate clocks in coverage areas of wireless access points to ensure WiFi signal is available for proper synchronization and operation of clocks.
- 3.1.5. Perform a site coverage test to ensure proper operation of clocks in locations as shown and in areas where future clocks may be added. Adjust, relocate, and/or add to system as required to provide full coverage of building.
- 3.1.6. Provide 120VAC power circuits to clocks requiring such power. Digital clocks with timers require 120 VAC power as confirmed with manufacturer.
- 3.1.7. Install remote control units of digital clock timers, in recessed wall boxes. Connect to clock units with required wiring in conduit.
- 3.1.8. Coordinate location of GPS antennae installation with Consultant to suit exterior architectural aspects of building. Obtain Consultant's approval of location and routing of cabling prior to roughing in.
- 3.1.9. 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.

- 3.1.10. Coordinate RJ45 outlet and structured cabling requirements with vendor responsible for providing structured network cabling system. Install telecom jack at each clock outlet and extend telecom UTP cabling back to LAN equipment serving area. Refer to section regarding structured network cabling for product and installation requirements.
- 3.1.11. Confirm exact clock requirements with Consultant prior to ordering.
- 3.1.12. Confirm locations of clocks and equipment with Consultant prior to roughing-in.
- 3.1.13. Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- 3.1.14. Provide onsite system inspection, testing, adjusting, start-up, and verification as specified in Part 1.
- 3.1.15. Demonstrate operation to Owner and Consultant.
- 3.1.16. Refer to drawings for system riser diagram and locations of equipment.

3.2. INSTALLATION OF MASTER WIRED CLOCK SYSTEM

- 3.2.1. Provide specified clocks and controller and install devices in accordance with manufacturer's requirements. Programme system to suit Owner's requirements.
- 3.2.2. Install clocks on mounting hanger type receptacles and connect complete. Provide wiring in conduit.
- 3.2.3. Confirm exact locations of devices and finishes with Consultant prior to roughing-in.
- 3.2.4. Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- 3.2.5. Provide onsite system inspection, testing, adjusting, start-up, and verification as specified in Part 1.
- 3.2.6. Demonstrate operation to Owner and Consultant.
- 3.2.7. Refer to drawings for system riser diagram and locations of equipment.

END OF SECTION

PART 1 - General

1.1 References

- 1.1.1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- 1.1.2 The contract documents for the Building Security System (BSS) include the following documents (drawings and specifications):
 - 1.1.2.1 Section 28 00 00 – Common Work Results for Security
 - 1.1.2.2 Section 28 13 00 – Access Control System
 - 1.1.2.3 Section 28 23 00 – Video Surveillance System
 - 1.1.2.4 Section 28 15 00 – Security Intercom System

1.2 DEFINITIONS

- 1.2.1 "OWNER" shall mean the Owner or their appointed representative.
- 1.2.2 "ARCHITECT" shall mean the Architect of Record for the project.
- 1.2.3 "ENGINEER" shall mean the Electrical Engineer for the project.
- 1.2.4 "CONSULTANT" shall mean the Project Security Consultant.
- 1.2.5 "CONTRACTOR" shall mean the BSS Contractor who shall provide the Building Security System.
- 1.2.6 "GENERAL CONTRACTOR" shall mean the General Contractor for the project.
- 1.2.7 "ELECTRICAL CONTRACTOR" shall mean the project electrical contractor.
- 1.2.8 "BSS" shall mean the complete Building Security System.
- 1.2.9 "FURNISH" shall mean purchase and deliver to the appropriate installing contractor/subcontractor or equipment manufacturer, complete with every appurtenance, document, commission, and warrant.
- 1.2.10 "PROVIDE" and "SUPPLY AND INSTALL" shall mean furnish, install, test, commission, and warrant.
- 1.2.11 "COMPONENT" shall mean any individual item of equipment, software or material, which is an element of the BSS.
- 1.2.12 The above definitions shall apply to the words regardless of capitalization.
- 1.2.13 Words used in the singular shall not be construed as limiting to one item where other requirements of the contract documents or the scope of work require multiple items and associated accessories in order to provide a fully functional BSS meeting all of the requirements detailed in the contract documents.

- 1.2.14 When a specific reference to a manufacturer of a product is made, and the terms "or approved equal" are used, substitutions of a product by another manufacturer or model will be permitted, but the substituted product must conform to all specified requirements. A submission including a compliance statement and technical information must be made to the Consultant for consideration. The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.
- 1.2.15 When a specific reference to a manufacturer of a product is made, and the terms "or approved alternate" are used, substitutions of a product by another manufacturer or model with a cost difference will be permitted. A submission including a compliance statement, technical information, and cost implication must be made to the Consultant for consideration. Areas where the product is not in compliance with the Specifications shall be clearly noted. The Consultant determination on the acceptability of substitutes shall be final. Approved substitution equipment shall conform to available space, functional, and power requirements. Substituted equipment that does not conform to the requirements shall be replaced or required modifications made at no additional cost to the Owner.

1.3 ABBREVIATIONS

- 1.3.1 The following abbreviations shall apply to this and all subsequent sections of the Specifications:

AKCS	-	Automated Key Control System
BSS	-	Building Security System
CIS	-	Computer Interface Station
CO	-	Control Output
CPU	-	Central Processing Unit
DRS	-	Digital Recording System
DVR	-	Digital Video Recorder
FAS	-	Fire Alarm System
GSM	-	Global System for Mobile Communication (Cellular)
HEACS	-	Hotel Electronic Access Control System
ICP	-	Intelligent Control Panel
ID	-	Identification
IDS	-	Intrusion detection system
MI	-	Monitored Input
NAS	-	Network Attached Storage
NDR	-	Network Digital Recorder
NDS	-	Network Data Server
NSW	-	Network Switch
OIW	-	Operator Interface Workstation
PACS	-	Physical Access Control System
PCS	-	Parking Control System
PIDS	-	Perimeter Intrusion Detection System
RAM	-	Random Access Memory
REX	-	Request to Exit
RFI	-	Request for Information
RFP	-	Remote Field Panel
RM	-	Remote Module
RWS	-	Resident Wandering System

SAN	-	Storage Area Network
SER	-	Security Equipment Room
SIS	-	Security Intercom System
SMD	-	Security Monitoring Desk
VBS	-	Video Badging System
VDW	-	Video Display Wall
VMD	-	Video Motion Detection
VMS	-	Video Management System
WDS	-	Web Data Server
WDU	-	Wall Display Unit
WFP	-	Workstation Flat Panel.

1.4 REQUIREMENTS

- 1.4.1 Provide a complete BSS turnkey installation as detailed in this and other sections of these specifications. The BSS shall comprise of the following systems:
- 1.4.1.1 All facility Cat6A Network Cables for all ICT scopes of work will be supplied by and installed by the Structured Cable Contractor. Any Local or system only network will be part of each vendor.
 - 1.4.1.2 An IP-based Physical Access Control System (PACS) throughout the facility as detailed on the BSS drawings and specification section 28 13 00. PACS shall be connected to and utilize the property's converged network for communication.
 - 1.4.1.3 Supply and install all field devices for the PACS throughout the facility as detailed in the BSS drawings and specification section 28 13 00.
 - 1.4.1.4 Supply sufficient credentials and credential creation accessories, including CMYK printer ribbons, lanyards, etc. to suit the initial credential provisions. Provide twelve hundred (1200) printable cards to the Owner, and associated accessories. Credentials shall be supplied with additional MiFare and Smart Card capability.
 - 1.4.1.5 Provide full point and click mapping of entire property where PACS devices are located. Maps shall report status of PACS components and provide control of devices using a point and click interface.
 - 1.4.1.6 An IP-based Video Management System (VMS) throughout the facility as detailed in the BSS drawings and specification section 28 23 00. VMS shall be connected to and utilize the property's converged network for communication.
 - 1.4.1.7 Supply and install cameras for the VMS throughout the facility as detailed in the BSS drawings and specification section 28 23 00.
 - 1.4.1.8 Supply and install sufficient VMS storage for a period of 31 days at a constant rate of 15fps, at 1080P resolution, unless otherwise noted. Storage sizing and calculation shall be submitted at time of proposal to ensure sufficient provisions. All event recording shall be pre-buffered for 15 seconds and post-buffered for 15 seconds.
 - 1.4.1.9 In addition to supplied VMS storage, supply an additional 10% storage capacity for future expansion.
 - 1.4.1.10 An IP-based Security Intercom System (SIS) throughout the facility as detailed on the BSS drawings and specification section 28 15 00. SIS shall be connected to and utilize the property's converged network for communication.
 - 1.4.1.11 Supporting networking, signal conversion/transmission devices, servers, workstations, and associated peripherals as detailed on the BSS drawings and specifications.
 - 1.4.1.12 For all systems, provide spare materials as detailed in the Execution section of the respective specification section(s).

- 1.4.1.13 Provide Interfaces & Integration for the BSS systems, subsystems, and to other systems in compliance with drawings and specifications.
- 1.4.1.14 Connect to fire alarm system as required and as identified on security drawings and specifications. Coordinate with building fire alarm system to ensure all installations are compliant with building codes. Include all necessary fees and labour for permits and inspection required with authorities having jurisdiction (AHJ).
- 1.4.1.15 All equipment installed shall be compliant to either the issued drawings and specifications, approved alternates, or approved in the shop drawing review process. Any equipment found not to be compliant to the contract shall be replaced/reinstalled at no additional cost to the Owner.

1.4.2 Provide the following for all components of the BSS:

- 1.4.2.1 All programming required for a turnkey system until final deficiencies are corrected, and substantial completion is achieved.
- 1.4.2.2 Warranty on all components furnished, and maintenance/repair/replacement during the warranty period.
- 1.4.2.3 Submittals, samples and record documentation in compliance with respective sections.
- 1.4.2.4 Comprehensive commissioning and testing with the Owner or Consultant during substantial completion in compliance with respective specification sections.
- 1.4.2.5 Training services for the Owner and Operators in compliance with respective specification sections.
- 1.4.2.6 Coordination with other site trades and contractors/subcontractors.
- 1.4.2.7 Reporting to the Owner, the Architect and Consultant for the coordinated and timely execution of the Work.
- 1.4.2.8 All power supplies and conditioners, interlocking and control relays, equipment enclosures, conduit and cable trays, junction and mounting boxes, cabling, access doors, sleeves, fire stopping and other components, software, materials and services required for a completed and fully operational turnkey BSS installation meeting these specifications.

1.5 GENERAL CRITERIA

1.5.1 The BSS shall meet the following general criteria:

- 1.5.1.1 All BSS control equipment, including but not limited to: system control panels, networked devices, servers, workstations, interface devices, storage devices shall be fully IP networked, microprocessor based, and feature real time distributed processing.

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- 1.5.1.2 The BSS shall be configured to ensure reliability of systems operation and control of critical functions/systems. The following describes, in very general terms, a relationship between the various components of the BSS that would be acceptable. Other BSS topologies shall be acceptable if they meet the intent and performance requirements defined in these specifications.
- 1.5.1.2.1 All Network Data Servers (NDS) supporting BSS components shall incorporate, at minimum, rack-mountable server grade computers with sufficient NIC bandwidth, video card, processor capabilities, RAM, storage, CDRW, USB ports to suit the application. The BSS NDS computers shall reside in the location(s) noted on the BSS drawings.
- 1.5.1.2.2 All Client Operator Interface Workstations (OIW's) for BSS components shall incorporate, at minimum, personal desktop PC grade computer terminals with sufficient NIC bandwidth, video card, processor capabilities, RAM, storage, CDRW, USB ports, and split screen capabilities to suit the application. The OIW's shall reside at the location(s) noted on the BSS drawings. The OIW's shall provide the Operators with a "window" into the BSS for the monitoring and control of the system. The OIW's shall be partitioned to reflect the administrative responsibilities, and secured access afforded the respective OIW station operators.
- 1.5.1.2.3 For OIW's designated for specific functions, provide all necessary accessories and peripherals to suit the function (e.g. enrolment card reader, credential printer, card punch, photo ID camera, PTZ joystick, etc.)
- 1.5.1.2.4 Provide details of credential provided, including card type, facility code, card range, encoding format, and instruct the Owner on procurement of additional cards as necessary.
- 1.5.1.2.5 Where requested in the BSS drawings and specifications, provide a BSS Local Area Network (LAN) to serve the BSS system(s). The BSS LAN shall be a high-speed Ethernet TCP/IP based network compliant to telecommunications standards, with either a copper or fiber backbone sufficient to support 10Gbps of network activity.
- 1.5.1.2.6 Any Intelligent Control Panels (ICP's) shall be network based, communicate natively via TCP/IP, and connect to the BSS LAN for communication to the PACS server. The network connection shall be via a direct on-board RJ-45 connection on the ICP. The use of code or protocol converters is not permitted.
- 1.5.1.2.7 Any Remote Modules (RM's) (specific system required control or monitoring panels if required) that are subcomponents of ICP's shall be directly connected to their corresponding ICP via dedicated cabling referred to as panel cabling. If physically possible, the RM's shall be located within the same room as the ICP, otherwise in approved locations as agreed upon by the owner and consultant.
- 1.5.1.2.8 Field devices connected to RM's or ICP's shall be directly connected via dedicated cabling. This cabling shall be compliant to the device's functional requirements, manufacturer's recommendations, and these specifications.

1.6 WARRANTY AND SERVICES DURING THE WARRANTY PERIOD

- 1.6.1 The Warranty Period for all components of the new BSS and their installation shall be a minimum of two (2) years from the date of Substantial Performance. The date of Substantial Performance shall be the date when all components have been certified by the Consultant and accepted by the Owner to be complete in accordance with the definition of Substantial Performance.
- 1.6.2 All components and their installations shall be free from defects. Any defective material or workmanship and any resulting damage to work of other trades shall be replaced or repaired as directed during the Warranty Period. Comply with General Conditions, agreeing to repair or replace any components of the BSS that have failed within the warranty period.
- 1.6.3 Schedule repair work with the Owner's representative to prevent interference with normal building activities.
- 1.6.4 The Base Tender price shall include the cost of all replacement parts during the warranty period and all of the associated installation costs and all of the costs associated with the repair of components during the warranty period but shall not include the cost of labour for routine maintenance during the warranty period. The cost of labour for routine maintenance during the warranty period shall be provided separately as an Alternate Price as detailed below.
- 1.6.5 Replace or repair all supplied defective installations. Respond and be on site within four hours of the Owner placing a system trouble call for items of a critical, urgent, or immediate nature (e.g. failed head end component, non-functioning controller, etc.). Response to Warranty call out by the Owner shall be within 24 hours for items not requiring immediate attention. Work to trouble shoot and identify the cause of the BSS or component failure shall begin immediately and shall continue until repaired to the satisfaction of the Owner.
- 1.6.6 Any software modifications or upgrades that become standard product offerings from the BSS Contractor and/or BSS equipment vendors during the warranty period shall be brought to the attention of the Owner and, at the discretion of the Owner, may be requested and, if so, shall be provided at no additional cost to the Owner.
- 1.6.7 The BSS Contractor shall maintain an inventory of commonly replaced components in the local office for the replacement of failed components. Larger components shall be readily available within the North America for overnight courier shipping response.
- 1.6.8 Provide replacement components within the specified time periods for the following components. The Contractor shall guarantee to the Owner that the delivery of replacement components will be provided within the specified time periods.

BSS Component

Delivery-Time
(business days)

Computer Equipment (server/central computer components, workstations and components, primary communication components (network switches, fiber optic switches, NIC cards, etc.)

Five days

<u>BSS Component</u>	<u>Delivery-Time (business days)</u>
Head End Equipment (ICP's, RFP's, remote modules, secondary LAN components including any concentrators, protocol convertors, etc.)	Ten days
Field Equipment (card readers, detection sensors and devices, cameras, intercom stations, etc.)	Five days

1.7 CODES, PERMITS AND APPROVALS

- 1.7.1 Obtain all required permits, such as Magnetic Lock Installation Permits, and any other security –related inspection certificates. All permits and certificates shall be made available to the Owner.
- 1.7.2 The latest requirements of all national, provincial, county, municipal and other authorities having jurisdiction shall be met.
- 1.7.3 Work that is not clearly defined by local ordinance or amendment shall be governed by the local Building Code, and by the Authorities Having Jurisdiction (AHJ).
- 1.7.4 The requirements of The Occupational Health and Safety Act (OHSA), Environmental Protection Act (EPA), Americans with Disabilities Act (ADA), Accessibility for Ontarians With disabilities (AODA) and CSA Barrier Free Design Standards shall be followed for all job-site procedures and installation methods.
- 1.7.5 Work shall be performed in compliance with Owner's insurance underwriters' requirements which will be provided to the successful BSS proponent following project award.
- 1.7.6 All equipment and materials furnished under this contract shall be new and shall meet all applicable UL/ULC standards and all requirements of these specifications.

1.8 SCHEDULE

- 1.8.1 Complete all requirements of the BSS contract prior to the scheduled Substantial Performance date for each portion of the work.
- 1.8.2 Provide to the General Contractor a schedule indicating the sequence of work, durations of individual tasks, delivery dates for all material, devices and equipment and detail any interface that must be coordinated with any other contractors/subcontractors.
- 1.8.3 Attend all project meetings as requested by the Owner and the General Contractor.
- 1.8.4 Provide written status reports at required intervals and in a format acceptable to the Owner. An updated schedule of work shall be included in each status report.
- 1.8.5 Comply with the Project Construction Schedule. Provide additional staff and work overtime as required to comply with the Project Schedule and so as not to interfere with other on-site contractors/subcontractors in their effort to comply with the Project Schedule.
- 1.8.6 Provide written Request for Information notices to the Owner when specific information or clarification of the specifications is required. Request for Information notices shall be provided at least two weeks prior to the need for the information.

1.9 CONTRACTOR QUALIFICATIONS

- 1.9.1 The Contractor shall:

- 1.9.1.1 Be certified by the manufacturer to procure, install, program, maintain, and service the acceptable BSS components.
- 1.9.1.2 The Contractor must have permanent full-time certified staff available in the project area to perform all necessary project cycle installation functions, including service and maintenance work following system acceptance.
- 1.9.1.3 Have staff and be able to supply information to support that their current installation and service technicians are competent factory trained and certified personnel capable of maintaining and servicing the proposed system.
- 1.9.1.4 Have a proven record of experience with similar in the supply and installation of equivalent systems over a minimum period of five years. Document at least three and no more than six projects, of equal or greater size and complexity, on the acceptable BSS components. Indicate quantities of card readers, VMS cameras, and SIS units included in the scope of the projects along with a description of the property secured.
- 1.9.1.5 Have been a factory certified representative for the BSS products indicated, for a minimum of three years entailing design, installation, configuration, and maintenance.
- 1.9.1.6 Have comprehensive local service and support facilities in the project area for the total BSS as provided.
- 1.9.1.7 Maintain local supplies or have access to a factory authorized organization that shall carry a complete stock of essential and expendable parts.

1.10 SYSTEM COMPLIANCE AND PERFORMANCE CERTIFICATION

- 1.10.1 The BSS Contractor shall thoroughly review all aspects of the BSS Design Documents and certify that their bid submission and proposed BSS facilities are in compliance with the Contract Documents. The Contractor shall provide a Compliance Review of all Specifications and Addenda as part of the Contractor's proposal. The Compliance Review will be an item-by-item list and review of the Specifications. The BSS Tender Respondents shall clearly identify any areas where the proposed BSS facilities are not in full compliance with the BSS design. An accompanying performance statement and technical supporting documentation must be supplied for consideration.
- 1.10.2 In lieu of a full Compliance Review, one or more general Letter of Compliance may be supplied if the proposed system(s) are in full compliance with the issued drawings and specifications. A Letter of Compliance from the bidder, contractor/subcontractors, and manufacturers are acceptable.
- 1.10.3 Unless an exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Exceptions taken in cover letters, subsidiary documents, by omission, or by contradiction do not release the Contractor from being in complete compliance unless the exception has been specifically noted (explicitly, not by implication) in the Compliance Review.

PART 2 - PRODUCTS

2.1 EQUIPMENT – MATERIALS REQUIREMENTS

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- 2.1.1 Equipment, materials, devices and facilities shall meet, at minimum, the following requirements:
- 2.1.1.1 Manufactured by experienced manufacturers of the specific components and facilities.
- 2.1.2 All equipment and materials shall be manufactured using new and high-quality components, without defects. All field devices of each system shall be products of one manufacturer with unified shape, colour, design, function, operation, and markings.
- 2.1.2.1 Design shall minimize the requirement for field repair or maintenance.
- 2.1.2.2 Modular design to allow expansion without substantial modification of existing installed components.
- 2.1.2.3 Internal or self-diagnostics for component failures.
- 2.1.2.4 Maintainable on a unit basis without affecting the ongoing operation of the balance of other systems.
- 2.1.2.5 Modular components, test ports and cable terminations shall be accessible.
- 2.1.2.6 Damage caused by the failure of one component will be limited to the component that has failed without affecting the ongoing operation of the systems.
- 2.1.3 Equipment and materials shall be provided with an Underwriters Laboratories, Inc. (U.L.) and Canadian Standards Association C.S.A label wherever applicable.
- 2.1.4 Hazardous Materials Notification: In the event that a product or material that does not contain asbestos, PCB, or other hazardous materials as determined by the Owner is not available, a "Material Safety Data Sheet" (MSDS) equivalent to OHSa Form shall be submitted for the proposed product or material prior to installation.
- 2.1.5 Asbestos and PCB Certification: After completion of installation, but prior to Substantial Performance, the BSS Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB).
- 2.2 EQUIPMENT – MOUNTING AND FINISHES**
- 2.2.1 Fire rated or U.L. /U.L.C. listed doors and frames shall not be drilled, cut or modified in any way without prior approval from the Architect. Doors or frames that require modification to meet the Contract Document requirements shall be brought to the attention of the Architect. Replace any door or frame that has been modified without the approval from the Architect.
- 2.2.2 Visible panel and instruction labels shall be in compliance with the CSA Barrier Free Design Standards as approved by the Architect. Graphics for all equipment in areas accessible by the public shall be approved by the Architect.

2.2.3 Visible security BSS contractor identification logos, trademarks, or evidence of their removal are not permitted on any equipment, or devices, etc. that are located in publicly-accessible, and viewable spaces. Equipment, devices, or enclosures accessible to the public shall utilize tamper proof fasteners or manufacturer-installed locks.

2.2.4 Final mounting locations shall be verified with the Architect prior to installation. Notify the Architect if a particular location is not acceptable for the application.

2.3 AMBIENT CONDITIONS

2.3.1 Provide equipment, devices and materials for interior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:

2.3.1.1 10 to 45 Deg. Celsius temperatures.

2.3.1.2 10-90 percent relative humidity (non-condensing).

2.3.1.3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz.

2.3.2 Provide equipment, devices and materials for exterior applications that shall be capable of withstanding and operate satisfactorily in, at minimum, the following ambient conditions:

2.3.2.1 -40 to 50 Deg. Celsius temperatures.

2.3.2.2 10 - 100 percent relative humidity.

2.3.3 Electrical power service of single phase, 85-110 percent of 120 Vac, 60 Hz.

2.4 PATHWAYS FOR BSS EQUIPMENT

2.4.1 All BSS cabling shall be in conduit unless otherwise noted. The electrical contractor shall provide the BSS required conduits as detailed on the Security Drawings. The BSS Contractor shall review the Security Drawings and indicate within the tender form if any additional conduit is required. If additional conduit is requested by the BSS Contractor within the tender submittal, it will be added to the electrical contractor's scope of work. If confirmation is not received at tender time, and subsequently it is determined that additional conduit is required, then the BSS Contractor shall provide all additional conduits required for a complete BSS installation at no additional cost to the owner. Coordinate with electrical contractor for exact junction box and termination locations for all required conduits.

2.4.2 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Provide larger or additional conduit if required. BSS cabling shall not share conduit with any other cabling. Coordinate installation of conduit with building structure and other trades. Colour-code all conduit and fittings with a unique colour at every junction box and at least every 10 feet along the conduit. All conduits shall be provided complete with "pull-string" for future pulls.

2.4.3 All BSS cabling required to be within conduit, shall be run in its own conduit and shall not share conduit with any other trade. BSS cabling of same type (i.e. PACS) may be combined provided CEC minimum fill requirements are maintained. Cable carrying voltage in excess of 48 volts shall not share conduit with cable carrying voltages of 48 volts or lower.

- 2.4.4 If lubricant is required for pulling of cables through conduits, only wipe on or spray on type shall be utilized. The wipe on or spray on type must be expressly designed for mitigation of wet link insertion loss. Cable damage from pulling of cables is the security Contractor's responsibility and new cable shall be provided at no additional cost to the Owner.
- 2.4.5 If a J-hook or trapeze system is used to support cable bundles, all cables shall be supported at a maximum of four-foot intervals- at no point shall cable(s) rest on acoustic ceiling grids or panels.
- 2.4.6 Cables supported by J-hooks shall be run in conduits from ceiling area to field device location.
- 2.4.7 Structural support members shall be galvanized.

2.5 PANELS

- 2.5.1 Provide panels and enclosures for all components of the BSS which are susceptible to physical or environmental damage. Equipment or devices that are not equipped with enclosures, as a specified unit shall be mounted within panels or enclosures that meet, at minimum, the following requirements:
 - 2.5.1.1 NEMA 1 rated painted steel panels with locking door.
 - 2.5.1.2 Ventilated to prevent excessive heat build-up, where required.
 - 2.5.1.3 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - 2.5.1.4 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.
 - 2.5.1.5 Cabling shall be neatly installed within wire guides with removable covers for easy access.
- 2.5.2 Interior panels and enclosures within plenum areas shall meet, at minimum, the following requirements:
 - 2.5.2.1 Approved plenum rated panel with locking door and gasketing as required.
 - 2.5.2.2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
 - 2.5.2.3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.
 - 2.5.2.4 Cabling shall be neatly installed within wire guides with removable covers for easy access and additional service-loop spare cabling common in best industry installation practices.
- 2.5.3 Exterior and garage mounted panels and enclosures shall meet, at minimum, the following requirements:
 - 2.5.3.1 NEMA 4 painted steel panels with locking door.

- 2.5.3.2 Field cabling shall be terminated on a terminal strip or directly on the component PCB fixed within the enclosure. Provide strain relief as necessary.
- 2.5.3.3 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal, or replacement of any component within the enclosure.
- 2.5.3.4 Cabling shall be within wire guides with removable covers for easy access.
- 2.5.4 All panels shall be lockable with the same key, which shall be unique to the building. Provide the Owner with ten keys.
- 2.5.5 Panels and enclosures are only allowed at the PACS RFP locations as indicated on the Security Drawings.
- 2.5.6 Provide cabling diagrams laminated in clear plastic at each field panel enclosure showing all cable terminations, relays, interlocks, power supplies, etc.
- 2.5.7 Provide heat output and space conditioning requirements to the Owner and Architect for all BSS components.

2.6 LABELLING

- 2.6.1 Provide labelling for all ICP's, RFP's, other panels, and enclosures. Labelling shall meet, at minimum, the following requirements:
 - 2.6.1.1 Plastic laminated label, which shall be affixed to the panel or enclosure with rivets or permanent adhesive.
 - 2.6.1.2 Lettering .25-inch high which sharply contrasts with the background.
 - 2.6.1.3 Coordinated with the approved project labelling scheme and consistent throughout the project.
 - 2.6.1.4 Indicated on the record documentation.

2.7 SECURITY EQUIPMENT RACK

- 2.7.1 Install all required security system equipment as detailed within these documents within the racks provided by others in the Main IT room. Refer to the detail drawings within the security drawings for equipment locations and rack quantities.
- 2.7.2 Provide all mounting hardware and supports as necessary to mount the equipment within the racks.
 - 2.7.2.1 Provide heat output and space conditioning requirements to the Owner and Architect for all BSS components.

2.8 PATHWAYS FOR BSS EQUIPMENT

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- 2.8.1 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Conduit, where required, shall meet, at minimum, the following requirements:
- 2.8.1.1 Building conduit shall be electrical metallic tubing (EMT), and shall be as follows:
 - 2.8.1.1.1 "Thin wall" zinc coated steel.
 - 2.8.1.1.2 ANSI C80.3 and UL-797.
 - 2.8.1.1.3 Assembled using concrete tight and rain tight gland-ring compression threaded type fittings.
 - 2.8.1.2 Liquid-tight conduit shall be used in wet locations.
 - 2.8.1.3 Flexible connections shall be provided for equipment subject to vibration or movement.
 - 2.8.1.4 Smooth interior surface free of obstructions.
- 2.8.2 Junction and pull boxes shall be installed where required by the corresponding electrical code and at locations to facilitate the pulling of cable. Junction and pull boxes shall meet, at minimum, the following requirements:
- 2.8.2.1 Meet NEMA/CSA and CEC Code requirements with respect to material, gages, dimensions and methods of fastening.
 - 2.8.2.2 UL/ULC approved for the installed application and location.
 - 2.8.2.3 Removable screw cover.
 - 2.8.2.4 Interior boxes shall be galvanized steel.
 - 2.8.2.5 Exterior boxes shall be hot-dip galvanized cast iron with weatherproof covers.
 - 2.8.2.6 100mm² or larger.
 - 2.8.2.7 Securely fastened to the conduit.
- 2.8.3 Cable support (J-hooks) shall meet at minimum the following requirements:
- 2.8.3.1 Shall Comply with UL, cUL, NEC and EIA/TIA requirements.
 - 2.8.3.2 Shall be available in diameter sizes of 25mm (1in), 50mm (2in), 75mm (3in) and 100mm (4in).
 - 2.8.3.3 Shall provide a bearing surface of sufficient width to comply with required bend radius of cables.
 - 2.8.3.4 Shall be metal (at least 0.052" thickness) not plastic or any other similar materials to support cabling in fire event.

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- 2.8.3.5 Any fasteners used to affix the cable support shall be metal and fastened to the metal of support.
 - 2.8.3.6 Shall have flared edges to prevent damage while installing cables.
 - 2.8.3.7 Shall meet the bend radius support requirements of supporting four (4) times outer diameter (O.D.) per TIA-C.5.3.2.1; all edges shall support a bend radius of 1 ½" or more.
 - 2.8.3.8 Shall support bend radius requirements on the "neck" to allow for pathways around corners.
 - 2.8.3.9 Shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
 - 2.8.3.10 Shall have an electro galvanized, G60, or powder coated finish.
 - 2.8.3.11 Shall have a cULus static load rating of 60lb.
 - 2.8.3.12 Coloured cable support shall have the two letter colour code added to the product number.
 - 2.8.3.13 Multi-tiered cable support assemblies shall be used where separate cabling compartments are required.
 - 2.8.3.14 Manufacturer shall have minimum of five years documented experience in the industry and certified ISO900.
- 2.8.4 Coordinate installation of pathways with building structure and other trades. Pathway's installation above accessible ceilings shall be such that there will be no interference with the installation of lighting fixtures, fire protection, air outlets or other devices. Colour-code all conduit and fittings with a unique colour at every junction box and at least every 3,000 mm (10 feet) along the conduit.
- 2.8.5 Primary communication LAN cable shall not share conduit with any other cable.
- 2.8.6 Secondary communication LAN cable shall not share conduit with any other cable.
- 2.8.7 Conduit sizes indicated on the drawings are to be considered the minimum size to be installed. Provide any additional conduit required to provide a complete system.
- 2.8.8 Pathway installed by the BSS Contractor shall be securely mounted in accordance with CEC Regulations and shall be concealed in all high finish/guest areas and areas to which tenants and/or the public have access.
- 2.8.9 Pathway shall run parallel or perpendicular to the building lines and shall be installed in a workmanlike manner. Avoid obstructions and crossovers where possible.
- 2.8.10 Pathway shall be installed such that any condensation in the conduit cannot run into BSS equipment. Where necessary conduit shall enter enclosures from the bottom or shall be sloped up to the enclosure.
- 2.8.11 Conduit/cable tray/cable support shall be provided for all BSS cables.

PART 3 - EXECUTION

3.1 BORING AND PATCHING

- 3.1.1 Provide boring and patching of work as required for a complete BSS. Boring and patching shall meet, at minimum, the following requirements:

- 3.1.1.1 Before boring any structural or fire rated components, obtain the Architects' approval.
- 3.1.1.2 Make boring with clean, square and smooth edges. Patches shall be inconspicuous in the final installation.
- 3.1.1.3 Restore fire ratings if boring has violated the fire rated assemblies.

3.2 SLEEVES, CUTTING, PATCHING, AND FIRE STOPPING

- 3.2.1 The Contractor shall be responsible for the timely placing of sleeves as detailed on the Drawings and the Coordination Drawings for all piping and conduit through walls and partitions, beams, floors and roofs as noted below, while the same are under construction:

- 3.2.1.1 All concrete or masonry construction.
- 3.2.1.2 Wall constructions where the penetration must be sealed airtight. Patches for penetrations through walls for Work installed prior to finish application shall be provided by others. 13mm (½")
- 3.2.1.3 Fire rated wall construction.

- 3.2.2 Sleeves shall be at least one size larger than the size of conduit or pipe, including the insulation where applicable; it serves except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves shall be sized such that the annular space between the sleeve and the conduit will not be less than 13mm (½"). All conduits passing through concrete or masonry walls above grade shall be at least 18-gauge galvanized steel sleeves. Sleeves shall be set flush with finished wall. All sleeves in floors shall extend a minimum of 50mm (2") above the finished floor. Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the fire safe system used. Sleeves set in concrete floor construction shall be at least 16-gauge, galvanized steel. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve and the conduit shall be centred in the sleeve.

- 3.2.3 Seal all penetrations in fire rated construction with factory-built devices or with manufactured fill, void or cavity materials "Classified" by Underwriters Laboratories, Inc. for use as a Through Penetration Firestop. All firestop devices and systems shall be approved for such use by the authorities having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated. Firestop systems and devices shall comply with ASTM E 814 (UL 1479) for all types of penetrations being sealed. Submittal data for firestop systems shall include the applicable UL System Numbers. Excessive shrinkage of the firestop materials, which would permit the transmission of smoke or water prior to exposure to a fire condition, is unacceptable. Where a mastic coating is used to seal the surface of the firestop, the mastic shall be non-hardening. The firestop manufacturer's representatives shall instruct the Contractor's representatives in the proper installation procedures so that the penetrations on the Project will be installed in accordance with the UL listing and the manufacturer's recommendations. If it complies with these Specifications, firestop-sealing component/system as manufactured by one of the following manufacturers will be acceptable:
- 3.2.3.1 Specified Technologies, Inc. SpecSeal Systems or,
 - 3.2.3.2 3M Fire Barrier Penetration Sealing Systems or,
 - 3.2.3.3 Hilti FS-601 Systems.
- 3.2.4 Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4" thick steel plate waterseal secured to the pipe with continuous fillet weld. The waterseal plate shall be located in the middle of the wall and shall be 50mm (2") wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. Seal off annular opening between pipe and sleeve with "Link Seal" type casing seal as manufactured by Thunderline Corporation or Innerlynx. The pipe sleeve shall be sized to accommodate the Thunderline casing seal. Casing seals shall be Series 300 for pipe size 20mm (3/4") through 100mm (4") and Series 400 for pipe sizes 125mm (5") and larger. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner. The Contractor shall undertake no cutting or patching without first securing the Architect's written approval.
- 3.2.5 All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

3.3 LABELLING

- 3.3.1 Provide labelling for all cabling. Labelling shall meet, at minimum, the following requirements:
- 3.3.1.1 Plastic laminated label, which shall be affixed to the cable with self-adhesive backing.
 - 3.3.1.2 Marker labelling directly on the cable jacket shall not be permitted.
 - 3.3.1.3 Lettering which sharply contrasts with the background.
 - 3.3.1.4 Coordinated with the approved project labelling scheme and consistent throughout the project. Approve with consultant prior to labelling.
 - 3.3.1.5 Indicated on the record documentation.

3.4 HANGING AND SUPPORTING

- 3.4.1 Install all equipment, devices, materials, and components in compliance with the manufacturer's recommendations. Supports shall be suitable for the environment within which the component is to be installed. Coordinate all hanging and supporting of components with all trades.
- 3.4.2 BSS cables shall be bundled in groups of not greater than forty (40) cables. Attention to cable bundle size must be taken; excess of forty (40) cables may cause deformation of the bottom cables within the bundle.
- 3.4.3 Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware.
- 3.4.4 The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- 3.4.5 Cables shall not be attached to ceiling grid or lighting support wires.
- 3.4.6 Cable damaged (conductor, shield or jacket) or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- 3.4.7 No plastic or metal cable ties are permitted.
 - 3.4.7.1 Allowable fill capacity and load rating shall not exceed manufacturer recommendation.

END OF SECTION

PART 1 - General

1.1 References

- 1.1.1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.
- 1.1.2 This section is related to and shall be read in conjunction with all other Division 28 sections.

1.2 APPLICATION

- 1.2.1 This section of the specifications details the work and components to be provided by the BSS Contractor relating to the Physical Access Control System.

1.3 REQUIREMENTS

1.3.1 GENERAL

- 1.3.2 The PACS system shall be installed to meet the requirements of these Specifications and BSS drawings shall include all software, hardware, Intelligent Control Panels (ICP), Remote Field Panels (RFP), Remote Modules, field devices, sensors, and other components to provide a turn-key operating PACS system for the Owner.
- 1.3.3 The PACS shall be designed in a modular fashion, such that addition and expansion to the PACS by adding components shall not require substantial modification of other components such as Server or Client equipment, or other ICP's and RFP's.
- 1.3.4 The PACS shall be capable of running on a TCP/IP network and shall be accessible, configurable, and manageable from any network-connected PC via a browser or client software on the same sub-network.
 - 1.3.4.1 The PACS shall monitor and control facility access, and shall perform alarm monitoring, communications loss monitoring. The system shall also maintain a database of system activity, personnel access control information, system user information, user permissions, and other relevant data.
 - 1.3.4.2 All card access requests, alarms, events, actions, commands, and responses shall be completed within two (2) seconds of being triggered. This shall occur across the entire PACS and its components and shall not be affected by system activity at any given time.
 - 1.3.4.3 The database of system activity, personnel access control information, system user passwords, user role permissions, and other relevant data shall be of a commercially available relational database management system that supports ODBC and shall run on the same equipment as the PACS Server/Controller.
 - 1.3.4.4 The system shall be controlled from a web browser or client software and provide control and access to users on Local Area Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet.
 - 1.3.4.5 The system functions shall take place in a point-and-click interface, through the use of a standard PC mouse and keyboard combination.

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- 1.3.5 The PACS Server/Controller shall serve as the central component of the PACS. The PACS Server or Controller contains an operating system, the security application software, and the database of personnel and system activity.
- 1.3.6 The PACS Server shall be installed on a rack-mountable server-grade computer meeting all the manufacturer's system requirements.
- 1.3.7 The PACS Client workstation shall serve as the monitoring component of the PACS. The Client software allows administrators and users to interact with the PACS Server/Controller, allowing for system configuration, management, and real-time monitoring of PACS events.
- 1.3.8 The PACS Client shall be installed or used on a desktop-grade computer with sufficient equipment to suit the purpose (i.e. multi-monitor, camera, credential printer, enrolment reader, peripherals, etc.) of the station.
- 1.3.9 The PACS Server and Client software shall be installable or embedded on commercially hardware platforms, on a Windows or Linux based operating system which is part of the manufacturer's support cycle at time of install.
- 1.3.10 The system shall be capable of being integrated to a Windows Active Directory (LDAP) server for single sign logon authentication. If activated in such a way, password and authentication will be controlled by the LDAP server.
- 1.3.11 The system shall be capable of being divided into partitions, allowing subsets of the overall system and components to be managed separately. Partitions of the system shall be capable of being assigned access rights, so that user level logins, where restricted, can only view partitions for which they are authorized.
- 1.3.12 Configuration of all system components shall follow a hierarchical format, where an object which logically belongs to a higher-level object is capable of inheriting the property of its "parent" object. This shall apply to, but not be limited to, partitions, logical groupings of system objects, schedules, access levels, card holders, and system users.
- 1.3.13 Each field device on the system shall be defined as active/inactive, secure/released, alarmed/suppressed as required by the function, on an as required basis via the operator, or based on a time schedule. Field devices shall be controllable individually, or as part of one or more groups.
- 1.3.13.1 The system shall be capable of providing email and/or text message alerts for all alarm conditions and threats.
- 1.3.14 All equipment and materials comprising the PACS system shall be standard components, regularly manufactured, stocked, and utilized in the manufacturer's system.
- 1.3.15 All PACS components shall have been thoroughly tested and proven in actual installations.
- 1.3.15.1 All PACS components shall be provided with a minimum manufacturer warranty of two (2) years.

1.4 FIELD INSTALLATIONS - GENERAL

- 1.4.1 Provide, except where otherwise noted, all associated power supplies, transformers, electronic relays, terminations, cabling, panels, enclosures, housings, interconnections, and equipment required to integrate the field devices into the PACS.
- 1.4.2 Provide, except where otherwise noted, modifications to doorframes and doors as required for the mounting of the security field door associated devices, to provided manufacturer details, as approved by the Architect and Consultant.
- 1.4.3 The BSS Security contractor shall provide interfaces to any door have electronic security PACS locks required to release upon fire alarm condition.
- 1.4.4 The BSS Security contractor shall provide interfaces to any automatic barrier free (BF) door operators located on BF doors required to have electronic security PACS locks. BF automatic door operator pushbuttons shall be provided by others.
- 1.4.5 The BSS Security contractor shall provide a control relay (if not supplied in the BF door operator design) for each automatic door operator pushbutton such that the signal from the operator pushbutton into the controller is interrupted whenever the electric lock is engaged. Review the architectural door hardware section, architectural drawings, and electrical drawings, for automatic door operator locations.

PART 2 - PRODUCTS

2.1 APPROVED SYSTEMS MANUFACTURERS

- 2.1.1 Subject to compliance with these specifications, PACS equipment, software and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
 - 2.1.1.1 Genetec Synergis with Mercury Authentic Hardware (or Genetec Security Center when combined with Genetec VMS)
 - 2.1.1.2 S2 Security with Mercury Authentic Hardware
 - 2.1.1.3 Avigilon Access Control with Mercury Authentic Hardware
 - 2.1.1.4 Software House CCURE 9000
 - 2.1.1.5 Approved equal or alternate

2.2 SOFTWARE – SYSTEM CAPACITY

- 2.2.1 At minimum, the system shall be capable of supporting the following capacities:
 - 2.2.1.1 64 Intelligent Control Panels
 - 2.2.1.2 256 doors/portals
 - 2.2.1.3 100,000 personnel records
 - 2.2.1.4 150,000 credentials
 - 2.2.1.5 512 credential formats

- 2.2.1.6 512 access levels
- 2.2.1.7 32 access levels per personnel record
- 2.2.1.8 512 time schedules
- 2.2.1.9 30 holiday schedules
- 2.2.1.10 10 concurrent operator logins
- 2.2.1.11 2,000 alarm inputs
- 2.2.1.12 2,000 relay control outputs
- 2.2.1.13 40,000,000 event log entries

2.3 SOFTWARE - MANAGEMENT

- 2.3.1 Password protection shall be provided for all aspects of the PACS. Only operators with the appropriate password and access privileges shall be able to access the management, reporting, alarm response, and database functions of the PACS.
- 2.3.2 Password features shall meet, at minimum, the following requirements:
 - 2.3.2.1 Individual passwords shall have a minimum of seven (7) characters in length.
 - 2.3.2.2 Enforcement of password strength, such as upper- and lower-case letters, numbers, and punctuation symbols shall be possible.
 - 2.3.2.3 Password history and aging to prevent re-use and expiry of passwords shall be possible.
- 2.3.3 Operators and operator levels shall be capable of being assigned rights, which restrict their access and capabilities in the system, based on job function. The rights of users and user levels shall be customizable to all of the system functions, monitoring capabilities, database fields, and login times/locations.
- 2.3.4 Operator interface shall be tailored to the individual operator level and access privilege. PACS features which are not accessible to the operator shall be removed, disabled, or hidden from the interface.
- 2.3.5 Login throttling, which can be enabled for the system to limit the number of invalid login attempts from the same location in a given period of time.
- 2.3.6 The system shall be capable of supporting multiple user levels. There shall be one "master" administrator, capable of performing all configuration and administration functions on the system, including creating additional users and user levels.
- 2.3.7 From the default top-level partition, one or more additional partitions can be created.
- 2.3.8 Each partition shall contain administrators, card holders with their credentials, and resources.

- 2.3.9 When performing administrative functions, the administrator of a partition shall have the ability to manipulate only the cardholders and resources in that partition. However, resources can be shared across partitions through the mapping of access levels from one partition to another.
- 2.3.10 Administrators shall have the ability to search for person records across all partitions to which they have access.
- 2.3.11 The system shall be capable of integrated photo ID creation capability. Use of secondary or third-party credential creation software shall not be permitted.
- 2.3.12 The photo ID creation function shall be capable of importing card holder photos in common graphic formats, in addition to capturing images from a connected USB camera or TWAIN device.

2.4 SOFTWARE – ACCESS CONTROL

- 2.4.1 The PACS shall be capable of the following access control functions:
 - 2.4.1.1 Legacy support for legacy Wiegand card readers.
 - 2.4.1.2 Keypad PIN support for 4-digit or 6-digit PINs.
 - 2.4.1.3 Compatibility with various input devices, including biometric readers.
 - 2.4.1.4 Card-in, card-out reader door/portal support.
 - 2.4.1.5 Elevator control, including enabling of buttons or floor selection (floor select) and logging of floors accessed (floor tracking) for valid credentials.
 - 2.4.1.6 Support for accessibility functions per credential to allow for additional door functions to accommodate accessibility requirements for valid credential holders.
 - 2.4.1.7 Multiple access levels and cards per person.
 - 2.4.1.8 Credential enrolment by reader or keyboard.
 - 2.4.1.9 Credentials shall be capable of being assigned active/expiry date and time and shall deny access automatically when the date and time are reached.
 - 2.4.1.10 The system shall allow for issuing of temporary replacement credentials to card holders for misplaced credentials and allow for the restoration of original credential if found or returned.
 - 2.4.1.11 The system shall allow for voiding or deleting lost credentials from card holder records in order to deny access to unauthorized card holders.
 - 2.4.1.12 Active credentials shall have operator defined access privileges and shall be assigned to one or more cardholder group(s).
 - 2.4.1.13 Simultaneous support for multiple card credential encoding formats.
 - 2.4.1.14 Credential format decoder to discover unknown credential formats.

- 2.4.1.15 The system shall be capable of creating card holder templates, to automate and simplify bulk creation of card holders.
- 2.4.1.16 Creation and enforcement of an unlimited number of time schedules which shall control access and locking/unlocking and arming/disarming of the PACS components automatically.
- 2.4.1.17 Creation and enforcement of an unlimited number of holiday schedules which shall control access and locking/unlocking and arming/disarming of the PACS components automatically.
- 2.4.1.18 Hard anti-passback function (credential shall not be valid at a zone entry card reader until it has been presented at a zone exit card reader).
- 2.4.1.19 Soft anti-passback function (credential shall not be valid at a card reader until an operator defined time period has elapsed).
- 2.4.1.20 Escort function (2 authorized access credentials must be presented at the card reader before entry through the controlled door/portal is allowed).
- 2.4.1.21 Elevator control.
- 2.4.1.22 Duress PINs, which can be enabled for the system to allow a valid user to raise an alarm if compelled under duress to use his or her credentials (credential + PIN) to allow access for another person.
- 2.4.1.23 Scheduled actions for arming inputs, activating outputs, and locking and unlocking portals.
- 2.4.1.24 Optional storage and recall of ID photos and personal/emergency data.
- 2.4.1.25 Up to 20,000 credentials are stored locally at each ICP. An unlimited number of credentials may be authenticated with the PACS Server.
- 2.4.1.26 The system shall support tracing a person's activity in the system if enabled.

2.5 SOFTWARE - MONITORING

- 2.5.1 The PACS shall be capable of the following monitoring functions:
 - 2.5.1.1 The main PACS Client screen lets users view a full system summary, graphic floor plans, an activity log, photo ID displays, system menus/links to frequent user tasks, and system configuration tools.
 - 2.5.1.2 The activity log shall display alarm events in real-time, with date/time stamp in a scrollable event list. Alarm events shall be clearly identifiable via the use of colour or visual cues, in order to call attention to high priority alarms.
 - 2.5.1.3 High priority alarms shall appear at the top of the alarm list. Alarms shall be queued in order of priority, then in order of occurrence.

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- 2.5.1.4 Clicking on an alarm event in the event list shall present the operator with contextual information and options to acknowledge, escalate, or silence the alarm, based on their user rights. Examples of contextual alarm information include, but at not limited to, card holder related alarms present an image of the associated card holder, and door alarms present options to re-lock or unlock the door.
 - 2.5.1.5 Alarm events shall also be configurable to present the operator with specific response instructions via a pop-up window, as well as requiring that a duty log entry be entered before the alarm can be acknowledged.
 - 2.5.1.6 Alarm transactions displayed shall include, at minimum, the following:
 - 2.5.1.6.1 Door forced or held open alarms
 - 2.5.1.6.2 Credential or card holder access, denial, or usage violations
 - 2.5.1.6.3 Operational alarms
 - 2.5.1.6.4 Alarm acknowledgements by operator
 - 2.5.1.6.5 Changes to the system by an operator
 - 2.5.1.6.6 Field device alarms
 - 2.5.1.6.7 Key switch operation
 - 2.5.1.6.8 Communications loss or other system fault alarms
 - 2.5.1.7 Support for the creation of custom sets of alarm event actions.
 - 2.5.1.8 Support for assigning sounds, including custom sounds to alarm events.
 - 2.5.1.9 Provides the ability to assign, at a minimum, twenty (20) priority levels to various alarms according to severity.
 - 2.5.1.10 Provides the ability to assign different annunciation events for the priority levels, including none (log only) for low priority events, up to annunciation events requiring multiple operator action.
 - 2.5.1.11 Provides the ability to enter a duty log comment into the Activity Log, or to append a unique or preset comment to a particular log entry while viewing the Activity Log.
 - 2.5.1.12 For high priority alarms, provide the capability to assign a mandatory duty log, or a higher operator level acknowledgement which must be completed before alarm can be acknowledged.
 - 2.5.1.13 Support for electronic supervision of alarm inputs.
 - 2.5.1.14 Support for the use of output relays for enabling circuits under alarm event control.
 - 2.5.1.15 Graphic floor plans shall represent a logical representation of the site, with clickable areas linked to other floor plans including:
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- 2.5.1.15.1 An overall site plan of the project, including distinct buildings, areas and floors allowing the user to click on the buildings to select the specific floor plan.
- 2.5.1.15.2 A floor plan including devices which are part of the area shown. Floor plan must be scaled to fit and display all devices clearly.
- 2.5.1.15.3 Where floor plans do not fit in the interface space while remaining legible, floor plans shall be divided into further graphics, allowing the user to click on the outer boundaries of the floor plan to select the next adjacent area.
- 2.5.1.16 Floor plans shall clearly identify the floor, area, and room names, and contain active icons of security system resources in the floor plan area. Icons shall provide near real-time status and updates of the associated devices, via the use of colour or visual cues, of the device status change.
- 2.5.1.17 Clicking on the icons allows for direct control of the resource (e.g. clicking on a door allows locking, unlocking, manual override, etc.).
- 2.5.1.18 An operator with appropriate privileges shall be able to override any controlled device within the system. The device shall remain in the override state until an operator restores it back to automatic state.
- 2.5.1.19 Upon alarm, if configured, the floor plan associated with the object in alarm status shall be capable of “popping up” or be displayed in the foreground of the user interface without manual intervention and shall clearly display the object in alarm status.
- 2.5.1.20 A user login with sufficient rights shall be capable of creating, modifying, and configuring graphic floor plans and associated functions.
- 2.5.1.21 Creation of graphic floor plans shall be via an icon-driven drag-and-drop interface. Importing of floor plans from different file formats shall be possible. Supported formats shall include, but not be limited to: BMP, GIF, JPG, PNG, TIF, WMF, PDF, and AutoCAD.

2.6 SOFTWARE - DATABASE

- 2.6.1 The PACS database shall maintain data of system activity, card holder data and access control information, system user passwords and custom user role permissions for whole or partial access to system resources and data.
- 2.6.2 The database shall store system settings, including but not limited to configuration settings, operator passwords, permissions, time schedules, holiday schedules, and access levels.
 - 2.6.2.1 Each PACS card holder entry shall be stored with, at minimum, the following:
 - 2.6.2.1.1 Card holder's name, phone number, employee number, department
 - 2.6.2.1.2 Special accessibility requirement(s).
 - 2.6.2.1.3 Access level or group assignment(s)
 - 2.6.2.1.4 Time schedule and holiday assignment(s)

- 2.6.2.1.5 List of assigned credentials, including credential type and number
 - 2.6.2.1.6 Unique card holder PIN
 - 2.6.2.1.7 Other custom fields as necessary, such as license plate number, emergency contact information, assigned assets, and other custom fields
 - 2.6.2.1.8 Photo file for ID creation
- 2.6.3 Each PACS system activity transaction shall be stored with, at minimum, the following:
 - 2.6.3.1 Date/time stamp of the transaction
 - 2.6.3.2 Brief description of the transaction
 - 2.6.3.3 Indication of resource initiating the transaction (i.e. device, card number, panel, operator).
- 2.6.4 The database shall have built-in Open Data Base Connectivity (ODBC) to allow external manipulation of database tables and entries.
- 2.6.5 Network-secure API for adding to, deleting from, modifying the database, and external application integration.
- 2.6.6 The database shall be searchable by all the relevant fields of each data type.
- 2.6.7 The database shall be capable of being backed up with an utility that enables scheduled or manual backups, and allows database backups to be specified by a date/time range, file size limit, or event quantity limit.
- 2.7 SOFTWARE - REPORTING**
 - 2.7.1 The system shall feature a native report writer interface that allows the interactive creation of custom reports. Report writer shall use an English-based query language for report creation. Reports may be saved for later reuse.
 - 2.7.2 System shall contain pre-configured “canned” reports for system configuration, activity, and other historical items including, at minimum, the following:
 - 2.7.2.1 An audit trail report that shows changes made to the security database over a specified period of time.
 - 2.7.2.2 A credential report that shows all existing access credentials (valid, void, lost, temporary, stole, and returned) by their current status settings. The report also shows for each credential the name of the person to whom it was issued and the credential number.
 - 2.7.2.3 User data report which details all information on a specific card holder, including history of access privilege changes, and credential use

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- 2.7.2.4 A duty log report that shows duty log comments residing in the current security database, including archives. For each duty log comment included in the report results, information is available on when the comment was entered, who entered it, the date and time of the logged event associated with the comment, the name of the logged event, and the specific comment text.
 - 2.7.2.5 Alarm report which shows details of past alarm transactions, defined by type of alarm and/or time period.
 - 2.7.2.6 Field device or hardware report which lists all devices connected to the PACS in a structured manner.
 - 2.7.2.7 Time schedule report which shows all programmed time schedules in the PACS.
 - 2.7.2.8 Operator report which displays a list of all active usernames and passwords, log on times and durations, including associated access privileges
 - 2.7.2.9 Door report which lists of all programmed doors/portals, including programmed groups and other logical organizational units
 - 2.7.2.10 Alarms report(s) which list and details of all devices and resources currently in alarm status or remain unacknowledged.
 - 2.7.3 For each transaction listed in the report results, information is available on when the transaction occurred, who made the changes, the fields that were modified, and the original and new values.
 - 2.7.4 Search criteria can be applied to filter the report results, by the relevant fields in the report.
 - 2.7.5 Reports shall contain, at minimum, the following information:
 - 2.7.5.1 Report title and column headers
 - 2.7.5.2 Time and date of the report
 - 2.7.5.3 Time and date range of the report period, if applicable
 - 2.7.5.4 Identification of resources and devices the report covers.
 - 2.7.6 Status of resources and devices during the report period.
 - 2.7.7 The system shall have a built-in data import tool or function, which allows for direct import of several file formats to populate the different system databases (i.e. schedules, access levels, card holder data, etc.). File formats supported shall include, but not be limited to: delimited text files, comma-separated values, Microsoft Excel spreadsheets, other common database and file exchange formats. All corresponding fields in the system databases shall be capable of direct import.
 - 2.7.8 Periodic scheduled or manual backup of system databases to local storage and optional network attached storage (NAS), including FTP servers. Databases, storage location, date/time range shall be configurable.
 - 2.7.9 Periodic archive creation for historical custom reporting and improved database performance.
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2.8 SOFTWARE - LICENSING

2.8.1 Licensing of the system shall be based on the following criteria:

2.8.1.1 Number of card readers or doors, inputs, outputs

2.8.1.2 Integrated third-party features (i.e. cameras, alarm inputs, communications devices, etc.)

2.8.1.3 Additional enabled system functionality.

2.8.1.4 Provide for video monitoring at two additional video monitoring workstations.

2.8.2 The software license installed under this contract shall cover all features, functionality, component quantities, and requirements as outlined in the project specifications and drawings, and associated addenda. Licenses not provided to cover the requirements shall be provided to the Owner at no additional cost.

2.8.3 The software license shall be perpetual, and not affect system operation if yearly support agreements are not maintained.

2.8.4 The software license shall include two (2) year of warranty, software updates, and support from the date of installation.

2.8.5 Additional warranty, software updates, and support in 1-year increments shall be available for purchase to maintain the system past the initial warranty period.

2.9 ANTIVIRUS SOFTWARE

2.9.1 Provide antivirus software for each PACS computer. Antivirus software shall be provided with free virus definition updates for the duration of the warranty period. Include step-by-step directions for updating the antivirus software during the warranty period. Antivirus software shall automatically scan the computer bios and all files opened, created, copied, or received for viruses.

2.9.2 Directions for obtaining and updating virus definition files shall be provided to the Owner within the record documentation.

2.10 CREDENTIALS

2.10.1 Access credentials shall be contactless proximity type only. Mag stripe, insertion, or any credentials requiring physical contact with the reader device shall not be permitted.

2.10.2 Access credentials shall consist of, at a minimum, a facility code and unique credential number, which can be programmed into the PACS database.

2.10.3 Access credentials shall be printable with, at minimum, a logo, photo, and name of the assigned card holder. A printable adhesive label applied to a credential is permissible.

2.10.4 Credential encoding format must be HID iCLASS, iCLASS SE, Corporate 1000, or a commercially available format which is not vendor dependent. Proprietary credential formats without encoding information shall not be permitted.

2.10.5 For printable cards, credential dimension shall be 5.4cm x 8.57cm x 0.084cm, be printable on minimum one side, and contain a sequential internal/external matching card number silkscreened or etched directly on the back of the credential.

2.10.6 For key fobs or smart keys, credential dimension shall be 3.95cm x 3.18cm x 0.60cm, be manufactured from ABS or similar durable material, and contain a sequential internal/external matching card number silkscreened or etched directly on the credential. Credentials shall be provided with appropriate badge clip hardware for attachment.

2.11 PACS HARDWARE

2.11.1 The PACS hardware shall be designed in a modular fashion, such that addition and expansion of an ICP shall not require substantial modification of other components, or cause downtime or operation of other ICP's.

2.11.2 The main hardware component is the Intelligent Control Panel (ICP). The ICP shall make and manage access control decisions with data provided by the PACS Server/Controller, and it shall continuously monitor and manage the communication between the PACS Server/Controller and Remote Field Panels (RFP's) connected to the system's inputs, outputs, and card readers.

2.11.3 The ICP shall be capable of managing access control and store system activity logs during loss of network connectivity. When network connectivity is re-established, the system activity logs are automatically re-synchronized with the PACS Server/Controller.

2.11.4 Failure of any ICP within the PACS system shall not affect the operation of the balance of the BSS systems. Failure of any ICP within the PACS system shall be annunciated at an OIW.

2.11.5 The secondary hardware component is the Remote Field Panel (RFP). The RFP shall support a combination of card readers, electronic locks, entry/exit devices, supervised inputs, relay outputs, and be connected directly to the ICP.

2.11.6 Each ICP shall support at a minimum the following connected devices, either directly or through a connected RFP:

2.11.6.1 16 card readers (including elevator cab, proximity card, proximity card + keypad, keypad, biometric, smart card, wireless, and mag-stripe readers)

2.11.6.2 7,000 credentials

2.11.6.3 10 card formats, up to 256 bits per card format

2.11.6.4 64 4-state (normal, alarm, short, open) supervised inputs, including elevator functions

2.11.6.5 64 relay outputs, including elevator functions

2.11.6.6 1 Ethernet connection

2.11.6.7 all access levels applicable to the ICP

2.11.6.8 all time schedules applicable to the ICP

2.11.6.9 all holiday schedules applicable to the ICP

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- 2.11.6.10 all alarm priority levels applicable to the ICP
 - 2.11.6.11 20,000 log events
 - 2.11.7 All ICP's and RFPs shall be installed in purpose built enclosures.
 - 2.11.8 All enclosures containing ICP's and RFPs shall be equipped with tamper switches connected to the PACS, to annunciate at the OIW's when the enclosures are tampered with or opened without authorization.
 - 2.11.9 All ICP's and RFPs shall be powered from dedicated power supplies, which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon main power failure.
 - 2.11.10 Dedicated power supplies shall be Bosch, Altronix, Pelco or approved equal.
 - 2.11.11 All electronic locks, card readers, annunciation and auxiliary devices which are connected to the PACS shall be either powered directly from the ICP or RFP, or from dedicated power supplies which shall have sufficient battery backup to maintain all intended system operations for a period of eight (8) hours upon main power failure.
 - 2.11.12 CABLING
 - 2.11.12.1 Where specified, provide all signal, video, data and control cables for the BSS. The wire and cable shall meet, at minimum, the following requirements:
 - 2.11.12.1.1 98% conductivity copper.
 - 2.11.12.1.2 Stranded conductors.
 - 2.11.12.1.3 Proper impedance for the application as recommended by the BSS component manufacturer.
 - 2.11.12.1.4 Shielded, where specified, with the shield grounded at the control panel end only to avoid ground loops.
 - 2.11.12.1.5 Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.
 - 2.11.12.1.6 Unique colour schemes for easy identification and prevention of inadvertent splicing. Coordinate unique colour schemes with all other trades.
 - 2.11.12.1.7 Provide surge suppression appropriate for all devices installed in exterior locations.
 - 2.11.12.1.8 Terminations shall be mechanically and electrically secure. Twist type wire nuts shall not be acceptable. Only sealed crimped connectors shall be permitted (Dolphin DC-100-S B Connector or equivalent). Terminations or connections not made within junction boxes shall be soldered and shrink cover insulated.
 - 2.11.12.1.9 Cable within panel or enclosures shall be installed in cabling guides.
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2.11.12.1.10 Provide the following cables for each end devices in the following size and conductor quantities, unless otherwise noted on the drawings:

Application	Cable Type
LAN connection for PACS panel/devices	Category 6A or fibre optic cable
Panel communications	1 pair-22 AWG twisted shielded Belden 9451P or equivalent
Card Reader Doors (including card reader, request to exit, door position, and lock)	Bundled Access Control Cable (Honeywell Profusion, Belden 538AFS non-plenum rated/638AFS plenum rated series, or equivalent)
Card Reader	3 pairs-22AWG shielded twisted Belden 6542FE or equivalent
Input device (unpowered)/spare	2 pairs-22AWG twisted Belden 6541FE or equivalent
Input device (powered) /spare	2 pairs-22AWG twisted Belden 6541FE or equivalent 18AWG-2 conductor bare copper Belden 6300FE or equivalent
Output device (unpowered)	2 pairs-22AWG twisted Belden 6541FE or equivalent
Output device (powered)	18AWG 2-conductor bare copper (up to 90m, 300feet). Belden 6300FE or equivalent. or 16AWG 2-conductor bare copper (up to 250m, 820feet). Belden 6200FE or equivalent. or Higher size, as necessary to accommodate voltage drop
Media conversion for distances up to 1000 feet	Fibre optic cable or unshielded twisted pair (UTP)

2.11.13 CARD READERS - CONTACTLESS

2.11.13.1 Provide PACS contactless card readers at locations indicated on the security drawings. Card readers shall meet, at minimum, the following requirements:

2.11.13.1.1 Multi-colour LED displaying green upon a valid read, red upon invalid read or normal at rest mode.

2.11.13.1.2 Appropriate colour matching location finish.

2.11.13.1.3 Environmentally protected on exterior applications.

2.11.13.1.4 Contactless smart card interactive type.

2.11.13.1.5 125 KHz and 13.56 MHz transmit frequency.

2.11.13.1.6 Exchange credential and authentication information with the PACS controller using OSDPv2.

2.11.13.1.7 Terminal strip panel connection.

2.11.13.1.8 Minimum read range of 5.0cm (2") for building applications.

2.11.13.1.9 Minimum read range of 38cm (15") for vehicle entry applications.

2.11.13.1.10 Supplier's visible identification logo or trademark is not permitted.

2.11.13.2 Installation of card readers shall meet, at minimum, the following requirements:

2.11.13.2.1 Utilize tamper resistant hardware.

2.11.13.2.2 Complete with any faceplates or trim that may be required. Provide standoff non-metallic (e.g. ½ inch Lexan with rounded edges) plates to prevent interference when mounted on metal walls, pedestals or building components.

2.11.13.2.3 Damage by static electricity or mechanical shock is avoided. Provide grounding as required.

2.11.13.3 Provide contactless smart card technology card readers at locations indicated on the Security Drawings. Types are as follows:

2.11.13.3.1 Interior or exterior single gang card reader - HID multiCLASS SE RP40 series or equivalent.

2.11.13.3.2 Interior or exterior mullion or slim type contactless card reader - HID multiclass SE RP10/RP15 series or equivalent.

2.11.14 ELECTRIC LOCKS

2.11.14.1 Electric door locking hardware (magnetic locks, electric mortise locks, electric strikes, etc.) shall be provided under a separate contract.

2.11.14.2 Coordinate lock and door hardware with the general contractor and all door hardware subcontractors and review each security device location as shown on the Security Drawings to ensure the proper door hardware is provided at required locations.

2.11.14.3 Provide and terminate relay output cabling from the PACS ICP/RFP to the electric door locking hardware.

2.11.15 REQUEST TO EXIT DEVICE

2.11.15.1 Supply and install request to exit device and signal cabling from the PACS ICP/RFP.

2.11.15.2 Request to exit motion detectors shall be programmed not to release the electric strike/lock upon motion detection. The request to exit shall act as a door position alarm shunt upon motion detection only.

2.11.16 DOOR POSITION SENSORS

2.11.16.1 Door position sensors for security doors shall be provided and terminated.

2.11.16.2 Provide and terminate door status sensors from the PACS ICP/RFP to the mounting location at the door.

2.11.16.3 Door position sensor shall be recessed mounted, either 3/4" or 1" in diameter.

2.11.16.4 Shall be General Electric Interlogix 1076/1078 series or approved equal.

2.11.16.5 For revolving doors, provide all conduit, cabling, and input connections from monitoring terminals of the revolving door controller to the PACS.

2.11.16.6 For overhead (roll up) doors, provide all conduit, cabling, and input connections from the overhead door contact to the PACS. Overhead door contact shall meet, at minimum, the following requirements:

2.11.16.6.1 Surface mounted SPDT magnetic contact switch.

2.11.16.6.2 Cable lead shall be encased in stainless steel armored cable.

2.11.16.6.3 Gap reading distance of 75mm (3")

2.11.16.6.4 Position switch shall be General Electric Series 2202 or approved equal.

2.11.17 DOOR ALARM

2.11.17.1 Door alarm shall be Honeywell/Ademco Wave 2 or approved equal.

2.12 BSS NETWORK

2.12.1 All networking equipment, products, racks, patch panels and network cabling will be supplied and installed by the Communications Cabling and Networking contractors.

2.12.2 BSS Contractor shall be responsible for coordinating requirements with the Communications Cabling and Networking Contractors for BSS components requiring connectivity.

2.12.3 BSS Contractor shall compile and provide a list of all network devices to the Owner and Consultant during the physical installation period, to facilitate coordination of network programming and configuration. The list shall include at minimum the following information where applicable:

2.12.3.1 Device type (i.e. VMS camera, SIS intercom, PACS panel, workstation, server, etc.)

2.12.3.2 Device IP address

2.12.3.3 Protocol(s) required (i.e. TCP/IP, UDP)

2.12.3.4 Transmission methods (i.e. unicast, multicast)

2.12.3.5 Port(s) required

2.12.3.6 Admin username/password

2.13 Access Control SYSTEM WORKSTATION

2.13.1 Intel i5 or better processor

2.13.2 Operating system: Compliant with requirements of supplied VMS

2.13.3 Video card: minimum of 4GB of memory, with dual DVI or HDMI outputs for monitor connections.

2.13.4 Memory: minimum of 16GB

2.13.5 2 x 1TB Hard Drives in RAID 1 configuration

2.13.6 CD ROM/DVD ROM

2.13.7 Internal Speaker

2.13.8 1GB NIC network card

2.13.9 USB connected quiet touch keyboard and mouse

2.13.10 Two (2) 24-inch high resolution (1080P or higher) monitors with monitor stand

2.14 COMPUTER INTERFACE STATION (CIS)

2.14.1 Provide a Computer Interface Station (CIS) at the BSS server equipment location. CIS shall meet, at minimum, the following requirements:

2.14.1.1 Self-contained pull-out unit with built in LCD, keyboard, touchpad, and 8 port KVM switch.

2.14.1.2 Rack mounted utilizing one U of rack space when folded and pushed into rack.

2.14.1.3 When pulled out, LCD monitor opens up providing access to keyboard, touchpad, and KVM.

2.14.2 Provide sufficient KVM cables to connect and control all BSS equipment within the rack.

2.15 EQUIPMENT CORDS AND PATCH CORDS:

- 2.15.1 Communications Patch cords, station cords.
- 2.15.2 Data cable assemblies for the horizontal cross-connect and the workstations shall match the facility's structured cabling standard (e.g. CAT5E, CAT6).
- 2.15.3 Cable assemblies shall be factory-assembled by the manufacturer of the cabling system.
- 2.15.4 Each security cabinet shall require sufficient cable assemblies to connect between the horizontal data patch panels and security equipment.
- 2.15.5 Each work station shall require 6 foot cable assemblies.

PART 3 - EXECUTION

3.1 SYSTEM PROGRAMMING

- 3.1.1 Implement all software and provide all applicable licenses in order to provide a fully operational system. Where information is required from the Owner in order to implement the software, request such information in writing at least one (1) month prior to the need of such information.
- 3.1.2 Programming of the database, the Contractor shall provide a proposed device naming standard to the Consultant and Owner for approval. The naming standard shall be based on the naming standard used in the Security drawings and expanded to accommodate all the components of the PACS.
- 3.1.3 The initial cardholder database information and all other required database information shall be entered into the system by the Contractor. The Contractor shall provide all work required for the development of PACS database(s) including individual cardholder file data entry and door control access level definition, as required for a fully functional and turnkey PACS installation.
- 3.1.4 The Contractor shall provide the initial administration level training, as identified in the training section of these specifications, to familiarize the Owner's staff with the database structure, cardholder file information, access levels, time zones, capabilities etc. The Contractor shall develop the required time zones, access groups, access levels, the cardholder information, database definition, etc. The Contractor shall develop blank forms for all required database and cardholder information and submit them to the Owner. The Contractor shall then enter the information.

3.2 PACS HARDWARE

- 3.2.1 The PACS hardware shall be designed in a modular fashion, such that addition and expansion of an ICP shall not require substantial modification of other components, or cause downtime or operation of other ICP's.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- 1.1.1 The requirements of the Project Manual are related to and shall be read in conjunction with this section.

1.2 APPLICATION

- 1.2.1 This section of the specifications details the work and components to be provided by the BSS Contractor relating to the Video Management System (VMS).

1.3 REQUIREMENTS

- 1.3.1 Supply and install a fully functional IP based VMS, including servers, workstations, peripherals, software, and network recording equipment.
- 1.3.2 The VMS shall operate on the converged facility network, and shall be controlled and switched through network-connected microprocessor-based digital NVR units capable of providing the required monitoring, switching, control and recording of the specified equipment and future expansion requirements.
- 1.3.3 Provide all equipment, racks, faceplates, interconnections, patch panels, termination boots, fiber optic patch panels, controls and other services as required for a complete, fully-functional and operational VMS system as contained in the security drawings and performance specifications.
- 1.3.4 Provide equipment located in the BSS racks, complete with faceplates, power supplies and mounting hardware. Coordinate the mounting of equipment with other Subcontractors as necessary for a complete installation.
- 1.3.5 Provide setup and configuration of the VMS to suit the requirements in these specifications, including alarms and actions, NVR configuration and connections, site mapping design, user setup, server, workstation and peripherals, camera number and descriptions, camera presets, camera tours, etc.
- 1.3.6 The VMS rack mount components shall be standard 19-inch rack mounted.
- 1.3.7 Provide video loss detection on all cameras.
- 1.3.8 Internet Protocol (IP) technology based Surveillance cameras are connected to the converged LAN for video signal transmission.
- 1.3.9 Provide VMS Workstation computers in locations shown on drawings complete with VMS operator interface application software, keyboards/mouse, network interface cards and graphic cards to support video display panels.
- 1.3.10 The BSS Contractor shall ensure proper equipment selection for each application. Consideration shall be given to such criteria as area of coverage, light conditions, etc., consistent with the generally accepted practices for VMS surveillance and to the approval of the Architect, Owner and Consultant.
- 1.3.11 The BSS contractor shall provide cable, transformers, and connection of power supplies to 120 VAC sources and power all VMS equipment.
- 1.3.12 Provide VMS equipment which is compliant with IEEE Standard 802.3af (PoE)
- 1.3.13 Refer to the electrical design drawings for details of electrical power supply circuit facilities to be provided by the Electrical Contractor for the BSS Contractor. Coordinate electrical requirements (where required) with the Electrical Contractor.

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- 1.3.14 Provide VMS Network Video Recorder (NVR) units for video signal switching, communications, monitoring, control and recording mounted in the locations shown on drawings. Coordinate mounting details with other trades. NVR Devices shall be compliant with the requirements specified within these specifications. Provide the number of NVR devices required to meet the capacity requirements of the project VMS cameras and as required to achieve the recording and storage performance requirements specified within these documents.
 - 1.3.15 The BSS Contractor shall provide the Owner and Consultant with space requirements for all VMS related equipment to be mounted within the detailed locations. The BSS Contractor shall also refer to the security drawings, electrical drawings and architectural drawings for equipment layouts. Coordinate equipment mounting in the locations with other trades.
 - 1.3.16 Supply and install a fully functional IP technology based internet protocol indoor, outdoor, etc. surveillance cameras and power supply equipment.
 - 1.3.17 Surveillance cameras shall be connected to the converged LAN for video signal transmission.
 - 1.3.18 Provide all equipment, bezels, mounting brackets, interconnections, power supplies, termination boots, controls and other services as required to integrate cameras into Video Management System (VMS) as contained in the security drawings and performance specifications.
 - 1.3.19 Surveillance cameras shall be provided complete with protective housings, mounts, fasteners, arms, cableways, heaters/fans, and all required hardware for proper installation and performance.
 - 1.3.20 All interior ceiling dome cameras, where possible, shall be recess mounted in finished areas. Where indicated by the Architect, provide wall mount brackets with concealed wiring. Surface mounted dome cameras are acceptable in unfinished areas provided they are mounted on a finished back-box, suitable for the installation. Obtain written approval from Owner and Architect prior to finalizing design of the camera mounts in all finished spaces.
 - 1.3.21 For high finish interiors, coordinate with Architect and Consultant to provide cameras with trim rings, bezels, mounts, etc. to match the surrounding finish. Submit all proposed finishes and configurations to the Architect and Consultant for approval.
 - 1.3.22 Surveillance cameras that are required to be mounted on non-structural walls or ceilings shall be provided complete with suitable mounting plates or supporting materials on the reverse side of the wall or ceiling to ensure the devices are securely fastened.
 - 1.3.23 Surveillance cameras shall be mounted at heights necessary to maximize the camera field of view. Housings and mounts shall be properly supported from building structure as appropriate. If required, custom mounts and housings shall be provided to allow for maximum use of the cameras. Provide any required miscellaneous materials for bracing and mounting. Conduit shall extend to the housing such that cables are not exposed.
 - 1.3.24 Provide video loss detection on all cameras.
 - 1.3.25 Internet Protocol (IP) technology based cameras connected to the converged LAN for video signal transmission.
 - 1.3.26 For IP based elevator cameras, power supplies, Power over Ethernet (POE) injectors, and media converters as indicated on the drawings and within these specifications, and in order to comply with code and prevent damage to transmission cables, coordinate with elevator contractor.
 - 1.3.27 The BSS Contractor shall ensure proper equipment selection for each application. Consideration shall be given to such criteria as area of coverage, light conditions, etc., consistent with the generally accepted practices for VMS surveillance and to the approval of the Architect, Owner and Consultant.
 - 1.3.28 The BSS Contractor shall coordinate 120 VAC power source for auxiliary VMS devices such as

power injectors, encoders, module boxes, and media converters as required.

- 1.3.29 The BSS contractor shall provide cable, transformers, POE network switches, POE power supply equipment (PSE), mid-span power injection devices, media converters, module boxes, dedicated 24 VAC transformer power supply units, connection of power supplies to 120 VAC sources and power all Surveillance cameras and devices.
- 1.3.30 Interior mounted fixed cameras shall be powered by POE. Provide VMS equipment which is compliant with IEEE Standard 802.3af.
- 1.3.31 Refer to the electrical design drawings for details of electrical power supply circuit facilities to be provided by the Electrical Contractor for the BSS Contractor. Coordinate electrical requirements (where required) with the Electrical Contractor.
- 1.3.32 The BSS Contractor shall provide the Owner and Consultant with space requirements for all surveillance cameras related equipment (such as power supplies, injectors, media converters, and auxiliary devices) to be mounted within the detailed locations. The BSS Contractor shall also refer to the security drawings, electrical drawings and architectural drawings for equipment layouts. Coordinate equipment mounting in the locations with other trades

PART 2 - PRODUCTS

2.1 APPROVED SYSTEMS MANUFACTURERS

- 2.1.1 Subject to compliance with these specifications, VMS equipment, software and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
 - 2.1.1.1 Genetec Omnicast (or Genetec Security Center when combined with Genetec PACS).
 - 2.1.1.2 Avigilon Control Center
 - 2.1.1.3 Approved equal or alternate
- 2.1.2 Subject to compliance with these specifications, surveillance cameras, mounts, and related components as manufactured by the following system manufacturing companies shall be considered for the work of this project:
 - 2.1.2.1 Axis Communications
 - 2.1.2.2 Bosch Security
 - 2.1.2.3 Samsung/Hanwha
 - 2.1.2.4 Approved equal or alternate

2.2 SURVEILLANCE CAMERAS

- 2.2.1 Provide cameras at the locations as indicated on the Security Drawings.
- 2.2.2 Provide solid state imaging with Charge Coupled Device (CCD) or CMOS, 1/3 " format, color cameras meeting the following minimum requirements:
 - 2.2.2.1 Provide a minimum of 2 (two) separate video streams, capable of 30fps for both a recording and live viewing stream.
 - 2.2.2.2 50 db signal to noise ratio.
 - 2.2.2.3 60 dB minimum dynamic range.

- 2.2.2.4 True Color Rendition circuitry or color temperature settings.
 - 2.2.2.5 Back-light (BLC) compensation circuitry.
 - 2.2.2.6 10/100 Base T Ethernet, auto-sensing, half/full duplex video signal data communications with integrated RJ-45 connection.
 - 2.2.2.7 Selectable video resolution at minimum: 720P, 1080P or higher.
 - 2.2.2.8 VMS cameras shall be a minimum of 720P or 1.3MP resolution for parking general surveillance, corridors, and lobbies.
 - 2.2.2.9 VMS cameras for the parking garage, building exterior, overhead doors (inside and outside) and the ground floor primary / public corridor cameras shall be 1080P or 2.1MP resolutions or higher.
 - 2.2.2.10 Output video utilizing H.264 video compression (MPEG-4 Part 10) and M-JPEG motion video compression.
 - 2.2.2.11 Video motion detection.
 - 2.2.2.12 Video signal loss detection.
 - 2.2.2.13 POE IEEE 802.3af compliant devices wherever possible or 12 VDC or 24 VAC if required to meet camera power requirements. Where required provide all power supplies cabling, transformers, enclosures to power cameras from the 120 VAC circuit locations.
 - 2.2.2.14 Discreet with easy flexible installation on wall or ceiling, recessed, flush, or pendant mounting to avoid obstructions.
 - 2.2.2.15 Three years warranty minimum.
- 2.2.3 Surveillance camera types shall, at minimum, meet the following requirements:
- 2.2.3.1 Indoor fixed dome camera (Axis M3045-V or equivalent):
 - 2.2.3.1.1 For indoor public/ front of house applications.
 - 2.2.3.1.2 Be capable of being powered via POE and connected via an RJ-45 connector.
 - 2.2.3.1.3 Image sensor progressive RGB CMOS sensor.
 - 2.2.3.1.4 Fixed IRIS lens 2.8mm.
 - 2.2.3.1.5 Light sensitivity performance at minimum 0.5 lx (color) and light transfer capability F2 maximum.
 - 2.2.3.1.6 HDTV performance 1080P, 2MP resolution.
 - 2.2.3.1.7 Designed for quick and flexible installations. Wall, ceiling, or pendant mounts.
 - 2.2.3.1.8 Vandal resistant, IP42 water and dust resistant. IK08 impact resistant.
 - 2.2.3.1.9 Operating temperature: 0°C to 45°C.
 - 2.2.3.1.10 Multiple video streaming and controllable frame rate and band width.
 - 2.2.3.1.11 Image rotation 0°, 90°, 180°, 270° including Corridor format for vertically oriented video streams for areas such as corridors, hallways, etc....
 - 2.2.3.1.12 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, wide dynamic range, text and

- image overlay, mirroring of images, and privacy mask.
- 2.2.3.1.13 Enable installation of intelligent video application such as people counting, and enable installation for third party applications.
- 2.2.3.1.14 IP address filtering, https encryption with password protection.
- 2.2.3.1.15 Video motion detection and active tampering alarm.
- 2.2.3.1.16 Minimum 512 MB RAM and 256 MB flash memory.
- 2.2.3.2 Indoor fixed dome camera (Axis P3227-LV or equivalent):
 - 2.2.3.2.1 For indoor back of house, building perimeter and parking areas applications.
 - 2.2.3.2.2 Be capable of being powered via POE and connected via an RJ-45 connector
 - 2.2.3.2.3 Image sensor progressive RGB CMOS.
 - 2.2.3.2.4 Varifocal P-IRIS control and IR corrected lens 3.5-10mm.
 - 2.2.3.2.5 Light sensitivity performance at minimum 0.18 lx (color) 0.04lx (black and white with IR on), and light transfer capability F1.7 maximum.
 - 2.2.3.2.6 With HDTV performance, 5MP resolution.
 - 2.2.3.2.7 Wide dynamic range and light finder technology.
 - 2.2.3.2.8 Vandal and IK08 impact resistant.
 - 2.2.3.2.9 Operating temperature: 0°C to 50°C.
 - 2.2.3.2.10 Multiple video streaming and controllable frame rate and band width.
 - 2.2.3.2.11 Image rotation 0°, 90°, 180°, 270°including Corridor format for vertically oriented video streams for areas such as corridors, hallways, etc....
 - 2.2.3.2.12 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, fine tuning of behavior at low light, forensic wide dynamic range, text and image overlay, mirroring of images, and privacy mask.
 - 2.2.3.2.13 IP address filtering, https encryption with password protection.
 - 2.2.3.2.14 Video motion detection and active tampering alarm.
 - 2.2.3.2.15 Enable installation of third party application.
 - 2.2.3.2.16 Minimum 1 GB RAM and 512 MB flash memory.
- 2.2.3.3 Indoor/outdoor fixed dome camera (Axis M3025-VE or equivalent):
 - 2.2.3.3.1 For indoor damp areas/outdoor applications.
 - 2.2.3.3.2 Shall be powered by the BSS LAN POE or POE+ and connected via an RJ-45 connector.
 - 2.2.3.3.3 Image sensor progressive RGB CMOS.
 - 2.2.3.3.4 Fixed IRIS, IR corrected lens 3.6mm.
 - 2.2.3.3.5 Sensitivity performance at minimum 0.8 lx (color) 0.16 lx (black and white) and light transfer capability F2.0 maximum.

- 2.2.3.3.6 Fixed dome with HDTV performance 1080P, 2MP resolution.
- 2.2.3.3.7 Vandal and IK10 impact resistant. Weather-proof has IP66 and Nema 4X rating.
- 2.2.3.3.8 Operate within the temperature range of -30°C to +50°C in a temperature controlled enclosure.
- 2.2.3.3.9 Minimum 256 MB RAM, 128 MB flash memory.
- 2.2.3.3.10 Multiple video streaming and controllable frame rate and band width.
- 2.2.3.3.11 Image rotation 0°, 90°, 180°, 270° including Corridor format.
- 2.2.3.3.12 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, wide dynamic range dynamic contrast, back light compensation, text and image overlay, mirroring of images, and privacy mask.
- 2.2.3.3.13 IP address filtering, https encryption with password protection.
- 2.2.3.3.14 Video motion detection and active tampering alarm enable installation of third party application.
- 2.2.3.4 Outdoor fixed dome camera (Axis M3026-VE or equivalent):
 - 2.2.3.4.1 For outdoor public, front of house and building perimeter applications.
 - 2.2.3.4.2 Shall be powered by the BSS LAN POE or POE+ and connected via an RJ-45 connector. Power Supply Equipment (PSE) are required, subject to the camera meeting the maximum POE power requirements and the minimum ambient operating temperature requirements
 - 2.2.3.4.3 Outdoor ready design, day/night mode providing automatic switching to low light level viewing capability, with maintaining high image quality even in low-light conditions.
 - 2.2.3.4.4 Image sensor progressive RGB CMOS.
 - 2.2.3.4.5 Fixed IRIS, IR corrected lens 2.0mm.
 - 2.2.3.4.6 Sensitivity performance at minimum 0.3 lx (color) 0.06 lx (black and white) and light transfer capability F2.0 maximum.
 - 2.2.3.4.7 Fixed dome with HDTV performance 1080P, 3MP resolution.
 - 2.2.3.4.8 Vandal and IK10 impact resistant. Weather-proof has IP66 and Nema 4X rating.
 - 2.2.3.4.9 Operate within the temperature range of -30°C to +50°C in a temperature controlled enclosure. Provide ventilation and/or heating elements either integral or within camera housing to achieve operational temperature.
 - 2.2.3.4.10 Minimum 512MB RAM, 128 MB flash memory.
 - 2.2.3.4.11 Multiple video streaming and controllable frame rate and band width.
 - 2.2.3.4.12 Image rotation 0°, 90°, 180°, 270° including Corridor format.
 - 2.2.3.4.13 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, wide dynamic range dynamic contrast, back light compensation, text and image overlay, mirroring of

- images, and privacy mask, exposure zones, fine tuning of low light behavior.
- 2.2.3.4.14 Enable installation of intelligent video application such as people counting.
- 2.2.3.4.15 IP address filtering, https encryption with password protection.
- 2.2.3.4.16 Video motion detection and active tampering alarm enable installation of digital auto tracking, cross line detection, and third party application.
- 2.2.3.5 Outdoor fixed dome camera (Axis P3227-LVE or equivalent):
 - 2.2.3.5.1 For outdoor back of house, building perimeter, parking garage, loading dock areas and overhead doors applications.
 - 2.2.3.5.2 Shall be powered by the BSS LAN POE or POE+ and connected via an RJ-45 connector. Power Supply Equipment (PSE) is required, subject to the camera meeting the maximum POE power requirements and the minimum ambient operating temperature requirements.
 - 2.2.3.5.3 Outdoor ready design, day/night functionality and wide dynamic range.
 - 2.2.3.5.4 Image sensor progressive RGB CMOS.
 - 2.2.3.5.5 Varifocal, remote focus and zoom, P-IRIS control, IR corrected lens 3.5-10mm.
 - 2.2.3.5.6 Sensitivity performance at minimum 0.18 lx (color) 0.04 lx (black and white) and light transfer capability F1.7 maximum.
 - 2.2.3.5.7 Fixed dome with HDTV performance 1080P, 5MP resolution.
 - 2.2.3.5.8 Multiple video streaming and controllable frame rate and band width.
 - 2.2.3.5.9 Enable for image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, forensic WDR, text and image overlay, mirroring of images, privacy mask, and fine tuning of low light behavior.
 - 2.2.3.5.10 Image rotation 0°, 90°, 180°, 270° including Corridor format.
 - 2.2.3.5.11 IP address filtering, https encryption with password protection.
 - 2.2.3.5.12 Video motion detection and active tampering alarm. Enable installation of digital auto tracking, and third party application.
 - 2.2.3.5.13 Vandal and IK10 impact resistant. Weather-proof has IP66 and Nema 4X rating.
 - 2.2.3.5.14 Operate within the temperature range of -40°C to +55°C in a temperature controlled enclosure. Provide ventilation and/or heating elements either integral or within camera housing to achieve operational temperature.
 - 2.2.3.5.15 Minimum 1 GB Ram and 512 MB flash memory.
- 2.2.3.6 Panoramic view indoor/outdoor cameras 180° multi Sensor (Axis P3807-PVE or equivalent):
 - 2.2.3.6.1 For indoor/outdoor wide areas applications and as identified on BSS drawings.

- 2.2.3.6.2 Shall be powered by the BSS LAN POE+ via RJ45 connector.
- 2.2.3.6.3 Fixed dome, provide high quality 180° panoramic view of large areas. With WDR – forensic capture and excellent light sensitivity.
- 2.2.3.6.4 Four Image sensors progressive CMOS. One IP address.
- 2.2.3.6.5 Four lenses, fixed focus 3.2mm.
- 2.2.3.6.6 Sensitivity performance at minimum 0.17 lx (color), 0.05 lx black and white, and light transfer capability F2.8 maximum.
- 2.2.3.6.7 8.3 MP (client dewarp): up to 25/30 fps (50/60 Hz) without WDR, up to 12.5/15 fps (50/60 Hz) with WDR 7.5 MP (dewarped): up to 12.5/15 fps (50/60 Hz).
- 2.2.3.6.8 Controllable frame rate and bandwidth.
- 2.2.3.6.9 Saturation, contrast, brightness, sharpness, Forensic WDR: up to 120 dB depending on scene, white balance, day/night threshold, exposure mode, compression, dynamic text and image overlay, exposure control, noise reduction, fine tuning of behavior at low light, polygon privacy masks.
- 2.2.3.6.10 Password protection and IP address filtering
- 2.2.3.6.11 Video motion detection and active tampering alarm enable installation of third party applications.
- 2.2.3.6.12 Network share and E-mail notification.
- 2.2.3.6.13 Vandal, IK10 impact resistant with IP66 and NEMA 4X rating.
- 2.2.3.6.14 Minimum 1024MB RAM and 512 MB flash memory.
- 2.2.3.6.15 Operate within the temperature range of (-30°C to +50°C).
- 2.2.3.7 Panoramic view indoor/outdoor cameras 180°/360° multi Sensor (Axis P3717-PVE or equivalent) :
 - 2.2.3.7.1 For outdoor large area building perimeter applications.
 - 2.2.3.7.2 Shall be powered by the BSS LAN POE/POE+ via RJ45 connector.
 - 2.2.3.7.3 Fixed dome, four varifocal lenses, with flexible positioning of four camera heads.
 - 2.2.3.7.4 4x1/2.8" Image sensors progressive RGB CMOS. One IP address for all channels.
 - 2.2.3.7.5 Varifocal lenses, 2.8-6mm.
 - 2.2.3.7.6 Sensitivity performance at minimum 0.3 lx (color) and light transfer capability F2.0 maximum.
 - 2.2.3.7.7 8 MP resolution.
 - 2.2.3.7.8 Camera rotation +-90°.
 - 2.2.3.7.9 Controllable frame rate and bandwidth.
 - 2.2.3.7.10 Image setting: color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, Fine tuning in low light behavior, text and

- image overlay, local contrast, and privacy mask.
- 2.2.3.7.11 Password protection and IP address filtering, and HTTPS encryption.
- 2.2.3.7.12 Video motion detection and active tampering alarm enable installation of third party applications.
- 2.2.3.7.13 Network share and E-mail notification.
- 2.2.3.7.14 Vandal, IK09 impact resistant with IP66/IP67 and NEMA 4X rating.
- 2.2.3.7.15 Minimum 1 GB RAM and 256 MB flash memory.
- 2.2.3.7.16 Operate within the temperature range of (-30°C to +60°C)
- 2.2.3.8 Elevator cameras (Axis M3046-V or equivalent):
 - 2.2.3.8.1 Fixed mini dome with wide field of view.
 - 2.2.3.8.2 Shall be powered by the BSS LAN POE via RJ45 connector.
 - 2.2.3.8.3 Image sensor progressive scan RGB CMOS.
 - 2.2.3.8.4 M12 mount, fixed IRIS fixed focus lens.
 - 2.2.3.8.5 Sensitivity performance at minimum 0.35 lux at 50 IRE. Light transfer capability F2.4 maximum.
 - 2.2.3.8.6 4Mp resolution.
 - 2.2.3.8.7 Controllable frame rate and bandwidth.
 - 2.2.3.8.8 Image setting: compression, color, brightness, sharpness, contrast, white balance, exposure control, wide dynamic range-dynamic contrast, text and image overlay, mirroring of images, privacy masks.
 - 2.2.3.8.9 Password protection and IP address filtering.
 - 2.2.3.8.10 Video motion detection, active tampering alarm support. Enable installation of third party application
 - 2.2.3.8.11 Vandal resistant, IK08 impact resistant.
 - 2.2.3.8.12 Minimum 512MB RAM and 256 MB flash.
 - 2.2.3.8.13 Operate within the temperature range of (0°C to +40°C).

2.3 SURVEILLANCE CAMERA MOUNTS

- 2.3.1 All exterior camera mounts, metal tubes, brackets and accessories shall be of sufficient strength and diameter to defeat any detectable camera shake in up to 65 km/h (40 MPH) winds. All components and mounting bolts shall not rust or deteriorate and shall be designed for the surface to which the camera is mounted. All mounts shall allow for complete pan and tilt positioning achieving the required field of view with positive locking position bolts. Cameras mounted over heights greater than 6 meters (20 feet) shall be completely swiveled to a safe location for servicing.
 - 2.3.1.1 Additional requirements by mount and camera type:
 - 2.3.1.2 Hard-ceiling mounted fixed units shall not be J hook mounted.
 - 2.3.1.3 Where electronics do not fit in camera housing coordinate imbedding an IP65 locking electronics box in base of pole or in nearest electrical ground vault. Surface boxes

attached to pole are not acceptable.

- 2.3.1.4 For ceiling or wall mounted cameras, when necessary provide all required accessories (wall bracket, extension pipes) in order to install cameras below any obstructions and/or allow complete pan and tilt positions.

2.4 SURVEILLANCE CAMERA HOUSINGS

- 2.4.1 Provide surveillance cameras complete with protective housings. Protective housings shall meet the following minimum requirements:

- 2.4.1.1 Complete with all mounting hardware and brackets. Refer to security drawings for mount.
- 2.4.1.2 Accessible, removable and lockable access doors to allow for maintenance.
- 2.4.1.3 Allow for the adjustment of the controls without removing the camera.
- 2.4.1.4 Power and signal cable harnesses and connectors to allow for the removal or replacement of a camera.
- 2.4.1.5 Tamper resistant.
- 2.4.1.6 Dome with captive shroud to conceal camera position.

- 2.4.2 Provide exterior mounted surveillance cameras with housings which are non-corroding and weather proof along with integral fans, powered heating elements and controls to maintain the functional operation of the cameras and controls in the ambient temperatures specified in these contract documents.

2.5 SURVEILLANCE CAMERA POWER SUPPLIES

- 2.5.1 POE primarily: All surveillance cameras shall be powered over Ethernet.

- 2.5.2 Cameras mounted on the building exterior, landscape exterior, and PTZ:

PART 3 - Exterior camera and associated pan/tilt/zoom drives shall be powered by POE+, dedicated Power Supply Equipment (PSE) when:

- 2.1.1.1.1 For PTZ camera and when the camera's power requirements exceed the maximum POE power requirements.
- 2.1.1.1.2 When the electric power requirement for camera's device and camera's location exceeds the maximum permissible distance of the POE switch.
- 2.1.1.1.3 When the ambient temperature is below the minimum ambient operating temperature requirements for the camera.
- 3.1.1.2 Provide exterior-rated POE injectors where necessary at camera's location to suit the installation. Provide Axis T8123-E (30W) or Axis T8213-E (60W) or approved equal. Or
- 3.1.1.3 Provide dedicated PSE 24VAC or 28VAC power supply at cameras location. PSE shall be NEMA 4/IP66 rated when installed outdoor, Or
- 3.1.1.4 Provide Centralized 24VAC or 28VAC power supply with sufficient battery backup to maintain camera's operation for a period of 8 hours upon main power failure. Located in IDF rooms and as indicated on BSS drawings.
- 3.1.1.5 For multiple exterior cameras, Provide purpose manufactured VMS power supplies meeting, at minimum, the following requirements:

- 2.1.1.5.1 Separate outputs for up to 16 cameras per enclosure.
- 2.1.1.5.2 Individual fuses for each camera output.
- 2.1.1.5.3 Outdoor NEMA 4 /IP66 rated for outdoor applications.
- 2.1.1.5.4 Utilize supply voltage of 120 VAC, 60Hz (105 to 130 VAC).
- 2.1.1.5.5 Selectable 24 VAC or 28 VAC outputs for long wiring runs. Voltage drop shall be calculated.
- 2.1.1.5.6 AC power indication and On/Off switch.
- 2.1.1.5.7 Built-in charger for sealed lead acid or gel type batteries with automatic switchover to stand-by batteries when AC fails.
- 2.1.1.5.8 Steel powder coated enclosures.
- 2.1.1.5.9 Surveillance camera power supplies shall be Bosch, Altronix, Pelco or approved equal.
- 3.1.1.6 Electrical contractor shall provide 120V Ac circuit on UPS at injector's and dedicated power supply locations. And shall provide 120V AC on emergency circuit at centralized camera's power supply location.
- 3.1.1.7 The BSS Contractor shall coordinate locations of 120 VAC power supply circuit facilities with the Electrical Contractor. Provide all required wiring, conduits, and terminations from the camera devices, power supply units and the electric power supply circuit.
- 3.1.2 Elevator cameras:
 - 3.1.2.1 Cabling Contractor to provide POE injector (Microsemi 30W-4 port PD-9004G) or approved equal, Media converter, Ethernet over copper extender (Comnet CLFE4EOU), or approved equal in each elevator machine room.
 - 3.1.2.2 BSS contractor to provide module boxes, and all required auxiliary VMS devices in each elevator machine room.
 - 3.1.2.3 Electrical contractor to provide 120V on emergency circuit in each elevator machine room for auxiliary VMS devices.

PART 3 - EXECUTION

3.1 INSTALLATIONS

- 3.1.1 Provide all required programming and complete calibration and set-up of all cameras, for integration into VMS System and fully functional system.
- 3.1.2 Adjust all camera varifocal lenses to meet the Consultant/Owners requirements.
- 3.1.3 Provide a video image snapshot showing the maximum field of view (FOV) of all installed fixed cameras complete with camera software port description. All images shall be provided to the Owner/Consultant on electronic format. The snapshot will be utilized by the Owner/Consultant to select the final desired FOV of the camera.
- 3.1.4 Coordinate IP addresses and all network configuration details with IT Services. Comply with building project IT Services requirements for IP addressing, device naming and documentation.

3.2 SIGNAL QUALITY

- 3.2.1 Video monitor units, power supplies and wiring shall be installed and mounted such that video cross talk or interference does not occur between units.
- 3.2.2 Video and control signal cables for VMS applications shall, at minimum, meet the following requirements:
 - 3.2.2.1 VMS video and control cables shall not share conduits with any non-security system.
 - 3.2.2.2 Video cables shall be fully compatible with the equipment manufacturer requirements and shall comply fully with the project standards for network design and cable provisions.
 - 3.2.2.3 Provide grounded surge filters on both ends of cables fed on the exterior of the building and those with 120 VAC power sources. Provide Ditek DTK-PVPIP or approved equal.
- 3.2.3 All cabling shall be routed in a clean and efficient manner. There shall be no exposed cable outside of the camera or mount.

3.3 VMS VIDEO SIGNAL SWITCHING, DISPLAY AND RECORDING

- 3.3.1 Provide a networked digital video management system. The VMS installation shall be configured such that video camera signals are connected to the BSS LAN and communicate with the network video recording (NVR) units.
- 3.3.2 A VMS network video management Rack-Mounted Workstation (OIW) shall be provided. The BSS Contractor shall provide the OIW PC. The BSS Contractor shall provide the application software installed on the OIW. Provide additional OIW as indicated in the specifications and drawings as required.
- 3.3.3 The digital video management system NVR's shall record VMS camera surveillance activity on a timed, real time or event driven basis as selected by the operators. Provide NVR's to enable video information to be recorded and stored on hard drives for the specified period prior to being overwritten or archived to other digital storage media. The BSS Contractor shall provide hard disk storage requirement calculations to the Owner and Consultant as shop drawing submittals.
- 3.3.4 As recording space on the storage array reduces, overwriting of recorded video shall occur automatically without operator intervention, and be managed by the NVR using a first-in first-out approach to ensure the most dated, unprotected video is replaced.
- 3.3.5 Provide a digital video management solution capable of future expansion that shall not render hardware or software supplied under this contract redundant.
- 3.3.6 All NVR's, external hard drives and associated digital video equipment shall be rack mountable in 19 inch wide racks. Provide equipment mounted within the equipment racks in the Owner's IT closets/rooms.
- 3.3.7 The digital video management system shall meet, at minimum, the following requirements:
 - 3.3.7.1 Utilize H.264 video compression (MPEG4 Part 10) and M-JPEG video compression format.
 - 3.3.7.2 Provide Pre and Post alarm incident recording/playback facilities. Pre and post alarm recording time durations shall be coordinated with the Owner during construction and shall be programmed by the BSS Contractor for all required camera video signals.
 - 3.3.7.3 Video motion detection facilities with adjustable sensing area and sensitivity.
 - 3.3.7.4 Camera video signal loss detection for all camera inputs.
 - 3.3.7.5 Video authentication.
 - 3.3.7.6 Complete with all required interconnection facilities for interconnection to the BSS Ethernet LAN and

to the Owner's Ethernet LAN / WAN.

3.3.7.7 Capable of simultaneously recording and viewing live camera images with no degradation to video recording.

3.3.7.8 Capable of displaying any camera video signal on any video display panel.

3.3.8 Provide NVR equipment, software and facilities with the following minimum functionality:

3.3.8.1 Capability to view multiple camera signals simultaneously.

3.3.8.2 Audit trail and event search facilities.

3.3.8.3 Time scheduled programming capabilities for video alarm events, recording functions, etc.

3.3.8.4 Capabilities to allow viewing of live and recorded video without interrupting video signal recording:

3.3.8.4.1 Capability for remote viewing of camera video signals from remote PC locations over the Owner's LAN/WAN enterprise, and over other TCP/IP LAN connection.

3.3.8.4.2 Capabilities to display any video input signal on any video display output.

3.3.8.4.3 Cyclically display any selected video inputs on selected video display output.

3.3.8.4.4 Provide auto tours with the following minimum capabilities;

3.3.8.4.4.1 Enable/disable multiple and independent auto tours running in either the forward or reverse direction on a time/schedule or operator initiated bases.

3.3.8.4.4.2 All cameras and all camera presets to be included in each tour.

3.3.8.4.4.3 A single view (camera or preset) to be assigned to any monitor at each step in the auto tour.

3.3.8.4.4.4 Multiple views to be assigned to multiple monitors at each step in the auto tour.

3.3.8.4.4.5 Select the indexing rate for auto tours for each monitor. The indexing rate shall be between two (2) to fifteen (15) seconds, definable per camera in a tour.

3.3.8.4.4.6 Provide alarm activation with the following minimum capabilities:

3.3.8.4.4.6.1 Auto pop of associated camera to a preprogrammed monitor.

3.3.8.4.4.6.2 Sequential alarm pop-up shall support the following programmable modes, sequencing current camera to a secondary monitor, cycling up to the last three alarms associated cameras in the secondary monitor. Holding the current camera in the primary alarm monitor and cycling additional alarm cameras in the secondary monitor until the current alarm camera view is released.

3.3.8.4.4.7 Operators:

3.3.8.4.4.7.1 Provide log-on/log-off facilities for operators. Operators shall only be able to perform those functions for which they have been approved.

3.3.8.4.4.7.2 Provide facilities for restricting users to selected cameras and selected monitors with selected log-in passwords and privileges.

3.3.8.4.4.7.3 Priority levels shall be assignable to each operator for the control of cameras, the locking out of cameras and the activating of camera tours.

3.3.8.4.4.8 Provide an interactive facility and site map allowing camera and alarm positions to be plotted on the map using interactive icons. Clicking on the camera icons shall allow direct operator control of the camera and/or display the live/recorded feed from the camera.

3.3.8.4.4.9 Provide facilities for full variable speed pan/tilt control and zoom control.

3.3.8.4.4.9.1 Provide video output titling. Titling shall be capable of, at minimum the following functions:

3.3.8.4.4.9.2 Define date, time, and video output number for each video output.

3.3.8.4.4.9.3 Ability to locate the titling information anywhere on the display.

3.3.8.4.4.10 Ability to turn off the titling information individually for each video output

3.4 VMS SYSTEM APPLICATION SOFTWARE AND LICENCES

3.4.1 Provide video management and viewing software installed on NVR units at Main IT room and on the VMS work station at reception, core office, spa reception, general/hotel manager, receiving and shipping manager, core office and for locations as indicated on BSS drawings.

3.4.2 Provide software programming and configuration services as required for a complete turn-key functional networked video management system.

3.4.3 The BSS Contractor shall provide all required component and software licenses for the connected devices.

3.5 VMS OIW COMPUTER

3.5.1 Provide an OIW at locations identified above and on the Security Drawings. OIW shall meet requirements identified in specification Section 28 05 13.

3.5.2 Shall be capable of displaying live and recorded video from 1 to 25 cameras at once, with preset layouts of 1, 4, 16, and 25 video windows.

3.5.3 Shall be capable of configuring and viewing a sequence of cameras in succession within the same camera window.

3.5.4 Allow for direct PTZ control via the camera window.

3.5.5 Allow for direct recording and playback of recorded footage via the camera window.

3.6 WORKSTATION FLAT PANEL

3.6.1 Provide WFP'S at locations identified above and on the Security Drawings.

3.6.2 Shall have a minimum diagonal screen size of 21", with a minimum resolution of 1920 x 1080 pixels.

3.6.3 5ms response time, 380cd/m2 brightness.

3.6.4 Front panel operating controls, integrated speaker.

3.7 LARGE FORMAT DISPLAYS

3.7.1 Provide large format displays at security office, core office and at locations identified on the security drawings and details.

3.7.2 Shall have a minimum diagonal screen size of 42", with a minimum resolution of 1920 x 1080 pixels.

3.7.3 Display shall be supplied with all mounting, connections, cables, and accessories for a complete connection to the VMS OIW's.

3.8 INSTALLATIONS

3.8.1 Provide all required programming and complete calibration and set-up of all switching equipment,

- digital video recording equipment and display devices for a fully VMS functional system.
- 3.8.2 Configure the automatic call up of cameras and their associated pre-position settings.
 - 3.8.3 Create a hierarchical, interactive facility map which allows operators to manage the facility's cameras using a floor plan with interactive icons to activate live viewing, recording, and other system functions. Provide all programming necessary.
 - 3.8.4 Coordinate all network configuration and installations with the building IT Services contractor. Provide all installations in compliance with the building IT Services Standards.
 - 3.8.5 Coordinate IP addresses and all network configuration details with IT Services. Comply with building project IT Services requirements for IP addressing, device naming and documentation.
 - 3.8.6 Provide all data communications network patch cables for interconnection of all BSS/VMS components.

PART 4 - END OF SECTION

PART 1 - GENERAL

1.1 Reference

- 1.1.1 Section 26 05 00 applies to and is a part of this Section of the Specification.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- 1.2.1 The following work which is related to the fire alarm system work is specified in other Sections of the Specification:

- 1.2.1.1 Provision of fire alarm system supervised valve contacts, alarm valve contacts and piping pressure switches;
- 1.2.1.2 Provision of pre-action sprinkler system;
- 1.2.1.3 Provision of fire suppression system in the kitchen.

1.3 INSPECTION, TESTING, START-UP AND VERIFICATION

- 1.3.1 In addition to requirements specified in this Section, refer to requirements of Section 26 05 70 and Section 26 08 00.

1.4 Shop Drawings

- 1.4.1 Submit shop drawings for equipment and accessories specified in this Section. Shop drawings shall include connection wiring schematic drawings for each system, system design drawings including dimensions and layouts, system riser drawings and copies of manufacturer's component literature sheets.

1.5 Software Nomenclature Reprogramming

- 1.5.1 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.

PART 2 - PRODUCTS

2.1 Fire Alarm System Products – General Features

- 2.1.1 The existing fire alarm system is a Tyco Simplex system, 4100U.

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- 2.1.2 Two-stage, addressable, zoned, supervised, fully integrated and field programmable system products complete with emergency voice communications (EVC) and firefighters' communications. Entire system is designed as a centralized data communication and processing system.
- 2.1.3 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:
- 2.1.3.1 CAN/ULC-S524, Standard for Installation of Fire Alarm Systems;
 - 2.1.3.2 CAN/ULC-S525: Audible Signal Appliances;
 - 2.1.3.3 CAN/ULC-S526: Visual Signal Appliances;
 - 2.1.3.4 CAN/ULC-S527, Control Units;
 - 2.1.3.5 CAN/ULC-S528: Manual Pull Stations;
 - 2.1.3.6 CAN/ULC-S529: Smoke Detectors;
 - 2.1.3.7 CAN/ULC-S530: Heat Detectors;
 - 2.1.3.8 CAN/ULC-S533: Egress Door Securing and Releasing Devices;
 - 2.1.3.9 CAN/ULC-S536: Inspection and Testing of Fire Alarm Systems;
 - 2.1.3.10 CAN/ULC-S537, Standard for Verification of Fire Alarm Systems;
 - 2.1.3.11 CAN/ULC-S541: Speakers for Fire Alarm System;
 - 2.1.3.12 CAN/ULC-S561: Installation and Services for Fire Signal Receiving Centres and Systems;
 - 2.1.3.13 local governing building code;
 - 2.1.3.14 local governing electrical code;
 - 2.1.3.15 local governing building permit applications for approvals;
 - 2.1.3.16 other requirements of local governing authorities.
- 2.1.4 Devices to be ULC listed and labelled devices suitable for fire alarm applications. Power supplies and other components to be CSA approved where required by local governing authorities and codes.
- 2.1.5 System to include but not be limited to following components:

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- 2.1.5.1 Central Alarm and Control Facility (CACF) (also known as Fire Command Centre (FCC);
 - 2.1.5.2 central processing units (CPU);
 - 2.1.5.3 EVC and paging system components;
 - 2.1.5.4 2-way supervised firefighters' communication system;
 - 2.1.5.5 transponders/data gathering panels (DGP);
 - 2.1.5.6 initiating devices (pull stations, heat/smoke/flame detectors);
 - 2.1.5.7 alarm indicating devices (speakers, horns, strobes);
 - 2.1.5.8 smoke control;
 - 2.1.5.9 interfaces and interconnections to auxiliary building systems;
 - 2.1.5.10 wiring in conduit and/or fire rated cables.
- 2.1.6 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.
- 2.1.7 System software to be of open protocol and be fully custom programmed with sequence of operations to suit specific project requirements. System programming to be performed by manufacturer's authorised technician. Include for system programming changes required for duration of project and as required for final acceptance and certification of entire system and project work, by local governing fire and buildings authorities. Include for additional two (2) onsite programming periods after successful system testing and verification of system, for any final revisions required by Owner. Refer to Part 3 of this Section for additional programming requirements.
- 2.1.8 Main panels, transponders/DGPs as defined in this Specification are intelligent, microprocessor based control panels that connect to and handle network communications in a peer-to-peer manner. Decisions pertinent to network are distributed among transponders/DGPs such that there is no need for a central fire alarm control panel. Each transponder/DGP to have full system operations data available on display on LCD.
- 2.1.9 If a group of transponders/DGPs become isolated from rest of network ring, that group forms a sub-network with common interaction of monitoring and control remaining intact. Network is notified with exact details of lost communications. In event that a single transponder/DGP becomes unable to handle network token, network interface card continues communications to rest of network. Off-line transponder/DGP is reported as such to network and is periodically interrogated to determine if it is ready to be brought back on-line with rest of network.
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- 2.1.10 System data and points monitored and controlled by each individual transponder/DGP are capable of being made available to network and are available to be displayed at each transponder/DGP. Such points include:
- 2.1.10.1 initiating circuit devices such as addressable analogue detectors, including detector type and detector values;
 - 2.1.10.2 conventional addressable or zone connected or cross zoned smoke, heat, and flame detectors;
 - 2.1.10.3 addressable pull stations; sprinkler devices;
 - 2.1.10.4 control circuits such as speaker/strobe circuits, fan/elevator/smoke exhaust controls, electromagnetic lock controls or other similar operations.
- 2.1.11 Network operations are via communication links that connect network transponders/DGPs and include data transfer, an audio signalling bus serving remote amplifiers, and a two-way phone communications bus serving individually controlled fire phone circuits. Communications trunk wiring to be electrically supervised.
- 2.1.12 Risers between network transponders/DGPs to include minimally a No. 18 AWG twisted shielded cable for each riser, wired in Class A (as required by local fire authorities) identifiable loops in addition to other fire rated conductors. Final wiring requirements to be determined by system manufacturer to suit specific applications and local governing authority code requirements.
- 2.1.13 Control and transponder/DGP enclosures to be NEMA 1 or 12 with additional sprinkler-proof provisions including gasketing of openings/doors and ventilation louvers designed to protect live components from water spray of activated sprinklers. Surface mounted panels to include drip shield. Panels to be wall mounted, enamel finished, steel cabinets. Where flush mounted, include suitable trim. Panels mounted in finished areas to be of finishes approved by Consultant.

2.2 Transponders / Data Gathering Panels (DGPs)

- 2.2.1 Transponders or data gathering panels (DGPs) to be complete with following:
- 2.2.1.1 multi-character alphanumeric back-lit LCD display complete with ability to annunciate full system networked points;
 - 2.2.1.2 common alarm LED and push-button acknowledge switch;
 - 2.2.1.3 common security LED and push-button acknowledge switch;
 - 2.2.1.4 common trouble LED and push-button acknowledge switch;
 - 2.2.1.5 signal silence switch;

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- 2.2.1.6 system reset switch;
 - 2.2.1.7 power on indicator;
 - 2.2.1.8 communications interface into network;
 - 2.2.1.9 multiple level password protected programmable function keys/LEDs;
 - 2.2.1.10 local alert and EVAC tone oscillators and amplifiers.
- 2.2.2 Transponders/DGPs to allow for loading or editing of special instructions and operating sequences as required. Software operations to be stored in a non-volatile programmable memory within each transponder/DGP. Loss of primary and secondary power to not erase instructions stored in memory. On-site programming changes to be password protected.
- 2.2.3 Signal/Speaker circuits to be independently supervised and fused such that a fault on one (1) circuit to not affect operation of any of other circuits. Signal circuits to be configured as follows:
- 2.2.3.1 Class "A" analogue addressable loop wiring for alarm initiating devices;
 - 2.2.3.2 Class "B" for EVC speakers and firefighter's handsets;
 - 2.2.3.3 redundant NFPA style 7 backbone wiring;
 - 2.2.3.4 rated at 2-amps of continuous power;
 - 2.2.3.5 capable of powering polarized 24 VDC audible signalling appliances.
- 2.2.4 Amplifiers and tone generators to supply required signals for voice paging, alert, and evacuation tones to speaker circuits. Amplifiers to be sized to accommodate speaker load (assume 1 watt tapping for determination of quantity of amplifiers) plus an additional 20 per cent spare capacity per speaker zone to accommodate future additions. Spare capacity to take form of additional amplifiers, as required. Amplifiers to be continuously supervised for proper operation.
- 2.2.5 System controls to be housed in a surface wall mounted steel cabinets. Finish to be according to manufacturer's standards.
- 2.2.6 Modules to be secured behind hinged locked door. Hinged locked doors to give access to operating controls but not expose live connections.
- 2.3 Addressable Device Network**
- 2.3.1 System provides communication with addressable initiating devices and these devices are annunciated on control panel/transponder/DGP main LCD display. Annunciation includes following conditions for each point:
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- 2.3.1.1 zone/device location;
 - 2.3.1.2 type of device;
 - 2.3.1.3 detector status (normal/alarm/trouble);
 - 2.3.1.4 device missing/failed.
- 2.3.2 A minimum of 100 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.
- 2.3.3 Each addressable device to be uniquely identified by an address code entered on each device at time of installation. Use of jumpers to set address will not be acceptable due to potential of vibration and poor contact.
- 2.3.4 A 100% digital loop controller within control panel/transponder/DGP to interface with intelligent microprocessor-based detectors and modules.
- 2.3.5 Loop controller connected to detectors and modules using any wiring material or method complying with local governing electrical code, without need for special shielded or twisted wire.
- 2.3.6 Loop controller to be capable of supporting Class A (Style 7) or Class B (Style 4) circuits without need for additional hardware modules. Multiple branch circuits can be T-Tapped from Data Communications Link (DCL).
- 2.3.7 Loop controller to be capable of automatically addressing devices connected to it electronically, without need to set switches at any of individual device locations.
- 2.3.8 Loop controller to determine electrical location of each connected detector and module. Location and type of each connected device to be mapped and stored in memory in loop controller. Map can be accessed and displayed.
- 2.3.9 Mapping report of devices connected to loop controller for confirmation of "as-built" wiring can be obtained. Mapping report shows electrical relationship of connected devices, including T-Taps, device types, and address of each device on circuit. Loop controller to be capable of reporting any additional device addresses, which may have been added to circuit, and/or changes that, may have been made to wiring. A specific trouble to latch on system until changes are verified and accepted in program by authorized personnel.
- 2.4 Voice Communication System**

- 2.4.1 Voice communication system to be an integrated modified minimum triple channel system with capability of transmitting minimum five (5) audio signals simultaneously to different areas of building. System to include custom pre-programmed digitised voice messages, words, and alarm tones that can be transmitted to all or specific areas of building. Exact sequence of operations must be confirmed with Consultant. Voice communication system to provide prioritised paging announcements to all zones and selected zones of building. As per ULC-S527, system throughout building to have ability to page (emergency and general) within 5 seconds of manually activation and provide sensory indication to operator within 1 second that function has been requested.
- 2.4.2 One (1) channel to be used for general paging from remote microphones. During a fire alarm condition, general paging to be automatically overridden by emergency alarm tones and emergency paging from CACF EVAC controls **fire alarm annunciator and control panel**. General paging to include ability to page specific zones only and "all call", except for specific areas and rooms as confirmed with Consultant, which can be separately zoned to have general paging turned off at select times. During programming, volume level of emergency paging may be set higher than general paging, as approved by Owner. Exact areas and rooms to be confirmed with Consultant prior to start of Work. Confirm zone arrangement with Consultant prior to programming and start of Work.
- 2.4.3 Digitised voice messages to include an EVAC Message, Drill Message, and an All Clear Message. Text of messages to be custom made to approval of Owner and Local Fire Department and must form part of fire safety plan for building. EVAC message to be configured such that floor of alarm can be incorporated into message. Voice splicing to allow EVAC voice message to indicate what floor or area is actually in alarm in a multi-floor building. Messages to be clear, background noise free recordings acceptable to Consultant and approved by local fire authorities and meet local code requirements. System to be able to store up to 100 minutes of pre-recorded messages as .wav files, which can automatically be directed to various areas of facility under program control.
- 2.4.4 Approved EVAC message may be automatically broadcast after one (1) minute to zones in evacuation alarm mode. Message may only be manually activated, at central alarm and control facility after one (1) minute to zones in alert mode, if supervisory staff is present and have acknowledged alarm. This is to prevent building occupants receiving a false sense of security that someone has responded to fire alarm condition.
- 2.4.5 Messages may be repeated three (3) times before being terminated. Once message has been completed speakers to automatically resume sounding same alarm tone they were sounding prior to announcement.
- 2.4.6 Messages, words, and alarm tones to be digitised and stored on a pluggable integrated circuit chip located on audio controller board. Equipment to be approved for use with specific voice communication system by voice communication system manufacturer.
- 2.4.7 1-way voice communication to provide intelligible low level reproducible tones and/or voice instructions to areas of building. System to automatically or manually sound second stage "evacuation" tone (of tone as approved by local fire authority) in zone and/or on floor of alarm, while at same time being able to sound first stage "alert" (tone as approved by local fire authority or "voice instructions" or as directed by local fire authority) to other areas of building. Tones on both stages to be synchronized.

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- 2.4.8 System to be capable of selecting proper tones and phrases based upon specific conditions and location, sort and transmit audible information and repeat transmission as many times as required. Phrases, words, and alarm tones to be stored on non-volatile solid-state integrated circuits and to be completely field programmable on site.
- 2.4.9 Handset Microphones to be a dynamic noise cancelling type with a frequency response from 100 to 10,000 Hz. Any automatic alarm which may be sounding may be overridden by use of microphone. When manual voice announcements are completed system to revert back to previous alarm unless reset or restored to normal by authorities in charge. Where shown on drawings, transponder/DGP to have a master microphone to control speaker circuits in its own area. Provide remote handset microphone and paging control unit at telephone switchboard room and CACF Room.
- 2.4.10 Manual control of building speaker circuits for general paging programs to be accomplished via dedicated speaker circuit toggle switches located at paging control units at CACF and any as noted on the drawings. This control unit to have an "all call" switch to broadcast paging throughout entire building simultaneously, a switch for each building zone and a night disconnect switch to disconnect general paging announcements in designated areas and rooms (i.e. resident rooms where applicable) confirmed with Consultant.
- 2.4.11 EVC paging to be controlled only at CACF with zone control switches for:
- 2.4.11.1 all call;
 - 2.4.11.2 each floor of each building zone;
 - 2.4.11.3 each stairwell of each building zone; switches to be grouped as per building zone.
- 2.5 2-Way Firefighter Communication System**
- 2.5.1 Provide a 2-way voice communication system between CACF EVAC controls and remote emergency fire phones. Wires between CACF and to remote telephones to be continuously supervised. Any fault which occurs to be reported visually and audibly at central control.
- 2.5.2 A master telephone control module to be furnished to provide processing of two-way communication functions. This module to include an audible sonalert for call and trouble signalling, a trouble silence switch with ring back, a trouble indication and supervising monitor circuit.
- 2.5.3 A black master telephone handset with flexible-coiled self-winding 5' (1.5 m) cord to be provided and recessed within a protective panel-mounted enclosure at local transponder/DGP.
- 2.5.4 Phone (talk) circuit modules to be furnished to electrically supervise for shorts, opens, and grounds of circuit wiring. Each phone module to contain a "Call-In" indication and a two (2) position switch to enable two-way voice communication between remote and master phones.
- 2.5.5 System to be capable of handling single or simultaneous conversations with as many as six (6) phones connected. Phone system circuits to be designed for clear, intelligible two-way conversation between phones of system.

- 2.5.6 System to indicate to person attempting to use a remote phone, by a beeping busy signal, that signal is being received at local transponder/DGP and that lines are intact. As many as six (6) phones to be able to be connected into active conversation at discretion of person at Command Centre.

2.6 Power Requirements

- 2.6.1 Control panels, transponders/DGPs and annunciators to receive power via a dedicated fused disconnect circuit. Incoming power to system to be supervised so that any power failure must be audibly and visually indicated at transponder/DGP and remote annunciator. A green 'Power On' LED to be displayed continuously while incoming power is present.
- 2.6.2 Power supplies to have following operating characteristics:
- 2.6.2.1 rated for five (5) amps continuous duty;
 - 2.6.2.2 24 VDC filtered and regulated;
 - 2.6.2.3 power limited with a range of 20.4 VDC to 32 VDC;
 - 2.6.2.4 automatic "Brownout" transfers to standby batteries when supply voltage falls to below set limit.
- 2.6.3 System to be provided with sufficient standby capacity to operate entire system upon loss of normal power in a normal supervisory mode for a period of minimum 24 hours, and immediately following, full load power (defined as power required for full signalling activation of devices both visual and audible for full alarm conditions) for not less than 15 minutes. These requirements to be confirmed with local fire authority and be amended to suit local fire authority requirements but such amendments to not lessen requirements herein specified. These requirements must be tested and demonstrated. Refer to Part 3 of this Section. System to automatically transfer to standby batteries upon power failure. Battery charging and recharging operations to be automatic.
- 2.6.4 Standby power for system to be produced by maintenance free, sealed lead acid or gelled cell batteries. System batteries to be supervised so that a low battery condition or disconnection of batteries to be audibly and visually annunciated at control panel. Battery chargers to have following operating characteristics:
- 2.6.4.1 ability to charge batteries to 70% of their capacity within 12 hours;
 - 2.6.4.2 compatible with either lead acid or nicad batteries;
 - 2.6.4.3 circuits requiring system operating power to be individually fused.
- 2.6.5 System to be provided with transient voltage surge protection device (SPD) to protect system electronics from surges and spikes on power lines. SPD units to be as recommended by fire alarm system manufacturer.

2.6.6 System to be provided with transformers as required to power ancillary devices and hardware.

2.7 Addressable Modules

2.7.1 Addressable modules to be used for monitoring of water flow, valve tamper, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.

2.7.2 Addressable modules to monitor any N/O contact device and be capable of powering

2.7.3 Addressable modules to communicate zone's status (normal, alarm, trouble) to transponder/DGP. Addressable modules zone address to be set at time of installation via a dip switch package.

2.7.4 Addressable modules to be able to provide supervised or non-supervised control of any control function. Addressable modules to communicate zone's status (normal, trouble) to transponder/DGP. Each addressable module to provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of relay to be equipped with a replaceable fuse sized as required.

2.8 Pull Stations

2.8.1 Pull stations to be addressable, single action, non-coded, 2-stage, semi-flush mounted type. Pull stations to be key locked and have 2-sets of sealed N/O contacts. One (1) contact is to activate when handle is pulled down, activating a first stage alarm. Second contact is operated by means of a key switch, which activates second stage alarm. Stations to be complete with auxiliary contacts to connect to other building systems, such as to release doors upon 2nd stage alarm activation. Confirm exact sequence of operation with Consultant prior to programming. Set station's address at time of installation.

2.8.2 Stations located in areas of high abuse or where designated to be complete with guard, to be equipped with STI type, ULC listed and labelled, hinged clear Lexan cover and which to include an integral battery operated alarm if required by code or local fire authority. Include for provision of a quantity of 5 covers to be installed in locations defined by Owner at site.

2.9 Photoelectric Smoke Detectors

2.9.1 Smoke detector to be addressable photo-electric technology types.

2.9.2 Detector's microprocessor measures and analyses signals and filters out signal patterns not typical for fires, thus limiting false alarms. microprocessor also performs:

2.9.2.1 self-diagnostics and history logging, with results stored in non-volatile memory;

2.9.2.2 automatic device mapping with supervision of each device location;

2.9.2.3 identification of dirty or defective detectors;

2.9.2.4 stand-alone operation if communications fail between it and main system CPU;

2.9.2.5 on board intelligence which limits information required to be sent to main CPU.

2.9.2.6 Sensitivity range of each detector set in transponder/DPG to be from

2.9.2.7 0.67-3.7% smoke obscuration. Each detector to have minimum five different programmable sensitivity levels within this range - 1.0, 2.0, 2.5, 3.0, and 3.5%.

2.9.3 Detectors feature:

2.9.3.1 a low profile design and ULC Listed for both ceiling and wall mount applications;

2.9.3.2 tamper resistant features;

2.9.3.3 electronic addressing;

2.9.3.4 electronics immune from false alarms caused by EMI and RFI;

2.9.3.5 insect screen;

2.9.3.6 environmental compensation;

2.9.3.7 automatic day/night sensitivity adjustment;

2.9.3.8 RED/GREEN status LED indicators.

2.9.4 Detectors to be equipped with a dust-bag, which is removed at time of verification, to prevent dust and dirt entering smoke chamber during construction.

2.10 Duct Smoke Detectors

2.10.1 Duct type smoke detector units with features as follows:

2.10.1.1 addressable photoelectric detector features;

2.10.1.2 duct air sampling tube of suitable required length;

2.10.1.3 magnetic activated test switch;

2.10.1.4 status LEDs;

2.10.1.5 form C auxiliary alarm relays;

2.10.1.6 remote alarm indicator assembly with LED type lamp and single gang stainless steel faceplate;

2.10.1.7 remote test station for detectors in locations not easily accessible to test.

2.10.2 Duct housing assembly to consist of air tight housing mounted on side of duct. This housing to contain detector base into which photoelectric detector head is inserted.

2.10.3 For units located within ductwork as shown on drawings and for units within air intake ductwork provide ULC listed and labelled weatherproof housing complete with integral heater and thermostat control with alarm contacts for monitoring and annunciation of low temperature. Provide wiring in conduit back to transponder/DGP/control panel.

2.11 Thermal Detector

2.11.1 Thermal detector to be addressable unit of following types:

2.11.1.1 fixed temperature 57°C (135°F) detector type;

2.11.1.2 combination 9C° (15F°) per minute rate of rise/57°C (135°F) fixed temperature detector type.

2.11.2 Detector's microprocessor measures and analyses signals and filters out signal patterns not typical for fires, thus limiting false alarms. microprocessor also performs:

2.11.2.1 self-diagnostics and history logging, with results stored in non-volatile memory;

2.11.2.2 automatic device mapping with supervision of each device location;

2.11.2.3 tamper resistant features;

2.11.2.4 stand-alone operation if communications fail between it and main system CPU;

2.11.2.5 on board intelligence which limits information required to be sent to main CPU.

2.11.2.6 Detectors feature:

2.11.2.7 a low profile design and ULC Listed for both ceiling and wall mount applications;

2.11.2.8 tamper resistant features;

2.11.2.9 electronic addressing;

2.11.2.10 electronics immune from false alarms caused by EMI and RFI;

2.11.2.11 insect screen;

2.11.2.12 RED/GREEN status LED indicators.

2.12 Carbon Monoxide (CO) Detection

2.12.1 CO Detectors

- 2.12.1.1 Advanced electrochemical carbon monoxide sensing technology
- 2.12.1.2 An intelligent device that gathers analogue information from its CO sensor, converting this data into digital signals
- 2.12.1.3 Continuous self-diagnostics ensures reliability over the long-haul
- 2.12.1.4 When the electrochemical cell reaches its end of life, the detector signals a trouble condition to the control panel.

2.12.2 CO Alarms

- 2.12.2.1 120V AC hardwire with battery back-up carbon monoxide (CO) detector with alarm horn.
- 2.12.2.2 No need to remove the unit from the ceiling to replace the 9V battery.
- 2.12.2.3 Red LED indicates which power supply is active — AC or DC.
- 2.12.2.4 have a button that will test the alarm by simulating CO, and silence any nuisance alarm.
- 2.12.2.5 Silences the alarm while the occupant(s) respond to an alarm. After the initial silence period, if levels of CO present still indicate a potentially dangerous situation, the alarm will sound again.
- 2.12.2.6 Can be connected to a UL listed control panel.

2.13 Audible/Visual Devices

- 2.13.1 Devices include horns/speakers, strobes and combination units. Devices to mount on wall/ceiling back boxes. Back boxes to be supplied by system manufacturer to suit specific devices and type of installation. Finish colours to be confirmed with Consultant or Owner prior to ordering.
- 2.13.2 For finished areas: 7.3" (180 mm) round baffled cone-type speaker suitable for ceiling mount applications. Speaker assembly to consist of following:
 - 2.13.2.1 fire retardant and moisture proof cone rated 15 watts;
 - 2.13.2.2 25/70 volt matching transformer complete with 1/4, 1/2, 1 and 2 watt taps;
 - 2.13.2.3 400 HZ to 4,000 HZ frequency response;

- 2.13.2.4 89 db at 10' (3 m), with a 1 watt input;
 - 2.13.2.5 moisture repellent treated steel enclosures;
 - 2.13.2.6 quality and frequency response for good clarity voice paging;
 - 2.13.2.7 pre-tap speakers at 1/2 watt tap.
- 2.13.3 For integrated speaker strobe units include integral synchronized strobe to be complete with Lexan lens, field changeable "FIRE" markings and candela output intensity as approved by local fire authority (output range from 15 cd to 95 cd or from 95 cd to 177 cd).
- 2.13.4 For mechanical rooms and non-climate controlled areas: re-entrant type speaker and speaker/strobe units with following features:
- 2.13.4.1 outdoor rated, weather-resistant;
 - 2.13.4.2 temporal or continuous tones to meet local governing authority requirements;
 - 2.13.4.3 sealed high compression driver with DC blocking capacitor for audio supervision;
 - 2.13.4.4 2W to 15W taps and 90 dbA @ 10' (3m) at 2W tap
 - 2.13.4.5 faceplate of impact resistant and weather-resistant red or white Noryl construction;
 - 2.13.4.6 integral synchronized strobe to be complete with Lexan lens, field changeable "FIRE" markings and candela output intensity as approved by local fire authority (output range from 15 cd to 110 cd);
 - 2.13.4.7 weather-proof back box suitable for surface or recessed mounting applications to suit required installation requirements.
- 2.13.5 Stand-alone strobes to be similar to features of combination units specified above but only with strobe features.
- 2.13.6 Visual signal strobe light to be 75cd in general areas or as noted on drawing and 30cd in sleeping rooms.
- 2.13.7 In finished areas, devices to mount to a 4" (100 mm) square, 2-1/8" (60 mm) deep, back box. Where devices are to be surface mounted, provide a red finished surface back box with no knockouts.
- 2.13.8 Devices mounted exterior to be complete with "weatherproof" box.
- 2.14 Remote Lamp Units**

- 2.14.1 Single gang stainless steel faceplate with LED indicating lamp, suitable for mounting on standard wall box; unit to be remotely connected to any smoke detector located in position where detector activated LED cannot be seen, such as under raised floors, in drop ceilings, above or in ductwork, etc.; smoke detectors to include auxiliary connections to suit connection requirements as per system manufacturer's recommendations; provide suitable identification labelling on faceplate.

2.15 Fire Signs

- 2.15.1 "FIRE DO NOT ENTER" custom nomenclature, illuminated, flashing, 24 volt D.C., ULC listed and labelled warning sign with slim line satin aluminium housing and with black face and red letters. Signs to be equipped with upper and lower rows of long life LED illuminators rated for at least 100,000 hour life, flasher, and Lexan guard. Minimum letter size to be "FIRE" – 2" (50 mm) high, "DO NOT ENTER" – 1-1/2" (38 mm) high. Lettering not to be visible until sign is energized.

2.16 Remote Fireman's Telephones

- 2.16.1 Remote firemen's telephones to be housed in a flush mounted steel cabinet with a lockable door assembly. Cabinet to be finished in red with inscription "LOCAL FIRE EMERGENCY PHONE." telephone to be constructed of red cyclac Type "T" thermal ABS material and have a 5' (1.5 m) coiled line cord.

2.17 End-Of-Line Resistors

- 2.17.1 End-of-line resistors for standard alarm and signalling circuits to be sized to ensure correct supervisory current flows in each circuit.
- 2.17.2 End-of-line resistors to be mounted on a stainless steel plate for mounting on a standard single gang box and bear ULC label.

2.18 Isolators

- 2.18.1 Isolators to be provided in accordance with code requirements and installed as per system manufacturer's requirements to isolate/monitor zones, loops, group of devices within building and between buildings.

2.19 Wiring

- 2.19.1 CSA approved 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; sized and installed in accordance with system manufacturer's instructions.
- 2.19.2 Provide Pentair "Pyrotenax" type "MI" ULC listed and labelled and 2 hour fire rated, mineral insulated, copper sheathed, copper conductors for power wiring to and between each transponder/DGP/control panel.

2.20 Warranty

2.20.1 Warranty to include following:

- 2.20.1.1 length of warranty as specified in Section 26 08 00 and Division 01;
- 2.20.1.2 repair or replacement warranty on components;
- 2.20.1.3 warranty to begin upon substantial acceptance of project, or where applicable, phase of project; provide extended warranty for system if used during construction stages and which to cover period of construction before turn over to Owner;
- 2.20.1.4 support of an operational remote maintenance capability;
- 2.20.1.5 repair response times for problems defined as routine to be addressed and corrected within 24 hours, excepting statutory holidays and weekends;
- 2.20.1.6 repair response times for problems defined as major to be addressed and corrected within 4 hours, excepting statutory holidays and weekends;
- 2.20.1.7 manufacturers of major components to provide written confirmation of full warranty, extended warranty and service back-up in case of failure to perform or insolvency of successful supplier;
- 2.20.1.8 maintain maintenance records for each system supplied, and must submit a monthly report containing a time and date record of reported or detected problems, detail of corrective action taken and cause of problem.

PART 3 - EXECUTION

3.1 Installation of Fire Alarm System – General

- 3.1.1 Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:
 - 3.1.1.1 device types to ensure that selected type is suitable for intended application on project;
 - 3.1.1.2 locations of devices to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
 - 3.1.1.3 device mounting heights to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
 - 3.1.1.4 device back box requirements to ensure size and depth suit system manufacturer's recommendations for specific devices;
 - 3.1.1.5 proposed system sequence of operation.

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- 3.1.2 Immediately advise Consultant of any requirements of above that may necessitate revisions to design documents.
- 3.1.3 Install fire alarm system components and connect complete.
- 3.1.4 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.
- 3.1.5 Perform Work in phases as specified in Divisions 00 and/or 01 and/or as noted on drawings.
- 3.1.6 Fire alarm system manufacturer's authorized technician to supervise control panel, transponder/DGP, and annunciator work.
- 3.1.7 Provide sequence of operation for fire alarm system as approved by local fire authority and Consultant. Owner's fire Consultant to also be contacted with regards to requirements of sequence of operation. sequence of operation and proposed graphic displays to be submitted to local fire authority and Consultant for review during shop drawing submissions. Refer to additional requirements on drawings.
- 3.1.8 Demonstrate system to local Fire Department and obtain their approval for complete system.
- 3.2 Sequence of Operation**
- 3.2.1 For pricing purposes and which must be confirmed and approved by local authority having jurisdiction and Consultant, fire alarm sequence of operation to include but not be limited to description in following paragraphs. Submit to Consultant for review, proposed sequence of operation based on specification requirements, Consultant comments and input from local governing authorities.
- 3.2.2 System to be flexible to easily program any sequence of operation. Control panel to be able to be programmed to initiate a series of pre-defined control actions. Confirm exact sequence of operation with Consultant and local fire authority prior to programming. Review fire plan prepared by Fire Consultant. Sequence herein is provided as an outline with exact requirements to be confirmed and programmed to requirements of fire plan, authority having jurisdiction and Consultant. Include for programming and software re-burning within 30 days of initial burning or within duration as directed by local authority having jurisdiction, and also for additional software reprogramming periods as previously specified. Generally, activation of any alarm initiating device including sprinkler system alarm valves in areas to cause:
- 3.2.2.1 fire alarm signal tone to sound a first stage fire alert signal as approved by local fire authority, throughout zones as scheduled on drawings or as required by local authority, for 5 minutes after which time they are to be manually silenced;
- 3.2.2.2 address and zone of fire alarm initiation to register on annunciators;
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- 3.2.2.3 activation of circuitry to transmit an alarm signal to device(s) provided by others (Owner's arranged monitoring company) to send alarm signal to Fire Department or to an outside private protection company; this work to comply with CAN/ULC-S561;
 - 3.2.2.4 smoke and fire doors as scheduled, in building which are normally held open by electric door holders to be released and closed, locked doors controlled by electric door locks and/or magnetic door locks to be opened and remain opened until fire alarm system is reset;
 - 3.2.2.5 a signal sent to automatic temperature controls of air handling systems to initiate sequence of operation of air handling equipment to operate;
 - 3.2.2.6 a signal to be sent to smoke control equipment such as designated fans as scheduled to operate or shut down or dampers to open or close and pressurization fans as scheduled to automatically start;
 - 3.2.2.7 alarm condition to be displayed on alphanumeric display on CPU and on remote annunciators;
 - 3.2.2.8 activation of assigned control points through control-by-event;
 - 3.2.2.9 assigned message and activated control-by-event functions, with time and date, for monitored point in alarm to be printed on CPU printer;
 - 3.2.2.10 colour graphic to show on screen layout of floor and zone area in alarm;
 - 3.2.2.11 homing elevator to 1st level or designated level automatically; elevators to operate in emergency sequence of operation;
 - 3.2.2.12 indicate alarm details in remote annunciators;
 - 3.2.2.13 log alarm/trouble events in historical event log;
 - 3.2.2.14 illuminated fire signs to be operated at fire alarm zones where they occur;
 - 3.2.2.15 visual notification appliances (strobe lights) to activate in applicable zones;
 - 3.2.2.16 associated integrated low voltage systems to be signalled, as required; exact systems to be integrated to be as confirmed with Consultant; emergency sequencing of other system to be initiated;
 - 3.2.2.17 integrated main fire alarm control units of other buildings of complex to be signalled, as applicable.
- 3.2.3 This alarm condition to be cleared and system reset only after activated alarm initiating device or devices on both stages of alarm have been restored to normal and building control panel is reset.

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- 3.2.4 If investigation of alarm zone by key personnel indicates need to evacuate zone, insertion of a special key and subsequent operation of a key switch if any of manual fire alarm pull stations or operation of control panel evacuation switch to sound a "general evacuation" alarm of temporal pattern in zones as scheduled on drawings. Exact tone pattern of signal to be confirmed with and approved by local governing fire authority.
- 3.2.5 Upon activation of fire alarm system, a signal to be sent to elevator controllers to implement emergency sequencing of cars. Generally, elevators to "home" to designated floor, unless alarm zone is on designated floor, in which case, elevators to stop at floor above. Exact emergency sequencing requirements to be as directed by Consultant.
- 3.2.6 Voice communication system to include provision for silencing alert signal and alarm signal when voice messages are being transmitted, but only after alert signal has sounded for at least 30 seconds.
- 3.2.7 Unauthorized closure of a fire protection system piping supervised valve to cause location of closed valve to be indicated at annunciators, trouble signals (audible and visual) to sound and illuminate, and a trouble signal to be transmitted to Owner's fire alarm monitoring company. This work to comply with CAN/ULC-S561.
- 3.2.8 Low pressure in fire protection piping mains (wet and dry), fire protection system pump (fire pump-standpipe system excess pressure pump-sprinkler pump and sprinkler system excess pressure pump) loss of power, sprinkler air compressor loss of power, generator fail to start, generator starting batteries low voltage or operation of fire pump to also activate audible and visual trouble alarm as specified above for supervised valves.
- 3.2.9 Refer to drawing notes for additional requirements.
- 3.2.10 Refer to Mechanical Division sections for additional pre-action sprinkler system requirements.
- 3.3 Installation of Control Units**
- 3.3.1 Install required central control panel/transponder/DGP, EVAC controls, associated panels, and annunciator in rooms and areas as confirmed with Consultant prior to rough-in.
- 3.3.2 Secure each panel enclosure to walls in accordance with manufacturer's instructions and connect with fire rated type power and fire alarm system wiring. Coordinate location and installation requirements with trade responsible for wall finishes and Consultant. Comply with local governing codes with regards to wiring requirements.
- 3.3.3 Programme approved sequence of operation of system. Submit detailed sequence to Consultant and local fire authority for review and approval prior to start of work.
- 3.3.4 Install units in accordance with manufacturer's instructions.
- 3.3.5 Connect panels/transponders/DGPs to dedicated 15A breakers in nearest emergency panel as shown or as scheduled. Ensure that room housing panels have fire rating to local governing code requirements.

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- 3.3.6 Mount remote passive graphic annunciator and printer at CACF room.
- 3.3.7 Provide GCC terminal in location as shown on drawings or as directed by Consultant. Programme GCC software and install hardware in accordance with system manufacturer's instructions. Custom program to suit Owner's requirements. Submit sample of screen with shop drawing submission.
- 3.3.8 Install electromagnetic lock control consisting of master reset switch and release switch onto control panel as required. Provide required wiring in conduit and relays and connect to electromagnetic door locks to provide required operation of resetting and release. Coordinate with trades responsible for providing electromagnetic locks, and ensure requirements are provided in compliance with local governing authorities.
- 3.3.9 Provide remote active annunciator panel at designate location(s) as noted on drawing.
- 3.3.10 Properly ground and bond control panels, transponders/DGPs and remote annunciator cabinets 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.
- 3.4 Installation of Devices**
- 3.4.1 Install required devices. Do not install devices in locations that may hamper proper operation of devices including adjacent devices.
- 3.4.2 Confirm device finishes with Consultant prior to ordering.
- 3.4.3 Install manual pull stations in boxes as required, recessed outlet boxes with plaster rings, except in unfinished areas where pull 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.
- 3.4.4 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.
- 3.4.5 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.
- 3.4.6 Provide interconnect work as required and coordinate requirements with resident/staff communication system vendor.
- 3.4.7 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.
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- 3.4.8 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 4" (100 mm) outlet box as close as possible or practicable to detector. Do not locate duct detectors within 3' (900 mm) of duct size increaser or decreaser fittings or any duct elbow. Provide wiring in conduit and extend to connect back to system control unit.
 - 3.4.9 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 pullstation). Provide required connections to fire alarm system and to electromagnetic locks.
 - 3.4.10 Provide required speakers. Speakers shall be flush and surface wall mounted cone type and surface mounted horn type as indicated to suit architectural wall/ceiling types, each complete with a proper backbox. Ensure that exterior speakers are weatherproof and mounted with a weather sealed gland nut connection at the proper dispersion angle. Install speakers in accordance with manufacturer's instructions for specific applications.
 - 3.4.11 Provide corridor speakers with dedicated dual zone speaker circuits. Provide resident 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 Consultant.
 - 3.4.12 Mount speakers in stairwells and wire vertically connected to specific zone as approved by local fire authority and Consultant. Refer to drawing riser and annunciator schedule.
 - 3.4.13 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.
 - 3.4.14 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.
 - 3.4.15 Install amplifiers sized as required to power additional speakers and include spare capacity as specified.
 - 3.4.16 Install specified telephone handsets and mount in recessed wall mounting boxes. Connect complete with wiring in conduit to local transponder/DGP.
 - 3.4.17 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.

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- 3.4.18 Install visual notification appliances 8' (2400 mm) above floor or 12" (300 mm) 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. Provide minimum two (2) circuits per floor and connect devices in alternating scheme.
 - 3.4.19 Install a paging microphone within CACF room and in other locations as required. Confirm locations with Consultant.
 - 3.4.20 Install fire signs in locations as confirmed with Consultant and connect such that activation of fire alarm system illuminates sign and when system is reset and alarm has been silenced, sign is de-energized.
 - 3.4.21 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.
 - 3.4.22 In areas of high abuse such as public parking areas and publically accessible areas, devices to include vandal resistant, tamperproof and vermin proof features such as guards, fasteners requiring use of special tools and fasteners not exposed.

3.5 Requirements for Integrated Systems and Equipment

- 3.5.1 Provide voltage sensing relays in all the phases, line side, of the fire pump controller and standpipe system excess pressure pump starters to sense loss of line voltage. The relays shall be energized from 15A 1P breakers and shall be complete with "C" contacts, one (1) per phase, which, if any one (1) phase voltage drops below 90% of nominal, trouble alarm shall signal in the fire alarm system indicating "Fire Pump Loss of Voltage" or "Standpipe Excess Pressure Pump Loss of Voltage" at all annunciators.
- 3.5.2 Provide an auxiliary N.O. contact in the fire pump controller and connect to the fire alarm annunciators, powered from the fire alarm system to indicate "Fire Pump Running".
- 3.5.3 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 of equipment, to perform required integrated to fire alarm system functions. Provide shunt trip breakers as required.
- 3.5.4 Provision of fire alarm supervisory wiring connections to include but not be limited to following (where applicable):
 - 3.5.4.1 fire protection system piping supervised valves and flow switches for alarm initiation;
 - 3.5.4.2 fire protection system piping supervised valves and flow switches for trouble indication;
 - 3.5.4.3 fire protection piping pressure detectors for loss of pressure trouble indication;

- 3.5.4.4 fire protection pre-action sprinkler system;
- 3.5.4.5 fan equipment starters and variable frequency drives;
- 3.5.4.6 pumps;
- 3.5.4.7 dampers;
- 3.5.4.8 fire suppression systems;
- 3.5.4.9 door holders/releases and electromagnetic locks;
- 3.5.4.10 telephone system key switch for connection to offsite central monitoring station;
- 3.5.4.11 fire pump transfer switch;
- 3.5.4.12 security systems;
- 3.5.4.13 BAS system;
- 3.5.4.14 dimming systems to initiate emergency operations;
- 3.5.4.15 sound systems to mute in event of emergency paging;
- 3.5.4.16 genset control panel for annunciation of "Genset Running", " Failure", "Genset Battery Low Voltage" and "Genset Low Fuel";
- 3.5.4.17 devices as shown on drawings.

3.5.5 Provisions for elevators to include but not be limited to following:

- 3.5.5.1 minimum three (3) dry contacts, one for connections to smoke detectors in lobbies, machine rooms and hoisting, one for connection to smoke detector activated at designated return landing; and one auxiliary contact for use as confirmed with Division 14;
- 3.5.5.2 conduit and wiring from fire alarm control panel to each elevator;
- 3.5.5.3 controller; confirm exact requirements with Division 14.

- 3.5.6 Interconnect fire alarm system to security system to provide a common "Alarm" signal to security system controls to release locked doors (designated by Owner) throughout the building on any or designated alarm condition. Interconnections between local fire alarm manual pull stations and local security system components door hardware to be provided in this manner. Coordinate work with respective system vendors and door hardware trade. Provide manual control switches for release and reset and mount onto control panel. Clearly label operators. Comply with local governing authorities regarding these requirements. Coordinate with General Contractor to obtain required Certificates of Approval for Work.

3.6 Additional Requirements

- 3.6.1 Install wiring in conduit unless otherwise approved by Consultant. Perform wiring connections associated with fire alarm 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. Paint conduit couplings red of paint type suitable for application to standards of Division 09.
- 3.6.2 Install wiring in accordance to requirements latest edition of applicable governing electrical code and to requirements of local governing authorities.
- 3.6.3 Run alarm indicating circuits (speakers) and alarm receiving circuits (pull stations, detectors) in separate conduits from each other.
- 3.6.4 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.
- 3.6.5 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.
- 3.6.6 Verify nomenclature of annunciator identification with Consultant and obtain necessary approvals prior to ordering.
- 3.6.7 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above a pull 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.
- 3.6.8 Refer to drawing riser diagram and connection schedules. Quantities of components to be as per floor plans and not riser diagram.
- 3.6.9 Confirm exact location of components prior to roughing-in.
- 3.6.10 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

3.7 Testing, Verification and Certification

- 3.7.1 Submit to Consultant for approval, proposed schedule for testing and verification of system. Obtain such approvals prior to start of testing. Refer to Division 00 and 01 for phasing requirements. Where areas of Work are to be phased construction and Owner requires to take occupancy, include for testing, verification and certification at each phase completion of Work, as required by local governing authorities. After completion of Work of last phase, include for total overall system testing, verification and certification of system.
- 3.7.2 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 seven (7) working days in advance of testing.
- 3.7.3 Include for fire alarm 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. Work to include but not be limited to following:
- 3.7.3.1 to ensure that type of equipment installed is that designated by Contract Documents;
 - 3.7.3.2 to ensure that wiring connections to equipment components show that installer observed ULC and CSA requirements;
 - 3.7.3.3 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;
 - 3.7.3.4 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;
 - 3.7.3.5 to ensure that sequence of operation is in accordance with specified building sequence of operation and any modifications identified on documents and are approved by local fire authority;
 - 3.7.3.6 to ensure that devices are commissioned and operable.
- 3.7.4 System manufacturer to also be responsible for but not be limited to following:
- 3.7.4.1 confirm that connections to security system and third party monitoring party are in accordance with CAN/ULC-S561;
 - 3.7.4.2 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;
 - 3.7.4.3 verify fire alarm system on a zone by zone basis, and also verify entire system in whole, at completion of installation;

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- 3.7.4.4 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 24 hours 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 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;
 - 3.7.4.5 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;
 - 3.7.4.6 full review, testing and verification of operation of integrated systems such as elevators and their emergency sequence of operation, 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, pre-action sprinkler system, and any other integrated components; coordinate requirements with trades responsible for integrated components and systems who will be present at time of testing and verification work;
 - 3.7.4.7 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 intelligibility requirements of local governing building code and is approved by local fire authority;
 - 3.7.4.8 assist in Testing and Verification of electromagnetic door locks to meet requirements of authorities having jurisdiction and to obtain overall approval of installation;
 - 3.7.4.9 coordination with Electrical Divisions and local fire authority to provide requirements needed to obtain certificates of approvals from local fire authority;
 - 3.7.4.10 provide full detailed test sheets of tested components and provide certification that system 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.
- 3.7.5 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.
- 3.7.6 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.
- 3.7.7 Obtain from local fire authority required certificate of approval of system and forward to Consultant.
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- 3.7.8 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.
- 3.7.9 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.
- 3.7.10 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.
- 3.7.11 Unless approved in writing by Consultant and Owner, do not use open flame and/or smoke for testing.
- 3.7.12 Testing technician to be certified and approved for fire alarm system testing by Canadian Fire Alarm Association (CFAA) and local Fire Marshall as applicable.

End of SECTION