1.0 GENERAL

1.1 Related UBC Guidelines

.1 Section 01 78 39 Project Record Documents
.2 Section 01 78 23 Operation and Maintenance Data
.3 Divisions 8, 10, 14, 20, 21, 23, 25, 26, 27, 28, 32, 33

1.2 Co-ordination Requirements

.1 UBC Energy & Water Services (Vancouver)
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Information Technology (IT)
.4 UBC Facility Management (Okanagan)

1.3 Description

.1 General requirements for all Division 26.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General

.1 The contractor is responsible for and keeps one complete set of white prints, including revision drawings in the job site, office.

.2 Construction Power
  .1 (Vancouver) The temporary power service includes a consumption meter. The connection point and voltage for the construction power will be determined by UBC Energy & Water Services.
  .2 The Contractor shall pay for all materials and installation of equipment for the provision of construction power.
  .3 The Contractor shall pay for all utility consumption until the building is turned over to UBC.
  .4 (Vancouver) The Contractor must contact UBC Information Technology for coordination and installation of temporary telecommunications cabling.

  UBC Information
  Technology IT Plant
  Coordinator
  Phone: 604-822-8659
  http://web.it.ubc.ca/forms/network

2.2 High Voltage Vaults *and Service Rooms*

.1 (Vancouver) All high voltage vaults shall have a floor drain and containment curbs.

.2 Housekeeping pads shall not extend beyond 100mm (4”) from the mounting frame of any electrical equipment within service rooms.

.3 Main electrical distribution and life safety related equipment (ie: Generators, Transfer Switches, Central Inverters, Fire Alarm Panels) shall be located in electrical room(s) on or above grade level where practicable.

.4 Main electrical rooms shall not be located more than 2 meters above grade.

2.3 Electrical Receptacles for Specific Purposes

.1 Provide duplex electrical receptacles of CSA spec 5-20 for custodial use at each floor level and near the doorway in each stairwell.

.2 Provide at least one convenience duplex electrical receptacle of CSA spec 5-20 in each electrical room, connected to standby power if available.

.3 A 120V Class A GFCI receptacle is required when the receptacle is located within 1m of any basin in kitchenettes and washrooms.

.4 Exterior receptacles are only permitted to be installed on the exterior of a building. Exterior receptacles located in site furnishings, trees/greenery and in floor are not permitted.

.5 Provide Mechanical rooms with CSA spec 5-20 receptacles in areas where operations and maintenance activities will be performed. At minimum 1 receptacle is required per wall.

.6 Receptacles with proprietary quick connectors are not permitted to be used.

.7 Red coloured receptacles shall be utilized for receptacles on standby (non-life safety) power.

2.4 General Installation

.1 The installation shall be installed in a manner that is conducive with quality workmanship. Exposed wiring that is visible in common areas shall be installed square and true to other areas and installations.

.2 All Electrical Rooms shall be designed in accordance with the requirements outlined in 10 00 10 Special Room Requirements 1.7 Electrical Room.

.3 Adequate unobstructed wall space shall be provided in all electrical rooms to permit the installation of new (future) equipment and shall not be less than *1.2 m* x wall height.

.4 The designer shall coordinate with the architect to ensure that all electrical and life safety equipment that is installed shall be readily accessible for maintenance, replacement and repair without the use of tools to remove building finishes such as decorative ceiling panels.

.5 Connection to existing services and street lighting circuits shall be included in detail on the IFC drawing set and shall be coordinated by the Project Superintendent at least 30 days before connection date.

.6 Do not install flush mounting boxes back-to-back in walls; provide minimum 150 mm horizontal separation. Provide minimum 600 mm separation in acoustic rated walls.

.7 Pull boxes shall be installed in locations that are easily accessible by maintenance personnel. Placement shall take into consideration the ease of removing panel(s)

and the potential of interference with other systems if access to either is required.

.8 No electrical equipment shall be masked by architectural finishes, furniture, artwork, bulletin boards or other similar items that would delay identifying their location in an emergency.

.9 For all Pathway installed for other Divisions systems, please consult that Divisions Guidelines as there can be specific requirements and or restrictions for performance reasons that could supersede code minimums.

.10 Electrical equipment shall not be abandoned in place and must be removed as part of the project.

2.5 Project Record Drawing Requirements

.1 The contractor shall be responsible for and keep one complete set of white prints, including revision drawings at the job site.

.2 The contractor shall deliver to the consultant at “substantial performance” one complete set of white prints, showing by colored lines and suitable notation all work as installed, together with sizes and routes of electrical service lines installed, relocated or adapted under this project. The contractor shall maintain a current record, as the job progresses, of any deviations from contract drawings. Manholes, pulling pits, etc. shall be located at the center lines, by co-ordinates, on a grid system shown on the site plan. Locations and levels shown on plans must be accurate to within 12 mm.

.3 (Vancouver) Approval for backfilling of underground services will not be given before the UBC Energy & Water Services is satisfied that the exact location of the underground service has been surveyed and recorded. The contractor must employ a qualified surveyor to record the horizontal and vertical location of underground services. This survey information is to be shown on the project record drawings and must indicate the location of all buried services, as well as, those capped or exposed by the work of this contract.

.4 Project Record White prints shall be delivered to the consultant at "substantial performance" in accordance with Division 01 General Requirements.

.5 For final Record Drawing submission, refer to Section 01 78 39 Project Record Documents.

.6 At time of energization of any new electrical installation a one line drawing shall be posted in the main electrical room.

.7 Upon handover of the electrical systems the project team will be responsible for providing passwords for all applicable equipment to UBC Facilities Electrical.

2.6 Electrical Operating and Maintenance Manuals

.1 For detailed requirements, refer to Section 01 78 23 Operation and Maintenance Data.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 26, Section 33 71 00 Electrical Utility Transmission and Distribution
.2 Division 10, Section 1 Room Requirements
.3 Divisions 27 and 28

1.2 Coordination Requirements:

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Energy & Water Services (Vancouver)
.3 UBC Information Technology
.4 UBC Facilities Management (Okanagan)

1.3 Description

.1 UBC requirements for the Design Development Documents for Division 26.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General Requirements

.1 Engaged Consultants supplies the University at the preliminary stage of the building project, a Development Brief which contains information listed below:

.1 Preliminary drawings clearly defining scope of work and equipment details.
.2 Specifications of all electrical systems and equipment.
.3 Power Riser Diagram.
.4 One Line Diagram.
.5 Fire Alarm Riser Diagram.
.6 Building area access routes for service of installed systems.
.7 Emergency Lighting System equipment details.

2.2 Off Site and Site Services

.1 Through discussion with UBC Energy & Water Services (Vancouver) / UBC Facilities Management (Okanagan) the Design Development Brief shall include:

.1 Underground duct system tie-in to existing duct or manhole.
.2 Expected peak demand, in KVA.
.3 Manhole size and approximate location, drainage provision.
.4 Number, size and type of power cables and neutral.
.5 Number of ducts in each duct bank.

2.3 Building Service

.1 The Design Development Brief shall include the following Building Service information:

.1 Size and location of main electrical and sub electrical rooms and distribution centers.
.2 Power switching components.
.3 Power transformer types and sizes.

.4 Secondary voltages.
.5 One line diagram including secondary distribution board, sub distribution centers, motor control centers, and risers.

2.4 Other Services

.1 The Design Development Brief shall include the following other information:

.1 Fire alarm and building alarm components and supervisory equipment.
.2 Communication rooms size and location.
.3 Other services to be provided such as clocks, bells, telephone/data outlets, TV outlets, closed circuit television system, P/A system, emergency lighting and standby generator.

2.5 Construction Power

.1 The Consultant obtains from UBC Energy & Water Services (Vancouver) / UBC Facilities Management (Okanagan), the location and voltage level for construction power.

.2 The Design Development Brief shall include the following construction power information:

.1 The Consultant provides in his design, a drawing showing the basic equipment and wiring for the service.

.3 Construction power consumption and all associated equipment and installation material and labour shall be paid for by the project.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 26
.2 Division 27

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Facility Management (Okanagan)

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 Wiring exposed to excessive vibration (i.e. generators) shall be copper and type SIS.

.2 Components used to fasten, mount or secure electrical equipment and cables outdoors or in other corrosive locations shall be suitable and rated for such.

.3 Drilling is the only permitted method for mounting of electrical equipment. Powder actuated methods are not permitted.

.4 Permanent motors are required to be hardwired. Cord connected motors are permitted with limited exception where industry standard and hardwired connection is uncommon such as: condensate pumps, glycol tanks with pump and alarm and fractional motors for fans.

.5 Electrical equipment that is designed by the manufacturer to be surface mounted on vertical surfaces containing pushbuttons, switches or doors shall not be horizontally mounted in ceiling spaces.

.6 Stored energy devices are not permitted to be installed above ceiling tiles or architectural panels.

.7 Boxes and conduit cannot be installed in locations that are easily susceptible to mechanical damage by users.

.8 The point of supply for any specialized piece of equipment must be short as practicable. For cord connected equipment the use of extension cords is not acceptable when determining the point of supply.

2.2 Receptacles

.1 The maximum general use duplex receptacles per circuit shall be installed as per the following:
  .1 Offices: 3 5-15R or 5 5-20R.
    .1 Circuits may not be shared between adjacent offices.
    .2 Designers should allow for 500W motorized desk in a workstation space circuited to general receptacles noted above.
  .2 Meeting/Conference Rooms: 4 5-15R
  .3 Break / Printer Rooms: 4 5-15R

.1 Copiers and other equipment rated at over 1000W require a dedicated circuit.
.2 Multi-function printers require a dedicated 5-20R
.4 Reception Areas: 3 5-15R or 5 5-20R
.5 Kitchen/Kitchenette Countertop Areas: 15-20R
.6 Washrooms: 2 5-15R
.7 Locker/Shower Room: 2 5-15R or 3 5-20R
.8 Service Rooms: 2 5-20R
.9 Study Carrells: 8 5-15R
.10 Study Rooms: 4 5-15R
.11 Corridors / Lobbies / Atrium: 4 5-15R
.12 Laboratories: 3 5-15R or 4 5-20R
.1 Equipment rated at over 1000W require a dedicated circuit.
.13 Lecture Hall / Auditorium: 9 5-15R
.14 Classroom: 4 5-15R
.15 Gymnasium/Recreation/Exhibition Rooms: 4 5-15R
.16 Building Exterior: 2 5-15R
.17 E-Bike receptacles in Bicycle Rooms: 6 5-15R

.2 The minimum quantity of general use duplex receptacles is required in the following spaces based on 3 meter spacing between receptacles on usable wall space:
.1 Dry and Wet Laboratories
.2 Classrooms

.3 The quantity of receptacles in Bicycles Rooms containing e-bikes shall be a determined using 25% of the total bicycle capacity in the space. Example: 100 Bikes → 25 Bikes → 13 duplex receptacles.

.4 The maximum size receptacle for cord connected equipment is 60A. Locking receptacles are required for 30A and above

.5 Red coloured receptacles are required for receptacles on standby (non-life safety) power

.

2.3 Floor raceway systems:

.1 On floor raceway systems shall employ an outside the wall configuration. For power only applications connections shall be made to standard wall receptacles if a manufacturer option exists. Otherwise, a direct connection may be utilized mounted at the same height as receptacles in the space. For mixed power and A/V applications connections shall be made to an outside the wall box to allow for ease of repair/replacement of the system without any modification to architectural finishes.

.2 Power and A/V are the only systems permitted to utilize a on floor raceway system. Voice and Data is not permitted and must adhere to the requirements outlined in Section 27 05 28.

.3 Pre-wired track systems comprised of modular interconnecting raceway segments are not permitted.

2.4 In floor systems:

.1 Poke through floor boxes is the default method for in floor systems. Cast in place system may only be utilized when technical challenges are present with poke through boxes. 4" round is the standard size that shall be utilized.

.2 4” round floor boxes utilizing 1 or 2 gangs shall have covers utilizing side hinged opening flip lids. Covers with a top or bottom hinged opening flip lid that open the entire round cover are not acceptable.

.3 Floor boxes shall be sized appropriately for the application. Usage of large capacity floor boxes in applications where they are underutilized and oversized is not acceptable.

.4 Where receptacles are required to be separately mounted within floor boxes, the mounting depth shall not exceed 50mm below finished floor.

2.5 Boxes:

.1 The following values shall supersede the requirements of CEC Table 22 Space for insulated conductors in boxes:
14 AWG - 30.8mL
12 AWG – 35.9mL
10 AWG – 46.1mL
8 AWG – 56.4mL
6 AWG – 92.1mL

.2 4 11/16" boxes shall not be used as pullboxes and shall only be used when required for a specific device.

.3 A gutter box is required for all new panelboards. The box shall be located at a typical of 600mm from the panelboard and can be located on the top or bottom depending on installation requirements. A minimum of 4 – 2” conduits are required between the panelboard and box.

.4 The maximum amount of extension rings that be utilized per application is 1.

2.6 Raceways:

.1 Cable ties are not permitted for supporting conduit or armoured cable.

.2 Raceways shall not be permitted to be utilized as support for other raceways or armoured cables.

.3 The maximum conduit fill % for 3 or more conductors shall not exceed 32%.

.4 All EMT conduit runs exposed to weather shall contain supplementary bonding conductors sized in accordance with the CEC. EMT shall not be used as the bonding method.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Energy & Water Services (Vancouver)

1.2 Description

.1 The University owns and operates the power system consisting of 60 KV and 12 KV overhead and underground lines. Two 60 KV lines feed two substations: one located in the South Campus, and one in the Main Campus. The Main Substation supplies a 12 KV indoor and outdoor switching station.

.2 The 12 KV systems are distributed underground in a combined duct and manhole system which serves throughout Main and South campuses. The 12 KV systems are nominally rated at 12,480 volts, 3 phase Wye System, low resistance grounded. The design limits are Basic Impulse Level 95 KV and Design Fault 300 MVA Symmetrical.

.3 The power distribution is a Dual Radial System with 500 KCM 15 KV single conductor cable for 12 KV System. For a General Distribution diagram of the 12 KV feeders, refer to Standard Drawing No. E1-1.

2.0 MATERIAL AND DESIGN REQUIREMENTS

.1 All new buildings, UBC Renew projects and any major additions to existing buildings shall be supplied from the 12 KV systems. 12KV main feeds shall NOT be fed as an interconnection from other buildings (“daisy-chaining”). Interconnection might compromise the research in both buildings, should a problem occur.

.2 Any major renovation adding electrical loads to an existing building that exceeds 300kW must discuss with UBC Energy & Water Services prior to design submission to ensure available system capacity. There are no exceptions.

.3 Any request for variance, such as where small buildings are concerned, must be reviewed with Building Operations Electrical Technical Support.

.4 Refer to Standard Drawing No. E1-1 attached as Appendix "A" in regard to the supply feeders into each building.

.5 Note that a ground of equivalent size (in general a 4/0) shall be installed to each building switch room. This ground conductor shall tie into the existing ground system and also be connected to an accessible ground bus on which all equipment and service grounds are to be terminated. Provisions shall be made for at least two spare connecting points for additional grounding, other than for the Telephone Company, fire alarm, etc.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Energy & Water Services
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Facilities Management (Okanagan)

1.2 Description

.1 UBC requirements for Protective Device Coordination and Arc-Flash Analysis for AC or DC electrical equipment.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 The engaged consultant shall review and validate the short circuit analysis and protective device coordination studies as prepared by the equipment manufacturer for all electrical protective devices to verify each device can safely withstand and interrupt the available fault currents.

.2 (Vancouver) Utility information shall be provided, upon request, to the consultant or equipment manufacturer by UBC Energy & Water Services

.3 Coordination information shall be shown on a graphical chart in log-log format for all applicable low voltage devices and for all devices used for Medium Voltage protection. All device settings shall be indicated either on the chart or accompanying the chart.

.4 The maximum allowable Arc Flash Hazard category for any part within Medium Voltage unit substations shall not exceed level 2 (8 cal/cm^2) as per Section 26 11 13 Primary Unit Substations, 2.1.9 and 2.13.

.5 The engaged consultant shall review and validate the Arc Flash hazard analysis for all applicable components of the project's electrical distribution system per CSA Standard Z462.

.6 The engaged consultant shall ensure that every effort is given to minimize the Arc Flash Hazard category while maintaining selective device coordination. Reduce distribution transformer sizes or incorporate circuit breakers with LSI capabilities to achieve a maximum of 8 cal./cm sq. at all switches, circuit breakers and MCCs.

.7 The Arc Flash hazard analysis shall clearly indicate the Incident Energy, Arc Flash protection boundary and Hazard Category for each applicable device.

.8 All documentation shall be in colour and provided in soft copy PDF format. Scanned copies shall not be permitted.

.9 All applicable equipment shall have Arc Flash Hazard labels affixed as required in Section 26 10 00 Secondary Power Distribution, 3.0.

.10 A copy of the model shall be provided to UBC Facilities Electrical after the final report has been issued. The files provided shall be in the default ETAP or SKM format.

END OF SECTION

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 26

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Energy & Water Services (Vancouver)
.3 UBC Facilities Management (Okanagan)

1.3 General

.1 The University has adopted a series of standards covering various electrical components such as manholes, duct systems, lighting poles, etc.

.2 These Standard Drawings can be found in this PDF document.

.3 Wherever applicable, these standards shall be used on University work.

.4 Any electrical civil standard not listed below shall be performed to MMCD and CEC specifications.

1.4 Index to Standard Electrical Drawings

AutoCAD files can be found on the Technical Guidelines website under Division 26.

Drawing No.	Description
E1-1	Single line diagram. Distribution systems 12 KV dual radial feeders typical building supply (Vancouver)
E1-2	Electrical unit substation one line diagram (Vancouver)
E1-2b	Electrical outdoor unit substation one line diagram (Vancouver)
E1-2c	Outdoor substation general layout (Vancouver)
E1-3	Electrical unit substation key interlocks (Vancouver)
E1-4	Typical electrical room layout (Vancouver)
E1-5	Jurisdictional block diagram (Vancouver)
E1-6	Unit substation feeder transfer control box (Vancouver)
E2-1	Standard concrete-encased electrical ductbank (Vancouver)
E2-2	Standard electrical service conduit directly buried (Vancouver)
E2-3	Standard electrical ductbank concrete encased (Vancouver)
E2-4a	Electrical ductbank clearances to DES Hot Water Lines (Vancouver)
E2-4b	Electrical ductbank clearances to DES Hot Water for 600 volts or less (Vancouver)
E2-4c	Electrical ductbank clearances to DES Hot Water for 12,000 volts or less (Vancouver)

Drawing No.	Description
E3-1	Standard electrical precast manhole (Vancouver)
E3-2	Standard electrical manholes pour in place (Vancouver)
E3-3	Additional reinforcing for pour in place electrical manholes (Vancouver)
E3-4	Standard electrical manhole cover and riser details (Vancouver)
E3-5	Standard electrical manhole sump detail (Vancouver)
E3-6	Typical manhole grounding and details (Vancouver)
E3-7	Typical manhole separations (Vancouver)
E3-8	Standard Manhole Cable Support Detail (Vancouver)
E4-1	Cable identification tags 12 KV (Vancouver)
E4-2	Mounting and shield grounding details for splices between 2 (or more) 15 KV 'X' - Link 500 MCM & 4/0 cables (Vancouver)
E4-4	Schneider Electric PM8240 meter 120/208V, 3 phase, 4 wire system. 3 element wiring connection diagram (Vancouver)
E4-5a	Schneider Electric PM8240 meter 347/600V, 3 phase, 4 wire system. 3 element wiring connection diagram (Vancouver)
E4-5b	Schneider Electric PM8240 meter 600V, 3 phase, 3 wire system. 2 element wiring connection diagram (Vancouver)
E4-5c	Setra Networked Multi-circuit power meter 208V or 600V wiring connection diagram, 4-wire system (Vancouver)
E4-5d	Setra Networked Multi-circuit power meter 600V wiring connection diagram, 3-wire system (Vancouver)
E4-6	Water and gas meter integration into electrical metering system, tenant and core buildings (Vancouver)
E4-6c	District Energy System Metering ION Network Interface (Vancouver)
E10-2	Interior Wiring Systems, Standard Transformer and Panel Identification
E11-1	Fire Alarm System Monitoring Equipment Installation
E12-1	Exterior Lighting and Receptacle Control

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Energy & Water Services
.2 UBC Facilities Electrical

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 Performance Standards

.1 High Voltage Cable shall comply with the requirements of the most recent edition of:
  .1 I.P.C.E.A. S-66-524/NEMA WC7.
  .2 CSA C68.3.

2.2 U.B.C. Power System Characteristics

Voltage	12480V
Phases	3
Wires	3
Frequency	60 Hz
System Neutral	Low resistance grounded 100A, 10 sec, 7.2 KV, 72 ohms
Available short circuit capacity	Maximum 300 MVA, 13.9 kA

2.3 Detailed Cable Specifications

Insulation	220 mil ethylene-propylene (EPR) insulation (133%), suitable for continuous operation at 105C conductor temperature, emergency conditions at 140C and 250C for short circuit conditions.
Shield	Metallic: 5 mil bare copper tape with 100% coverage and a minimum of 12.5% overlap.
Conductor	ASTM Class B soft bare copper, compact stranded.
Size	Building Services: 1 Conductor - 4/0 AWG per phase
	Feeders: 1 Cond. 500 KCM per phase
Construction	Solid plastic
Jacket, Outer	PVC
Rated Voltage	15 KV

2.4 Applicable Manufacturers

.1 Aetna Insulated Wire Company.
.2 Phillips Cable.
.3 Prysmian Cable.
.4 Alcatel.
.5 Okonite
.6 Southwire
.7 All substitutes shall be pre-approved by UBC Energy & Water Services.

2.5 UBC Underground Duct System Consideration

.1 All cables will be pulled into underground duct systems constructed to UBC Standards.

.2 The duct system is not waterproof and the cables may be immersed in water for long periods of time.

.3 Ducts are to be constructed as per UBC Standard Drawings E2-1, E2-2 and E2-3.

2.6 Ground Wires

.1 Grounding conductors shall be installed to UBC standards and as required by the Code. Specify wire size 4/0 and 500 kCM.

2.7 High Voltage Cable Termination

.1 High voltage cable terminations shall be Elastimold #K656 BLR 600 amp series only, unless otherwise specified.

.2 Termination cable kit shall match conductor insulation diameter for 500 kCM or 4/0 conductors.

.3 Refer to UBC Standards Drawing # E4-2.

2.8 Interruption of Services

.1 Shut down for any 12 KV circuits must be requested 4 weeks in advance of the actual shutdown date.

.2 At any time no more than one 12 KV circuit can be shut down.

2.9 Manhole Access

.1 Permission to access any utility manhole must be coordinated and approved by UBC Utility Department. A Manhole Entry Permit must be approved before entry.

.2 Entry into any manhole must be made in the company of UBC Utility personnel.

2.10 Safety Standards

.1 All work within a utility manhole shall comply with WorkSafeBC confined space access requirements.

2.11 Labeling

.1 Feeder labels to be installed around feeders at cable heads, stress cones, manholes, pull pits, etc. Refer to UBC Standard Drawing E4-1.

.2 Feeders revised from existing circuit arrangements shall be relabeled at all “downstream” locations such as manholes, pull pits and building switchgear.

2.12 Testing

.1 Tests to be performed using qualified personnel. Provide necessary instruments and equipment.

.2 Perform Hi-pot testing of cable at a voltage level not exceeding cable rating on the original reel at the UBC site. Failure to comply will void the factory warranty and the installation will be at the Contractor's risk.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check insulation resistance after each splice and/or termination to ensure that the cable system is ready for acceptance testing.

.5 Acceptance Testing

.1 Ensure terminations and accessory equipment is disconnected including ground shields, ground wires, metallic amour and conductors not under test.

.2 UBC Energy & Water Services shall perform installed cable acceptance tests on all new cable installations using VLF testing equipment. All tests performed to NETA specifications.

.3 Review test with the Engineer before proceeding.

.4 Provide Engineer with list of test results showing location at which each test was made, circuit tested and result of each test.

.5 Remove and replace entire length if cable fails to meet the test criteria. Contractor will be responsible for the cable and installation costs to replace damaged cable.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Divisions 20 to 28

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Facilities Management (Okanagan)

1.3 Description

.1 UBC Requirements for Wire and Cables (0-1000 V).

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General Requirements:

.1 Wires shall be copper throughout with R90 XLPE 90°C insulation. Minimum wire size shall be #12 AWG except for control wire. Wires #12 AWG and larger shall be stranded. #14AWG conductors shall be an acceptable minimum size if no part of the conductor is installed outside of the Student Housing and Community Services residential suite it services.

.2 Color shall be impregnated in the insulation for wire #3 and smaller. Larger wire shall be clearly identified with colored vinyl tape at both ends and at all splices for large wire.

.3 Control wiring shall be clearly identified if AC or DC.

.4 Color coding for motor control wiring shall reflect accepted industry standards, but be sized no smaller than #18.

.5 Wiring installed in underground ducts installed outside of building footprint (i.e. Building Services, Distribution or Lighting) shall be copper, RWU rated, XLPE.

.6 Splicing is only permitted for Normal and Standby conductors. Splicing is not permitted for Emergency and Life Safety conductors.

.7 Shared neutrals is not permitted between 2 or more circuits. The only exception where shared neutrals is permitted is for lighting circuits. Proper labelling must be applied to ensure clear identification of shared neutrals for operations staff.

.8 For splicing of conductors long barrel compression connectors with water-tight heatshrink must be utilized. Raychem or UBC Facilities Electrical approved equivalent.

.9 The largest conductor size that may be utilized is 500 MCM.

2.2 Raceway Requirements:

.1 Raceways are required for all installations and cannot be substituted with armoured cable.

.2 The following raceways are acceptable for use:
  .1 EMT Conduit – ¾" minimum size
  .2 Rigid PVC Conduit

.3 Rigid Metal Conduit.
.4 Surface Metal Raceway. It is preferred to utilize surface raceway in renovation projects where EMT may prove problematic due to limits of existing finishes.

.3 The following raceways are not acceptable for use:
.1 ENT Conduit.
.2 Non Metallic Raceway.

.4 Flexible conduit shall not be used as a general purpose raceway. The conduit shall not be less than 300mm and greater than 750mm.

.5 An additional conduit matching the largest utilized size, shall be provided for all building power feeds, power sub-feeds, and all electrical systems requiring inter-building connections.

.6 Conduit or cables entering boxes or equipment located in outdoor environments shall be bottom entry.

.7 Utility High Voltage conductors run within buildings shall be installed in rigid steel conduit unless encased in no less than 50mm of concrete and clearly marked with embedded brass plate indicating danger, voltage and burial depth.

2.3 Armoured cable may only be used for the following:

.1 Drops to individual luminaires and shall have a maximum length of 1.5m (5'). Daisy-chaining of luminaires is not permitted.

.2 Final connection to motors, transformers or vibrating equipment to a maximum length of 3m. Cable shall be run neatly, not secured to heat emitting mechanical systems and secured using mechanical fasteners not cable ties.

.3 Armoured cable is not permitted for final connections to receptacles.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Divisions 26 and 28
.2 Division 27 Section 27 05 26 Grounding and Bonding for Communications Systems

1.2 Coordination Requirements

.1 UBC Energy & Water Services (Vancouver)
.2 UBC Information Technology
.3 UBC Facilities Electrical (Vancouver)
.4 UBC Facility Management (Okanagan)

1.3 Description

.1 UBC requirements for Electrical Grounding.

2.0 MATERIALS DESIGN REQUIREMENTS

2.1 Grounding

.1 General
- .1 Grounding conductors shall be installed as required by the latest edition of the Canadian Electrical Code. In all cases the material shall be copper.
- .2 From the neutral ground position of each transformer, a grounding conductor shall be extended to the UBC system ground bus.
- .3 Ground wires for ground electrodes in 600V systems or lower may be sized as per Canadian Electrical Code, latest edition. Ground wires to ground electrodes for high voltage systems shall be #4/0 copper. All ground wire shall be tested for continuity. Record each continuity test and include in ground system report.
- .4 In all buildings with 600V distribution a system ground bus shall be installed in each Electrical Room housing a Distribution Centre rated 400A or larger or a transformer 15kVA or larger.
- .5 Insulated ground wires shall be utilized for all applications.
- .6 Unit substation and pad-mounted transformers servicing buildings shall have a ground grid.

.2 Ground Rods
- .1 Ground rods shall be 3/4" x 10' copper clad ground rods.

.3 Ground Fittings
- .1 Ground connections shall be made with compression fittings that are CSA approved for grounding.
- .2 Ground grid connections for buried ground grid splices shall be CSA approved compression connected.
- .3 All ground connections shall be labeled. The label shall contain at minimum the type of equipment grounded, location of the equipment and equipment name as identified on the single line diagram.

2.2 Bonding

.1 General
- .1 An additional bonding conductor is required for equipment when a raceway is installed as per the following:
  - .1 EMT in exterior, non-conditioned and uncovered locations.
  - .2 EMT is installed in slab for part or all of the run.

.2 Telecommunications Bonding
- .1 Please refer to 1.1.2 Section 27 05 26 Grounding and Bonding for Communications Systems for specialized telecommunications bonding requirements.

.3 Fire Alarm Bonding
- .1 Please refer to Section 28 31 00 Fire Detection and Alarm for specialized Fire Alarm systems bonding/grounding.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 26

1.2 Coordination Requirements

.1 UBC Energy & Water Services
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Facility Management (Okanagan)

1.3 Description

.1 UBC seismic requirements for Electrical Equipment.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General

.1 Submit a detailed and sealed report from Structural Engineer of record who shall also ensure the specified restraint system has been installed.

.2 All electrical equipment shall be seismically secured in compliance with BC Building Code.

.3 All secondary distribution transformers shall incorporate vibration isolation reviewed and approved by the structural engineer.

2.2 Transformer and Unit Substation Seismic Support

.1 The Substation Manufacturer shall have a Seismic Engineer design and select, the seismic restraint system.

.2 Structural Engineer of record shall ensure the floor is sufficiently thick for the required bolting and that the specified restraint system has been installed.

.3 For substations located on grade on slab, mount core and coil assembly on bridge bearing neoprene Super 'W' pads, and provide hemi grommets for each bolting location designed to suit system. Alternatively, if substation is located on a suspended floor above grade, mount core and coil assembly on Lo-Rez spring isolators designed to suit system and provide separate seismic snubbers for use with springs.

.4 Supply chemical bolts for securing the transformer.

.5 Submit bolting requirements for all substation cubicles.

.6 Acceptable manufacture of seismic restrain system is Mason Industries.

.7 Provide flexible braid connections at transformer line and load connections. Cable connections are not acceptable.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Section 26 05 06 Standard Drawings

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Energy and Water Services (Vancouver)
.3 UBC Facility Management (Okanagan)

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 Labeling Requirements

.1 Feeder labels to be installed around feeders at cable heads, stress cones, manholes, pull pits, etc. Refer to Standard Drawing E4-1.

.2 Feeders revised from existing circuit arrangements shall be relabeled at all 'downstream' locations such as manholes, pull pits and building switchgear.

.3 Engraved lamacoid nameplates with the name of the load shall be installed on breakers or switches at the switchgear cubicles and elsewhere where called for on the drawings.

.4 Nameplates shall be securely fastened and screwed or riveted.

.5 Exterior cubicle nameplate dimensions shall be engraved brass 4" x 1 ½" black lettering.

2.2 Labeling General

.1 Labelling is required for any electrical equipment rated at 20kW and above.

.2 Junction Boxes
  .1 Junction boxes in visible areas shall be labeled with machine printed material. The label(s) shall consist of Panel #, Cct #(s), FA zone #, etc.

.3 Disconnects
  .1 Disconnects (Non Fused/Fused/Breaker) shall have a firmly affixed lamacoid label indicating the following (as applicable):
    1. Downstream device tag #
    2. Disconnect maximum rating
    3. Fuse/Breaker rating

  .2 If a VFD is upstream of the disconnect an additional label must be placed stating the following: Disconnect shall not be operated until motor has been verified to be disengaged at the VFD.

.4 Labels Outside
  .1 Labels located outside shall be of the engraved lamacoids type and be affixed with UV or corrosion resistant ties.

.5 Equipment and Devices
  .1 All equipment and devices shall be labeled with their tag # first and if this is not available the circuit #, IP address or Zone shall be labeled with machine printed material. Examples of the equipment and devices that shall be labeled:
    1. Receptacles
    2. Light switches
    3. Motors / Pumps
    4. AHU's
    5. Heaters
    6. Equipment specific to the area
    7. Fire Alarm System field devices
    8. Unit Equipment

2.3 Distribution Equipment and Panel Board Identification

.1 Panel Boards, Load Centers and Transformers shall be labeled and identified in accordance with Standard Drawing E 10-2 in all new buildings, UBC Renew projects and in any major additions to existing buildings.

.2 Secondary distribution equipment, such as Panel Boards, Load Centers and MCCs shall have conspicuously attached a permanent 2" X 4" Hazard Warning Label to meet OHSA and NFPA standards that clearly identifies:
  .1 Incident Energy
  .2 Arc Flash protection boundary
  .3 Hazard Category
    .1 Secondary distribution equipment that is identified as Hazard Category two or higher, the above label shall be 3.5" X 5"

.3 The following outline the color requirements for lamicoids at distribution equipment:
  .1 Utility Power:
    1. Black with White Letters

  .2 Generator Power:
    1. Single generator with 1 transfer switch (Life Safety and Standby / Life Safety only loads):
      1. ATS (Red with White) → Main EM distribution (Red with White) → Downstream distributions (Red with White)
    2. Single generator with 1 transfer switch (Standby only loads):
      1. ATS (Yellow with Black) → Main EM distribution (Yellow with Black) → Downstream distributions (Yellow with Black)
    3. Generator(s) with 2 or more transfer switches:
      1. Generator Main Distribution (Red with White)
      2. ATS and downstream distributions for Life Safety (Red with White)
      3. ATS and downstream distributions for Standby (Yellow with Black)
      4. ATS and downstream distributions for Data Center/IT Equipment/UPS/IT Exclusive loads (Blue with white)

  .3 UPS/Inverter power:
    1. UPS and Downstream Distributions (Blue with white).

2.4 Secondary Distribution Raceways and Cables Identification

.1 Raceways and cables for interior LOW VOLTAGE systems shall be identified in accordance with Drawing E10-1.

2.5 Concealed Equipment Identification

.1 BLUE colored dots shall be utilized for identification of concealed electrical equipment where removable panels/tiles exist. This includes but is not limited to:
- .1 Suspended T-Bar ceiling
- .2 Wall or Ceiling.

.2 Equipment Type:
- .1 Lighting Controllers
- .2 Electrical boxes

.3 Dot requirements:
- .1 Provide self-adhesive color coded dots 13 mm in diameter.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Facilities Electrical
.2 UBC Energy & Water Services

2.0 REQUIREMENTS FOR COMMISSIONING AND TESTING

2.1 Testing

.1 Unit Substation Factory Testing
- .1 Production tests: Perform all production tests listed in CSA Standard C22.2 No. 31 (current edition) and submit a detailed test report signed by the chief engineer or chief testing engineer.
- .2 Provide a production heat run test on the transformer to verify temperature rise.
- .3 Provide a factory sound level test for this transformer to verify transformer sound level. Submit copy of this test prior to shipping transformer.
- .4 Provide a three phase energization of transformer and switchgear at factory at both rated voltage and 110 % rated voltage. Verify that all meters and trip circuits function correctly. Consultant and UBC Utility Engineer shall witness the energization test.

.2 Unit Substation Tests
- .1 After manufacture, perform corona test to verify rating. A certificate signed by the Chief Testing Engineer shall be provided to verify the corona level and other production tests required by CSA C22.2 No. 31.

.3 High Voltage Cable
- .1 High voltage cables shall be tested as outlined in Section 26 05 05 High Voltage Cables.

2.2 Commissioning

.1 12 KV Unit Substation
- .1 Manufacturer shall provide on-site direction to the Contractor for reassembly of 12 KV unit substation.
- .2 Upon completion of reassembly, the manufacturer shall provide visual inspection to review and check all components for condition and correctness of installation.

.2 Vacuum and Cleaning
- .1 All electrical equipment tested shall be cleaned and left in first class condition.
- .2 Accumulated dirt and dust visible equipment shall be removed with high volume, low pressure blow-type vacuum.
- .3 Wiping shall be performed where required.
- .4 At completion of testing and cleaning, area around and adjacent to electrical equipment shall be cleaned and left in first class order.

.3 Insulators
- .1 Station insulators shall be inspected as follows:
  - .1 Clean and inspect insulators for chipped porcelains and radial cracks and foreign contaminants.
  - .2 Test insulators with DC high potential test set to the value specified by the manufacturer.

.4 Fuses
  .1 Fuses shall be inspected and checked as follows
    .1 Check fuse links for continuity.
    .2 Check fuse cartridge and holder for correct alignment and adjustments.
    .3 Inspect fuse mounting and grounding.
    .4 Inspect for spare fuses & report any set of fuses without spare back-up fuses.

.5 Interlocks
  .1 Verify system interlocking & labeling.

2.3 On-Site Testing – Switchgear Test

.1 Immediately prior to energization the Contractor shall make all arrangements and pay all costs of field testing, cleaning and calibrating of the following items.

.2 The on-site testing, cleaning and calibration shall be performed by qualified field personnel from the following companies, if required:
  .1 Wismer & Rawlings – Service Division.
  .2 Schneider Canada.
  .3 Prime Engineering.
  .4 Eaton Technical Services.
  .5 Or other approved testing firms.

.3 The tests and work to be performed are outlined as follows:

  .1 12 KV Unit Substation
    .1 Inspect all porcelain bushings and stand-off insulators for cracks, chips, dust, dirt and tightness.
    .2 Inspect the operation of each breaker in its cell; checking auxiliary contacts and all tripping devices.
    .3 Inspect and test overall grounding system.
    .4 Inspect all stress cones.
    .5 Test the insulation resistance of all bus using a DC Hi Potential test set. Measure current leakage of each phase to ground with all other phases grounded.
    .6 Inspect and tighten, if necessary, all connections.
    .7 Verify all C.T. characteristics.
    .8 CT saturation test.
    .9 Inspect the operation of each breaker in its cell; checking the racking mechanism and ground bus.

  .2 Breaker Remote Controls and Synch Check
    .1 Verify each breaker can remotely open and close when voltage is present.
    .2 Verify closed transition transfer between normal and alternate feeders and back.
    .3 Verify system lockout on attempted out of synch or dead bus closure for all combinations of phase orientation.
    .4 Verify time delay for all breaker close and rack in/out functions.
    .5 Verify no time delay for all breaker open functions.
    .6 Verify all pilot lights indicate correctly.

  .3 High Voltage Vacuum Circuit Breakers
    .1 Verify that cell electrical and mechanical interlocks function correctly.

.2 Remove the breaker from the cell, and check the tightness of all control wiring.
.3 Check motorized racking mechanism for operation and binding.
.4 Check power and control stabs.
.5 Check porcelain and insulating for cracks and holes.
.6 Open and close breaker to check for friction and binding.
.7 Manually rack in and close breakers and check contacts for alignment mating and wipe.
.8 Operate the breaker and check the operation of the assembly.
.9 Follow manufacturers' specifications for lubrication.
.10 Operate the breaker electrically.
.11 Verify mechanical emergency open function of breaker.
.12 Put the breaker in test position in the cell; operate the breaker using the control switch.
.13 Open the breaker by closing the relay tripping contacts.
.14 Insulation resistance test measurements from phase to phase and phase to ground.
.15 Pole resistance to be measured by a contact resistance test set.
.16 Supply copy of Fuse Coordinate Study to UBC Facilities Electrical.

.4 Protective Relays – Phase and Ground Protection
.1 Electrical Tests
.1 Zero adjustment.
.2 Pickup value test.
.3 Time current characteristic tests - two points on curve.
.4 Instantaneous element pickup test.
.5 Differential protection test.
.6 Target and seal-in unit operation test.
.7 Check all settings to the co-ordination study or setting data sheet.
.8 Prove tripping circuit via primary injection from C.T. terminals.

.5 Ground Fault Protection
.1 Check mechanical tightness of all electrical connections from the zero sequence or other ground fault C.T.'s.
.2 Verify settings as per co-ordination data.
.3 Test pickup value.
.4 Test the time current characteristics.
.5 Prove C.T. and tripping circuits via primary injection.
.6 Verify that the breaker and relay will reset after a tripping operation.

.6 Ground Electrode Resistance
.1 Ground resistance tests for substation grounding electrode shall be performed using the fall-of-potential method. A test mat will be established approximately 100 to 150 meters out from the ground grid and 9 to 15 traverse readings taken. From the resulting readings a curve will be plotted to establish the ground mat resistance.

.7 Surge Arrestors
.1 Visual inspection for
.1 Cracked and/or chipped porcelain.
.2 Check for overall cleanliness.
.3 All electrical connections are secure.
.2 Meggar test insulating base and cable.

.8 Cast Coil Transformer
- .1 Insulation resistance tests to be carried out using an insulation resistance test set and the resulting insulation resistance values corrected to a base of 20° C. Polarization of Index readings at 1 (1) minutes and 10 (10) minutes shall be recorded.
- .2 Winding resistance measurements to be taken on all windings and all positions of the off-load tap-changers, where applicable.
- .3 Ratio, polarity and phase relationship tests completed for all taps, where applicable.
- .4 Core insulation tests (when core ground is accessible).
- .5 Cooling equipment and associated auxiliary controls to be inspected.
- .6 Temperature indicator and associated control and alarm systems to be checked for continuity of wiring from instrument to transformer control cabinet and or wiring from transformer control cabinet to external system.
- .7 Test insulation resistance of auxiliary and control wiring.
- .8 All external bushing connections to be inspected for tightness.
- .9 Inspect all bushings and insulators for cracks, chips, dust and overall cleanliness.
- .10 Inspect transformer core, coils, terminal boards, tap changer, and all insulated surfaces for visible damage, foreign material or moisture, and tighten all electrical connections as necessary.
- .11 External inspection of cell for rusting damage and apparent impediments of ventilation.
- .12 Measure noise level rating around transformer with readings taken adjacent to each core & coil and between each core & coil.

.9 Secondary Distribution
- .1 Inspect all bushings and stand-off insulators.
- .2 Inspect buss supports and check all connections.
- .3 Check insulation resistance; phase to phase and phase to ground.
- .4 Verify all C.T. characteristics
  - .1 Meggar.
  - .2 Check Polarity.
- .5 Verify all V.T. characteristics.
  - .1 Meggar.
- .6 Check C.T. secondary circuits by secondary current injection of the C.T. terminals to verify the operation of all relays and meters.
- .7 Check V.T. secondary circuits by voltage source at the V.T. terminals to verify the operation of all associated relays, meters, and control circuits.
- .8 Test and calibrate all secondary breakers over 225 amps.
- .9 Record and report all field settings for each LSI and thermal magnetic circuit breaker.
- .10 Record and report all conductor termination torque settings applied.

.10 Transfer Switches
- .1 Visual inspection for condition.
- .2 Confirm nameplate, warning decals & arc flash labels are attached to the operating side of the equipment and are legible.
- .3 Check insulation resistance; phase to phase and phase to ground.
- .4 Verify all C.T. characteristics
  - .1 Meggar.
  - .2 Check Polarity.
- .5 Verify all V.T. characteristics.
  - .1 Meggar.

.6 Check C.T. secondary circuits by secondary current injection of the C.T. terminals to verify the operation of all relays and meters. Ensure shorting block is accessible and clearly labeled.
.7 Check V.T. secondary circuits by voltage source at the V.T. terminals to verify the operation of all associated relays, meters, and control circuits. Ensure V.T. fusing is accessible and labeled.
.8 Test and calibrate all active components.
.9 Record and report all field settings.
.10 Record and report all conductor termination torque settings applied.
.11 For closed transition transfer switches confirm shunt trip operation of upstream utility CB by 3rd party injection testing of reverse power relay. Provide 3rd party report as part of transfer switch submittal package.
.12 UBC Energy and Water Services require the following tests and submittals for closed transition transfer switches:
.1 CTTS factory settings for maximum interconnect duration shall not exceed 100msec.
.2 CTTS factory settings shall not permit peak shaving or soft load transfer.
.3 CTTS factory settings shall include passive synchronization for closed transition.
.4 CTTS shall incorporate a separate reverse power relay (32R) set to a maximum of 5% generator rating for 1 second. The reverse power relay shall be mounted on the operating face of the transfer switch, incorporate a resettable “flag” and be capable of being reset without opening the transfer switch enclosure.
.5 The 32R relay must connect to a shunt trip device in the transfer switch utility supply breaker. This operation shall be commissioned by a 3rd party using injection testing of the 32R relay.

.11 Panelboards and Disconnects
.1 Visually inspect all internal components and ratings.
.2 Check all internal connections and confirm wire sizes.
.3 Ensure bushings are installed and all unused conduits are capped.
.4 Confirm nameplate, warning decals and arc flash labels are attached to the operating side of the equipment and are legible.
.5 Confirm required spaces and spare circuit breakers are installed.

2.4 Voltage Calibration

.1 After energization and loads applied, secondary voltages of each transformer shall be checked against rated voltage. Taps shall be changed to correct deficiencies as required.

.2 Record output wattages of all transformers under load conditions. Voltage readings shall include all phases-phase and phase-neutral conditions.

2.5 Reporting

.1 Reports on all inspections and tests must be submitted with 10 working days of completion of tests.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Energy & Water Services. Refer to https://energy.ubc.ca.

1.2 Description

.1 UBC requirements for Indoor and Outdoor Unit Substations.

2.0 MATERIAL AND DESIGN REQUIREMENTS – INDOOR UNIT SUBSTATIONS

2.1 Indoor Unit Substations General Requirements

.1 The unit substation assembly shall be CSA approved 15 KV rated and be a completely unitized assembly of components as described in the next section.

.2 Outdoor fluid filled padmount unit substations are acceptable to UBC and shall meet the minimum requirements in sub-section 3.0 and only in coordination with Energy & Water Services - Electrical Technical Services.

.3 Switchgear located in sprinklered rooms, or rooms where the likelihood of water ingress could occur from above, shall have drip hoods installed on all cubicles. Openings for ventilation shall have suitable sprinkler protection. Where multiple cubicles are joined to form a single unit, individual drip hoods shall form a single continuous water barrier by means of factory provided upturned flanges or approved caulking methods.

.4 Air conditioning units located within electrical rooms shall not have evaporator coils, drains, condensers or any powered equipment located directly above unit substations.

.5 Unit Substation Components shall consist of:
- .1 15 KV switchgear.
- .2 Main feeder and standby feeder cable entrance sections.
- .3 Drawout, 15KV vacuum circuit breakers and protection relay.
- .4 Cast coil transformer, (aluminum shall not be specified).
- .5 Metering.
- .6 Secondary Distribution (if applicable).

.6 Characteristics of the unit substation shall be:
- .1 Primary voltage
  - .1 12,480 volts.
- .2 Secondary voltage
  - .1 347/600 volts or 120/208 volts.

.7 Transformer KV Rating
- .1 KVA rating as required.
- .2 Fan cooling to provide 50% additional capacity.

.8 High voltage equipment shall be rated.
- .1 3 phase 60 hertz.
- .2 95 KV BIL.
- .3 300 MVA interrupting capacity at 12.5 KV.

.9 Primary service connections shall be nominal 3 phase 3 wire 12.5 KV.

.10 Secondary voltage shall be 347/600 volts 3 phase, 4 wire, or 120/208 volts 3 phase, 4 wire.

.11 Maximum allowable Arc Flash Hazard/Risk Category within any part of the unit substation between primary cable entrances and main secondary bus shall not exceed level 2 (8 cal/cm^2).

.12 All equipment shall be housed in factory assembled enclosed cubicles. Adjacent cubicles shall be separated by metal barriers.

.13 Where it is necessary to construct the components in separate enclosures these, when mounted and bolted together, shall present a unified appearance as to height, form and color.

.14 All exterior surfaces shall be free from projections. Cubicle construction shall be rigid with formed metal corner posts and with all metal edges returned.

.15 Access to all individual components must be readily obtainable. All cubicles shall have hinged doors to allow for easy infrared scanning. Doors shall be maximum 1200 mm wide with a minimum 90 degree opening. All panels on which relays, meters, or instruments are mounted shall have a barriered compartment with hinged door. All hinges shall be concealed.

.16 Cubicles shall have heavy duty locks with common key or inter-lock.

.17 Access doors shall have two vault-type handles with padlocking feature or be secured with bolt(s) where required. This will allow easy infrared scanning.

.18 Interlocking shall be to Canadian Electrical Code and UBC Utility Requirements.

.19 Inside of cubicles shall be painted white or ASA 61 grey. Exterior shall be ASA 61 grey, two coats of high gloss enamel.

.20 All power connections shall be rigid bussing adequately supported for available fault currents. All equipment shall be wired at manufacturer's plant and required field connections wired to accessible load terminals. Grounding ball studs shall be affixed to bus at each cable entrance compartment and on the high voltage bus within the transformer section.

.21 All ground conductors including equipment ground shall be copper.

.22 A flat copper bonding strip of 0.50 sq. in. (1.3 sq. cm) minimum cross sectional area shall extend the length of the unit substation and be extended to all non-current carrying metal parts of the unit substation and the neutral grounding bus. Grounding ball studs shall be located for easy access during maintenance and shall be located within easy access of all door openings.

.23 All control fuses mounted in substation shall have downstream long life LED indicating lights, with nameplates, to indicate circuits are energized. Supply one set of spare fuses for all fuses locations.

.24 Provide wiring terminal box with terminal block for all outgoing control circuits and spare contacts. Terminal block shall be located where access is possible without de-energizing.

.25 Corrosion resistant approved warning signs shall be securely mounted on the outside of the unit substation cubicles.

.26 All operating control and indicating equipment shall be clearly labeled with lamacoid labels. Provide engraved brass nameplates for each section and general nameplates directed by Engineer.

.27 All high voltage vaults must have floor drains and containment curbs.

.28 Approved manufacturers of unit substations are as follows:
- .1 Eaton.
- .2 Electric Power Equipment.
- .3 Schneider Electric.
- .4 Unit Electrical Engineering (UEE).
- .5 Prime Engineering.

2.2 Performance Standards

.1 Unit substation assembly installation shall comply with:
- .1 CSA C22.2 No. 31, current edition and CSA labeled.
- .2 BC Hydro “Requirements for Primary Substations Supplied at 12.0 KV and 25.0 KV”.
- .3 Canadian Electrical Code.
- .4 BC Electrical Regulations and Bulletins.
- .5 UBC Utility Standards.

2.3 Submittals

.1 Shop drawings shall include:
- .1 All major electrical equipment.
- .2 High voltage switch.
- .3 Unit substation
  - .1 High voltage breaker.
  - .2 12 KV switchgear.
  - .3 Transformer cubicle.
  - .4 Protection and control.
- .4 Factory Transformer Test Report – test report of no-load and load losses, winding resistance tests and impedance test.
- .5 Co-ordination study and curves.
- .6 Secondary distribution.
- .7 High voltage cable.
- .8 High voltage terminations.
- .9 Secondary bus.
- .10 Distribution centre.
- .11 Revenue metering.
- .12 Seismic restraints.
- .13 Ground pad.

.2 Submit the following test reports associated with the unit substation:
- .1 Production Tests - manufacturer’s standard product test as requested in Section 26 08 00 Commissioning of Electrical Systems 2.1.
- .2 Unit Substation Test - manufacturer’s factory test on supplied unit substation as specified in Section 26 08 00 Commissioning of Electrical Systems 2.1.
- .3 Site Commissioning - test report on site commission as specified in Section 26 08 00 Commissioning of Electrical Systems 2.3.

.4 Factory Transformer Test Report – test report of no-load and load losses, winding resistance tests and impedance test. Refer to Section 26 12 00 Medium-Voltage Transformers, sentence 2.4.4, for required loss limits for various size transformers.

.3 Station Ground Resistance
.1 Submit ground resistance test as outlined in Section 26 08 00 Commissioning of Electrical Systems 2.3.6.

.4 Cable Testing
.1 Submit conductor and cable test reports as outlined in Section 26 05 05 High Voltage Cables 2.12 Testing.

.5 Voltage Calibration
.1 Submit voltage calibration report as outlined in Section 26 08 00 Commissioning of Electrical Systems 2.4.

.6 Seismic Certification
.1 Submit certification of compliance with seismic requirements as specified in Section 26 05 48 Vibration and Seismic Controls for Electrical Systems.

.7 Final Inspection Certificate
.1 Submit a copy of the final provincial electrical inspection certificate.

.8 Operating & Maintenance Manuals
.1 Operating and maintenance manuals shall be submitted.

.9 Project Record Documents
.1 Project record documents shall be submitted as specified and as per CCDC standards.

.10 Shop drawings shall be submitted for review prior to construction. Shop drawings shall be AutoCAD or PDF with minimum 600 dpi resolution. Hard copies shall be on AO (841 mm x 1189 mm) sized drawings. Supply digital files with Shop Drawing submittal.

.11 Before assembly of the unit substation, submit the following information in digital format:
.1 Electrical one-line diagram.
.2 Protective device co-ordination graph.
.3 Layout plan with dimensions.
.4 Reviewed and approved equipment cubicle drawing, including circuit breaker control wiring diagrams and key interlock scheme.
.5 Shop drawing information.

2.4 Drawing Requirements

.1 AutoCAD Drawings Shall Include:
.1 Equipment layout and overall dimensions.
.2 Equipment specifications.
.3 One line diagram.
.4 Relating information including relay specs; time-current graphs; wiring diagrams, and tripping system.
.5 Seismic support and restraints.
.6 Metering information.
.7 Terminal block wiring and labeling.
.8 Labels.

.2 Electrical One-Line Diagram
.1 The electrical one-line diagram shall show the connection of all the service entrance equipment. It shall contain the proposed service entrance relay settings.

.3 Protective Device Co-ordination Graph
.1 A standard size 4 ½ x 5 cycle log-log graph shall be used for the co-ordination study. It is mandatory that the service entrance protective device setting be compatible and co-ordinate with UBC Energy & Water Services protective equipment. The manufacturer shall provide the required co-ordination study. Refer to Section 26 05 04 Protective Device Coordination and Arc Flash Analysis.

.4 Equipment Drawing - Unit Substation
.1 The unit substation shop drawings shall be submitted for review prior to assembly.
.2 The drawings shall show fully dimensioned equipment assembly details and the wiring diagram of the circuit breaker control scheme.

2.5 Metering Requirements

.1 Metering shall be supplied by Switchgear Manufacturer at the project's cost and installed by manufacturer.

.2 Switchgear manufacturer to incorporate Schneider Electric PM8240 meter with i/o module meter into construction.

2.6 Testing & Commissioning

.1 Factory tests shall be performed as specified in Section 26 08 00 Commissioning of Electrical Systems. Provide written report of test results prior to shipment of unit substation.

.2 Provide written report of test results prior to energization of unit substation.

.3 Unit substation, when fully assembled, shall be made available for inspection in the factory by the Engineer.
.1 Unit substation to have factory test and site and commissioning as outlined in the Specification.

2.7 Cubical Specifications

.1 Cable Entrance and Withdrawable Breaker Cubicles
.1 Shall house incoming cable terminations with provision for stress cones and cable supports.
.2 Shall include grounding ball studs on both incoming buses.
.3 Shall house Capacitive Voltage Transformers (CVT).
.4 Shall house Current Transformers (CT).
.5 Shall house electrically operated withdrawable vacuum circuit breakers.
.6 Shall house electrical operating controls for breaker racking mechanism behind lockable door.
.7 Shall house electrical operating controls for breaker open/close override behind lockable door.
.8 Shall include viewing windows.
.9 Doors shall have provisions for heavy duty padlock.

.2 Transformer Cubicle
.1 Shall house cast coil transformer. Aluminum transformers are not permitted.

.2 Ventilation louvers and fan cooling shall provide adequate cooling and ventilation.
.3 Access doors shall be interlocked with main breaker.
.4 May house metering equipment if not located in secondary distribution.
.5 Transformer mounting shall meet seismic requirements.

2.8 Stress Cones

.1 Stress cones shall be Raychem “Hot Shrink“ or 3M “Cold Shrink“ termination kit for 4/0 XLPE 25 KV rated.

2.9 15kV Cable Entrance

.1 All components with the 15kV cable entrance section shall be fully accessible after substation installation.

.2 The cable entrance section shall house the 15kV Current Transformers (CT) and Capacitive Voltage Transformers (CVT).

.3 Grounding ball studs shall be installed on all incoming feeder connections and shall be positioned to allow access after the equipment is installed.

.4 Cable support blocks shall be installed such that they do not interfere with cable terminations or cause undue mechanical stress to cable or connections. Supports blocks shall be constructed of electrically insulating material rated for the application. Support blocks shall utilize a clamping method to secure cables. Cable ties are not permitted.

2.10 Primary Bussing

.1 15 KV primary copper bussing, minimum 600 Amp capacity.

2.11 15kV Withdrawable Circuit Breakers

.1 15kV, 3 pole, 600 Amp group operated vacuum circuit breaker with magnetic actuator.

.2 Each vacuum interrupter shall be mounted in molded epoxy housing with a minimum pole spacing of 210 mm. Vacuum interrupters shall be designed and rated as “sealed for life”.

.3 The breaker shall be operated by an electrically operated magnetic actuator controlled by position sensors and by electronic module. The energy required for operation shall be provided by integrated capacitors capable of storing sufficient energy for a complete operating cycle: open – close – open.

.4 The breaker shall have local control buttons for open and close with an emergency mechanical opening operation and shall include a position indicator.

.5 Rated interrupting capacity shall be minimum 300 MVA and 16kA RMS symmetrical at 15kV. Rated current 630 Amps. Rated duty cycle: open - 0.3 sec. - close/open - 15 sec. - close/open.

.6 Number of operations at rated current = 30,000. Number of operations under short circuit = 100.

.7 Rated impulse withstand of 95 KV BIL.

.8 Breaker shall be type tested in accordance with ANSI Standard C57 and/or IEC 62271-100, CEI 17-1 file 1375.

.9 Breaker shall be withdrawable type via motorized operator and manual racking lever.

.10 Electric operators shall be 24 or 48V DC type compatible with unit substation control voltage and be powered directly from the DC Battery System.

.11 The breaker shall have position sensors to prevent racking out while breaker is in the closed position.

.12 The breaker shall have an integrated lockable hasp for the provision of personal lockout with mechanical and electric interlock to prevent the breaker from being able to be racked in.

.13 The breaker shall be able to be fully racked in and out with the doors closed.

.14 The breaker door shall be able to be closed after applying personal padlocks to the breaker.

.15 All doors shall have provisions for padlocks.

.16 A window shall be provided to permit viewing of the breaker in both the open, closed and racked out position.

.17 Approved manufacturers are:
- .1 ABB
- .2 Eaton
- .3 Schneider Electric

2.12 15kV Breaker Trip

.1 Tripping power shall be obtained from the DC battery system.

.2 The operating voltage for breaker trip shall be either 24 or 48 V DC.

.3 Auxiliary trip coils shall be DC operated and independent of availability of AC current.

.4 In addition, provide a shunt trip for over temperature and ground fault trip. Power to be from the DC battery system. Provide LED lamps for monitoring of shunt trip.

.5 Provide one set of NO and NC auxiliary contacts to indicate whether breaker is open or closed wired to a terminal block located in an outlet box at the top of the cubicle.

2.13 Relay Current Transformers and Zone of Protection

.1 Current Transformers (CT) shall be installed within the switchgear to create a complete protection zone. The zone of protection shall include cable terminations for both incoming feeders, HV circuit breakers, main transformer and main secondary bus and distribution board.

.2 Provide window style, 600V, relay accuracy C100 CT's, ratio XX:5, in each 15kV cable entrance section. CT window shall be sized to allow for cable to pass through without interference to cable or its termination. CT's shall be permanently and securely mounted in switchgear cable entrance section.

.3 Provide window style, 600V, relay accuracy C100 CT's, ratio XXX:5 in the low voltage section. Locate CT's as close as possible to the secondary connections of the transformer to maximize the protection zone area. CT's shall be permanently and securely mounted in switchgear.

.4 The Arc Flash Hazard category within any area covered by the Zone of Protection shall not exceed level 2 (8 cal/cm^2).

2.14 Protection Relay

.1 Overcurrent and short circuit protection shall be provided by a single Schweitzer Engineering Laboratories (SEL) 700GT+ series relay.

.2 The SEL relay shall also provide protection for primary and secondary ground faults.

.3 Protection shall be of the circuit closing type with programmable current range from 0.1 to 96.0 amps.

.4 CT inputs shall be rated for 5 amp CT secondary.

.5 The SEL relay shall be powered directly from the DC Battery System.

.6 The SEL relay shall be surface mounted on the switchgear.

2.15 Capacitive Voltage Transformers

.1 Three (3) Capacitive Voltage Transformers (CVT) shall be installed in each 15kV cable entrance section.

.2 CVT's shall be mounted on the line side of each 15kV breaker and used exclusively for the purposes of live line detection.

.3 CVT's shall have a voltage rating of at least 22kV to permit high potential cable testing.

2.16 Breaker Remote Operation

.1 Both the normal and alternate breakers shall normally be operated remotely via control cabinet located in an area outside of the arc flash protection boundary.

.2 The control cabinet shall house a single operating switch to transfer from one feeder to the other.

.3 The control cabinet shall house operating controls to open and close individual 15kV breakers.

.4 The control cabinet shall house pilot lamps to indicate breaker position for both 15kV feeders.

.5 A time delay shall be incorporated of up to 15 seconds before the first action for the purposes of transferring between feeders or closing an individual breaker. This time delay will allow sufficient time for anyone that may still be within an arc flash protection zone to safely exit the area before the breakers operate. There shall be no time delay associated with opening an individual breaker.

.6 Control wiring between the unit substation and the control cabinet may be via individual control wires, fibre optic cables or a combination of both.

.7 All breaker operations shall be supplied from the DC Battery System.

.8 The control cabinet shall have a hinged cover with provision for a heavy duty padlock.

.9 The control cabinet controls shall look similar to that in UBC Standard Drawing E1-6.

2.17 Location of Auxiliary and Control Equipment

.1 All components used for protection and control shall be housed in a separately barriered compartment from any high voltage equipment. This also applies to all auxiliary components including terminals, relays and pilot lamps.

.2 Provide a 27mm conduit extending from the barriered control section of each feeder to a junction box on top of the substation equipment to allow for connection to external devices or monitoring equipment.

2.18 DC Battery System

.1 Provide 24 or 48 volt DC battery system complete with heavy duty charger. Batteries shall have sufficient storage capacity to fully operate the circuit breakers (open – close – open), pilot lights and protection and control system in the event of a power failure.

.2 Batteries shall store sufficient energy to ably maintain, monitor and control for up to 24 hours.

.3 The DC charger shall be fed directly from the substation at 120 volts.

.4 The DC charger shall have output relays with Form C dry contacts for the following conditions:
- .1 AC power loss
- .2 Charger failure
- .3 DC power loss

.5 The DC charger shall have an internal audible alarm that will annunciate during any of the above abnormal conditions.

.6 The DC Battery System may be located in a separately barriered section of the switchgear or stand-alone outside of the switchgear. The system shall be designed such that any component of the system can be readily and safely accessed without shutting down the substation.

2.19 Main Secondary Breaker

.1 A main secondary breaker, 600 or 208 volt, is not preferred.

.2 In lieu of a secondary main breaker, provide current transformers (CT) to perform necessary overload, short circuit protection and Arc Flash Hazard Category reduction as outlined in Section 26 11 13 Primary Unit Substations, 2.1.8.

.3 A main secondary breaker may only be provided for the purposes of derating downstream buses or as approved by UBC Energy & Water Services.

3.0 MATERIAL AND DESIGN REQUIREMENTS – OUTDOOR UNIT SUBSTATIONS

3.1 Outdoor Unit Substations General Requirements

.1 Substation assembly shall be CSA, cUL or field (SPE-1000) certified.

.2 15kV, 16kA rated, switchgear, solid dielectric or gas insulated with integrated high voltage main feeder and standby feeder cable entrance section.

.3 Fluid filled transformer and integrated vacuum fault interrupter, with FR3® Envirotemp insulating fluid.

.4 Overcurrent protection and auxiliary control components.

.5 Low voltage distribution equipment, if required.

.6 Outdoor transformers shall be sized not more than 3MVA.

.7 Outdoor transformers may have a distribution panel integrated within the low voltage section rated not more than 3000 amps.

.8 In installations requiring integrated distribution equipment, no single circuit breaker shall be rated higher than 1600 amps.

.9 Overhead services for outdoor unit substations is not allowed.

3.2 15 KV Outdoor Switchgear Minimum Requirements

.1 16kA rated equipment maintenance free design.

.2 Dead front cable entrance and exit sections. Cable connections shall be IEEE 386 15kV, 600 amp deadbreak type.

.3 Cable connection bushings shall be minimum 30” from bottom of equipment.

.4 Solid dielectric or gas insulating medium only. Air insulated equipment shall not be permitted.

.5 2 separate high voltage 3 phase fully load break rated isolating switches (2 ways) in a loop/feed through configuration within in common tank.

.6 Each operating switch shall have one cable entrance connection with a 3rd outgoing cable connection directly on the common bus.

.7 Cable entrance and exit connections shall only be mounted on front, back or side walls. Cable connections shall not be permitted on top or bottom of equipment.

.8 Load break isolating switches shall have either 2 operable positions, Closed-Open or 3 operable positions, Closed-Open-Ground.

.9 Load break Isolating switches shall be padlockable in the Open position to meet WorkSafe BC requirements.

.10 Ability to operate load break isolating switches independently of each other while energized.

.11 Large viewing window(s) for load break isolating switch contact position verification.

.12 Approved manufacturers of outdoor solid dielectric or gas insulated switchgear are:
- .1 Eaton/Cooper
- .2 G&W Electric
- .3 S&C Electric
- .4 Prime Engineering

3.3 Fluid Filled Transformer with Integrated Vacuum Fault Interrupter Minimum Requirements

.1 XXXX kVA 3 Phase Transformer
.2 Insulating fluid FR3® environmentally friendly fluid for transformers
.3 Integrated single vacuum fault interrupter (VFI) device installed by transformer manufacturer fully immersed in common tank
.4 Factory supplied external 3 phase self-powered protection controller with auxiliary shunt trip inputs in a NEMA 4 enclosure
.5 VFI operating handle and contact position viewing window in separate section from HV or LV cable entrances.
.6 Cooling Welded Panel Type Radiators
.7 Coatings ANSI 61 grey 3 mil
.8 Touch-Up Paint (aerosol cans) (Qty: 2)
.9 Notifications Standard Aluminum Nameplate
.10 Notifications CSA, cUL Listed & Labeled
.11 Nitrogen Blanket Nitrogen blanket With Purge Valve
.12 Liquid Level Gauge Liquid Level Gauge
.13 Liquid Temp Gauge Liquid Temp Gauge with Alarm Contacts
.14 Pressure Vacuum Gauge Pressure Vacuum Gage
.15 Pressure Relief Cover Mounted Pressure Relief Device
.16 Valves Upper Fill Valve (1")
.17 Valves Drain Valve (2") with Sampler
.18 Tank Designed to meet seismic requirements of BC Building Code, current edition
.19 Tank Designed for Skid Mounting, Continuous Operation @ 4-5° Tilt
.20 Tank Welded Main Cover with Handhole
.21 Tank Manhole Cover (Qty: 1)
.22 Tank Stainless Steel Ground Pads
.23 Installation Location Outdoor
.24 Temperature Rise 65
.25 Cooling Class KNAN
.26 Frequency 60
.27 Impedance 5% - 7% max
.28 Efficiency Standard CSA C802.1
.29 Elevation Designed for operation at 1000 m (3300 ft) above sea level
.30 High Voltage 12,480 Delta
.31 Primary Conductor copper
.32 Primary BIL 95 kV
.33 Taps 2 - 2.5% taps above and 2 - 2.5% taps below nominal
.34 High Voltage Bushings, IEEE 386, 15kV 600amp deadbreak
.35 High Voltage Bushing location Sidewall minimum 36” AFF
.36 600 volt donut style XX:5 C100 (C50 minimum) CT’s (3) field mounted within incoming cable section
.37 Primary Phasing H1-H2-H3 (Left to Right)
.38 Low Voltage 600Y/347 Wye solidly grounded
.39 Secondary Conductor copper
.40 Secondary BIL 30 kV
.41 Secondary Bushing Location Sidewall
.42 Secondary Phasing X1-X2-X3-XO (Left to Right)
.43 Integrated overcurrent protection and controls section (see item 6 below)

3.4 Secondary Cabinet Minimum Requirements

.1 Secondary Cabinet Front access door, including either 2 padlockable handles or a single padlockable handle and 2 tamperproof pentahead bolts.

.2 Secondary Cabinet Side access panel.

.3 600 volt donut style XXX:5 C100 (C50 minimum) CT's (3) permanently mounted at secondary phase bushings.

3.5 Overcurrent Protection and Auxiliary Control Equipment Minimum Requirements

.1 Provide a 3000VA 600/120-240V station service transformer with primary class CC fuses installed in a NEMA enclosure within the transformer VFI operating section.

.2 Provide a 60 amp rated 120/240V, 8 circuit load centre within the VFI operating section.

.3 Provide a single 20 amp, 5-20R, GFCI convenience receptacle within the VFI operating section.

.4 Provide 120VAC - 24VDC power supply c/w sealed lead acid battery backup. Batteries shall be sufficiently sized to provide protection and control for up to 24 hours. Batteries shall be provided by UBC.

.5 24VDC power supply shall have integrated form C relay output and local audible alarm that activate on loss of AC or general trouble.

.6 Provide 24VDC powered SEL 700 GT+ relay for primary, secondary 50/51 and ground fault protection.

.7 Provide 120VAC heater, thermostatically controlled, mounted in the control cabinet and the LV section (when distribution equipment is installed).

.8 Provide 120VAC heater in the 15kV switchgear cabinet enclosure.

.9 Heaters, lights and convenience receptacle shall be supplied directly from the load centre.

.10 Provide 600 volt donut style CTs, field mounted, in transformer high voltage cable entrance section.

.11 Provide (3) 15.3 kV MCOV surge arrestors with 600 amp IEEE 386 connection for installation in high voltage cable entrance section.

.12 Provide 600 volt donut style CTs, factory mounted, on secondary transformer bushings.

.13 All auxiliary protection and control equipment shall be powered from the station service transformer and located within the transformer primary VFI operating switch section within a separately barriered enclosure mounted into a rigid side panel but accessible with transformer doors closed.

.14 All operating and control components shall be located behind lockable NEMA 3R or 4 rated panel covers.

3.6 Approved Manufacturers of Outdoor Transformers and Associated Enclosures

.1 Eaton/Cooper
.2 Vantran Industries
.3 Partner Technologies Inc. – PTI

.4 Prime Engineering
.5 Schneider Electric

3.7 Relay Current Transformers and Zone of Protection

.1 Primary and secondary Current Transformers (CTs) shall be installed within the transformer enclosure to create a complete protection zone. The zone of protection shall include all components within the entire transformer enclosure and incorporate the VFI, transformer and secondary supply cables.

.2 The Arc Flash Hazard category within any area covered by the Zone of Protection shall not exceed level 2 (8 cal/cm^2).

.3 The SEL 700GT+ relay shall act as the main protection device for the zone of protection and programmed with the following settings:
1. HV 50/51
2. HV 51N
3. LV 50/51
4. LV 51G

.4 All other ancillary protective devices (49, 63, etc.), if used, shall connect into the SEL 700GT relay.

.5 The factory supplied protection controller (if provided) shall act as a backup protection device and shall effectively coordinate with the SEL 700GT+ relay.

.6 Refer to UBC standard drawing E1-2b for Protection and Control Single Line.

3.8 Switchgear and Transformer Cable Interconnection

.1 High Voltage cable interconnection between the switchgear and transformer shall be installed by UBC Energy & Water Services only and charged to the project.

.2 All protection and control equipment wiring shall be installed by the contractor.

3.9 Concrete Equipment Pad and Seismic Anchoring

.1 The contractor shall design and provide the concrete equipment pad and all interconnecting conduits.

.2 15kV switchgear and transformer shall be physically separated by the minimum requirements of the equipment supplier and applicable codes with a minimum of 300mm clearance between equipment.

.3 UBC Energy & Water Services shall approve all concrete pad layouts along with all protective bollard locations or architectural surrounds prior to any installation.

.4 Refer to typical concrete pad layout in UBC standard drawing E1-2c.

.5 UBC Energy & Water Services may refuse permanent power connection to any installation that is not installed as per approved layout design.

.6 The contractor shall ensure all seismic anchoring requirements are met as per UBC Technical Guidelines section 26 05 48.

3.10 Grounding and Bonding

.1 Counterpoise grounding and bonding shall be designed, installed and tested as per UBC Technical Guidelines section 26 05 26.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Energy & Water Services
.2 UBC Facilities Electrical

1.2 Description

.1 UBC requirements for Substation Transformers.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 Primary Bussing

.1 15 KV primary copper bussing, minimum capacity 600 amps, 300 MVA bracing.

2.2 Surge Arrestors

.1 Provide three 15.3 kV MCOV distribution class surge arrestors. Install immediately upstream of transformer primary connection. Ground arrestors directly to ground bus with 4/0 copper.

2.3 Transformer Connection

.1 Flexible copper braid connections at both primary and secondary connections of transformer.

.2 Grounding ball studs shall be affixed to the primary transformer bus and meet accessibility requirements as per section 26 11 13 2.1.

2.4 Cast Coil Transformer

.1 Substation transformer(s) to step down voltage from 12.48 KV to 347/600V or 120/208V shall be cast coil type, Class F insulation.

.2 Cast coil transformer with fan cooling to provide 50% additional load capacity. The transformer cubicle shall contain transformer core and cast coils, fans and controls, temperature measuring assembly, neutral/ground CT, primary and secondary busses and ground bus.

.3 The transformer shall be designed and built in accordance with the current issues of CSA Standard C9 and ANSI Standard C57.12.00.

.4 Losses shall be in compliance with or exceed CSA Standard C802 requirements.

Transformer Size (KVA)	No. Load Losses (Watts)	Load Losses (Watts)
750	2,300	7,500
1000	2,900	9,000
1250	3,250	10,100
1500	3,800	12,100
2000	5,200	14,300
3000	5,700	19,500

.5 The transformer shall be a 3 phase core type with cast epoxy coils fiber glass reinforced, type AN with forced air cooling. To provide 50% additional capacity both HV and LV coils shall be cast under a hard vacuum in steel moulds and the cores shall be mitered.

.6 Insulation system shall be Class F (185 °C) but the average winding temperature rise shall be 80 °C maximum, at rated voltage and full load.

.7 Windings shall be copper. Aluminum shall not be used.

.8 Each LV winding shall be equipped with embedded temperature sensors connected to the detection system temperature relay unit with separate output dry contacts for fan operation, remote alarm and tripping corresponding to 80% and 95% and 105% of rated operating temperature.

.9 Provide a digital readout for each phase and constant memory of the highest temperature with readout on demand.

.10 Provide remote contacts for high temperature monitoring wired to outlet box at roof of transformer.

.11 Mount temperature relay unit and thermometer on a hinged panel of a barrier instrument compartment on the side of cubicle. Connect tripping contacts to trip the primary vacuum breaker. Extend 1-NO and 1-NC alarm contact to terminal blocks in a six inch outlet box on the roof of the transformer enclosure.

.12 Power supply for cooling fan shall be supplied from power source in transformer cubicle (secondary connection).

.13 Provide design data and shop drawings for all transformer characteristics for approval by the consultant before proceeding with manufacture.

.14 The core shall be protected against corrosion by a coating of epoxy resin not less than 1 mm thick. All steel parts other than the core shall be hot dip galvanized with a minimum coating thickness of 0.1 mm or epoxy painted.

.15 After manufacture, the transformer shall be partial discharge and sound level tested in addition to standard production tests list in CSA Standard C9 to verify the specified ratings. The partial discharge shall not exceed 15 pico coulombs at a corona extinction voltage of 120% of rated voltage when energized by induction from a three phase, 60 HZ or higher frequency source. A certificate issued by the Testing Engineer shall be provided verifying the results of all factory tests.

.1 Continuous (XXX) KVA rated output.
.2 (XXX) KVA fan cooled rated output.
.3 Insulation Class - F 185 °C maximum winding temperature.
.4 Temperature Rise Design - 80 °C average winding temp rise.
.5 Frequency – 60 Hz.
.6 Rated Primary voltage – 12,480V.
.7 Rated secondary voltage 347/600V or 120/208V.
.8 Connections - delta / grounded Wye.
.9 Impedance 5% min. to 7% max.
.10 Off load taps - 4 - 2 1/2%, 2 FCAN, 2 FCBN.
.11 Basic Impulse Level – 95 KV.
.12 Available fault current rating - 300 MVA sym.
.13 Number of phases is three (3).
.14 Maximum noise level 65 dBA at full load at one meter.

.16 Approved Manufacturers are:
- .1 LG Industrial Systems.
- .2 ABB Resibloc Cast Resin.
- .3 LSIS
- .4 Jinpan International
- .5 Hammond EnduraCoil
- .6 Rex Power Magnetics

.17 Provide the Following Features for the Transformer:
- .1 Access doors key interlocked with primary circuit breaker.
- .2 Engraved transformer nameplates including connections, voltage ratings, impedance, and other data as required by CSA, one on core and coils and one on exterior of enclosure.
- .3 On completion of manufacture, but prior to shipment, the following tests shall be performed and results certified by a registered Professional Engineer.
  - .1 All CSA C9 tests, including losses.
  - .2 Partial discharge test – Factory Test.
  - .3 Sound level test – Factory Test.

.18 Three copies of these results shall be forwarded to the Consultant for approval prior to transformer shipment from the factory.

2.5 Transformer Neutral

.1 Transformer secondary neutral shall be solidly grounded to ground bus mounted in transformer cubicle.

.2 Connect grounding bus in transformer cubicle with ground bus in 12 KV switchgear.

2.6 Ground Bus

.1 Provide a ground bus capable of terminating all ground and neutral connections. Allow for 3 spare 4/0 lugs and space for 6 future lugs.

2.7 Ground Fault Protection

.1 Current Transformer
- .1 Ground fault sensor current transformer sized to match requirements of ground fault relay up to full load current rating of transformer.

.2 Ground Fault Relay (51G)
- .1 Provide a secondary over current ground fault relay 50/51M with current pick-up range (0-XXX) amps, 0 - 10 seconds, adjustable definite time, with current transformer sensor in the neutral conductor of the transformer relay. Ground fault conductor shall trip main vacuum breaker.

2.8 Temperature Relay

.1 Transformer temperature relay with 3 temperature sensors, one for each winding. Relay shall have three contact settings to be set at:
- .1 80 °C Alert.
- .2 100 °C Alarm.
- .3 120 °C Trip.

2.9 UBC Energy and Water Services Revenue Meter

.1 Revenue meters shall be switchboard mounting, 3 element watt hour demand type, Schneider Electric PM8240 meter with i/o module.

.2 Multifunction Meter with Ethernet capability. Refer to Section 26 27 13 Metering.

2.10 System Monitoring

.1 The following monitor points and contacts shall be wired out to a terminal block located in a junction box on the unit substation roof for future connection to UBC BMS system to monitor:
- .1 Circuit breaker #1 status.
- .2 Circuit breaker #2 status.
- .3 SEL Relay health status.
- .4 DC Battery System – AC power loss.
- .5 DC Battery System – Charger failure.
- .6 DC Battery System – DC power loss.
- .7 Transformer fan on transformer temp ‘alert’.
- .8 Transformer temp ‘alarm’.
- .9 Three (3) spare spaces.

.2 Refer to Section 25 05 00 Building Management Systems (BMS) Design Guidelines for technical requirements of BMS.

2.11 Interlocking

.1 Safety interlocks shall be provided as required, equal to Kirk or FPE. Load break switches shall be interlocked with the transformer tap door. Refer to interlocking diagram.

2.12 Vibration Isolation Requirements

.1 Particular attention shall be paid to the installation of the transformer to reduce the noise level in the transformer room.

.2 Supply transformers generating a space average noise level in the transformer room not exceeding 60 decibels measured in any third octave bank between 50 Hz and 1000 Hz based on a 300 KVA transformer.

.3 Other sizes shall meet equivalent noise level with noise correction based on 10 Log KVA re. 300 KVA.

.4 Supply vibration isolation such that the airborne noise isolation provided by the building structure is not limited by structure borne noise transmission. The following are minimum isolation requirements:

- .1 Mount the transformer core on 25 mm deflection spring isolators, including in series neoprene elements with an effective deflection of 2.5 mm, and restraints meeting the National Building Code with respect to seismic requirements.

- .2 For a slab on grade installation, use neoprene isolators sized for a minimum 2.5 mm deflection, with seismic restraints.

- .3 If the transformer core is mounted on separate transverse steel supporting members, independent of the transformer enclosure, size the members for a 140 Hz cantilever resonant frequency under the dead load of the member (0.013 mm dead load cantilever deflection) and the spring stiffness.

.4 Provide sufficient flexibility in the braided connectors on both the low voltage and high voltage sides of the transformer such that the vibration isolation provided by the spring/neoprene isolator supports is not limited by the braided connectors. If such flexibility is impractical, isolate the cabinets on neoprene isolators with 2.5 mm deflection and isolate the conduit.

.5 Within the electrical room, provide neoprene hangers with 0.1" static deflection in threaded rod supports for all new conduit, cable trays, etc. Avoid rigid connections to the structure. Avoid any contact of electrical equipment to drywall partitions where transformer rooms are located adjacent to occupied spaces.

.5 Submit shop drawings detailing proposed isolation.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 33, Section 33 10 00 Water Utilities - 2.4; Section 33 51 00 Natural Gas Distribution - 2.4; and Section 33 61 00 Hydronic Energy Distribution - 2.5; Division 27, Section 27 05 08 Description of System – 1.4; Division 25, Section 25 05 00 Building Management Systems (BMS); Division 01, Section 01 92 00 Monitoring Based Commissioning.

1.2 Coordination Requirements

.1 UBCO Energy

1.3 Description

.1 UBCO requirements for Metering.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 Division 26 contractor shall supply and install primary meter at the project's cost.

2.2 Electrical Metering

.1 Primary and secondary meters shall be provided by BMS vendor. Refer to Section 25 05 00, 4.3 for metering requirements.

.2 Approved Test Block Manufacturers:
- .1 ABB type FT-1.
- .2 Sangamo.
- .3 Superior #1082F.

2.3 Metering Transformers

.1 Metering transformers shall be provided by the Division 26 contractor.

.2 Three current transformers (CT's) shall include revenue metering accuracy of 0.3B0.9, ratio XXX/5.Mount CT's on transformer secondary bus.

.3 All current transducers shall be provided by the electrical trade, and shall be Rogowski Coil type for building secondary metering. Split CTs are acceptable for building primary metering.

2.4 Mechanical Meters

.1 Main building gas and water meters are to be integrated into the building BMS system and Siemens BMS. Pulse outputs from each of these meters are to be brought to a building automation controller for recording purposes.

.2 The Division 26 contractor shall install all pathways and wiring between the mechanical meters and the BMS controller. Coordinate with Division 20 contractor and UBCO Energy Team.

.3 District Energy meter shall be network connected directly to the building BMS system. Refer to Section 01 92 00 Monitoring Based Commissioning, Section 25 05 00 – 4.9, and Section 20 00 06 Metering for applicable details.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Section 33 10 00 Water Utilities - 2.4
.2 Section 33 51 00 Natural Gas Distribution - 2.4
.3 Section 33 63 00 Steam Energy Distribution - 2.5
.4 Section 27 05 08 Description of System – 1.4
.5 Section 25 05 00 Building Management System (BMS) Design Guidelines.
.6 Section 26 27 13 Secondary Metering

1.2 Coordination Requirements

.1 UBC Energy & Water Services

1.3 Description

.1 UBC requirements for Metering for revenue grade applications. Refer to Section *26 27 13* for secondary metering requirements.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 Switchgear manufacturer shall supply and install Revenue grade meter at the project's cost.

2.2 Revenue Metering

.1 Revenue grade meter shall be Measurement Canada approvable, Schneider Electric Type PM8240 Multifunction Meter with i/o module and Ethernet options.

.2 It shall be for use with 3 current transformers and programmed for CT's to allow for direct readout.

.3 The meter shall be flush mounted @ 54" above finished floor (centre of meter) in a separately barriered instrument compartment in the distribution enclosure. Provide a 10-pole test block for current and potential circuits, surface mounted on the outside of the door of the metering compartment.
  .1 For 120/208V Systems wire the meter as shown on Drawing E4-4.
  .2 For 347/600V 4W Systems wire the meter as shown on Drawing E4-5a.
  .3 For 347/600V 3W Systems wire the meter as shown on Drawing E4-5b.

.4 Approved Test Block Manufacturers:
  .1 ABB type FT-1.

2.3 Metering Transformers

.1 Metering transformers shall be provided by the switchgear manufacturer.

.2 Three current transformers (CT's) shall include revenue metering accuracy of 0.3B0.9, ratio XXX/5 for Schneider Electric PM8240 with i/o module multifunction meter. Mount CT's on transformer secondary bus.

.3 Metering at 600V, 4 wire secondary shall include three voltage transformers, revenue accuracy, 360:120 ratio shall be mounted in a separately barriered instrument compartment. For 3 wire systems, the consultant or manufacturer shall contact UBC Energy & Water Services for recommended solutions.

2.4 Mechanical Meters

.1 Main building gas and water meters are to be integrated into the electrical metering system. Pulse outputs from each of these meters are to be brought to the Schneider Electric PM8240 meter for recording purposes. Refer to standard drawing E4-6 for wiring connections.

.2 The Division 26 contractor shall install all pathways and wiring between the mechanical meters and the electric meter. Coordinate with Division 20 contractor and UBC Energy & Water Services.

.3 District Energy meter shall be network connected directly to UBC ION metering network. Refer to Division 20, 23 and 27 for applicable details and Drawing E4-6c.

.4 Refer to Drawing E4-6 for wiring requirements of the gas and water metering integration into Schneider Electric PM8240 meter.

3.0 Other

.1 A raceway shall be provided between the PM8240 meter and the nearest communications closet. Provide an IT demarcation box within 3 metres of the PM8240 meter. Refer to Division 26 standard drawing E4-6 and Division 27 standard drawing ITSTD-22.

*****END OF SECTION*****

1.0 GENERAL

1.1 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Facility Management (Okanagan)

1.2 Description

.1 The Low-Voltage Transformer technical guideline outlines the requirements for dry type distribution transformers utilized at UBC facilities with primary/secondary voltages between the ranges of 120 to 600 volts.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 Design

The following variables must be evaluated when specifying a transformer:

.1 Primary and Secondary voltage/phase/frequency requirements.
.2 Total loading on the transformer.
.3 Future capacity required.
.4 Type of loads.
.5 % of linear and non-linear loads.
.6 Environmental requirements (Water/dirt egress, sound).
.7 Spacing and weight requirements for proposed location.
.8 Adequate ventilation in proposed location.
.9 Mounting type.
.10 Mechanical protection.
.11 Tamper resistance in areas accessible to the public.
.12 Ease of access for inspection, maintenance, removal and replacement.

2.2 Transformer Types

.1 Isolation transformers are required for all installations. The only exceptions are the following:
  .1 Transformer serving a single piece of equipment that does not contain a switching power supply.
  .2 Serving a single piece of equipment with written confirmation from the manufacturer that an alternative type of transformer is acceptable for use.

.2 The following dry type transformers may be specified based on the following requirements:

  .1 General Purpose:
    .1 General purpose transformers shall be specified when there are less than 15% non-linear loads.

  .2 K-Factor Rated:
    .1 K-Factor Rated transformers shall be utilized in applications where 15% or greater non-linear loads are present:
      - 15-35% non-linear loads → K-4 rated transformer.
      - 36-75% non-linear loads → K-13 rated transformer.
      - 76-100% non-linear loads → K-20 rated transformer.

  .3 Harmonic Mitigating:
    .1 Harmonic Mitigating transformers can be specified for the following applications:

- Mitigation of potential nuisance tripping of overcurrent protection upstream in the distribution due to harmonics.
- Mitigation of harmonics to sensitive equipment that are highly susceptible to voltage distortion.
- Improving the effects of decreased Power Factor due to harmonics.

.4 Encapsulated:

.1 Encapsulated transformers can be specified for the following applications:

- Harsh environment locations (i.e.: Laboratories, Street Lighting).
- Hazardous locations requiring Class 1, Division/Zone 2 rated equipment.

2.3 Material Specifications

.1 Capacity: The allowable range of capacities shall be from 3kVA minimum to 300kVA maximum.

.2 Frequency: 60Hz shall be the default frequency.

.3 Cooling: ANN Air Natural Convection Cooling shall be utilized for all transformers.

.4 Winding Configuration: The transformer shall be delta connected primary with wye connected secondary unless another winding configuration is explicitly stated and required.

.5 Conductors: Core conductors shall be copper windings, with terminations brazed, welded or bolted. Aluminum windings are only acceptable for transformers sized at 30kVA or less that service normal distribution equipment (emergency, essential, stand-by and life safety do not qualify).

.6 Insulation: Insulation class shall be 220°C with 150°C temperature rise for all open wound transformers. Encapsulated transformers insulation class shall be 180°C with 135°C temperature rise.

.7 Impregnation: All open wound transformers shall be immersed and baked in a CSA/UL recognized 220C varnish. Encapsulated transformers shall be completely encased in an approved resin or epoxy.

.8 Efficiency: The transformer shall be meet the following Energy Efficiency Standards: Canada - (NRCan 2019) SOR/2018-201, Amd. 14 & ON Reg. 404/12

.9 Basic Impulse Level: Transformers shall have a minimum 10kV BIL unless otherwise stated.

.10 Impedance: Shall not be greater than 6%.

.11 Grounding:

.1 A ground terminal for all grounding and bonding conductor connections shall be secured inside the transformer enclosure and not installed on or over any vented portion of the enclosure.

.2 Ground core & coil assembly to enclosure with a flexible copper grounding strap or equivalent.

.3 Transformer secondary neutral shall be solidly grounded to the ground bus.

.1 The neutral is always required to be tied back to the building main ground bus. The only exception is the following:
.1 Transformer is equal to or less than 75kVA and
.2 Only serves a single piece of equipment. Panelboards and distributions do not qualfy.

.12 Neutral: Wye connected secondaries shall have the neutral brought out to a separate fully rated neutral bus.

.13 Sound Level: The transformer shall at minimum shall meet the sound requirements outlined in NEMA Standard ST-20 Table 3.9.

kVA	NEMA Standard ST-20
3-9	40dB
10-50	45dB
51-150	50dB
151-300	55dB

Lower dB ratings shall be specified for sensitive locations that require minimal sound disturbance.

.14 Enclosure Type:
.1 General purpose areas: NEMA 1
.2 Locations where water ingress will occur: NEMA 3R
.3 Locations where pressurized water ingress will occur: NEMA 4
.4 Wood processing locations and locations subjected to circulating dusts/lints/fibers: NEMA 12

.15 Enclosure Finish: ANSI/ASA 61 grey finish.

.16 Seismic Rating: International Building Code (IBC), SDS=2.00g ; z/h = 1.00 ; Ip = 1.5 rated transformers shall specified by the designer as required for critical applications.

.17 Installation Hardware: Where applicable, lifting lugs shall be adequately strengthened, sized and arranged on the transformer to provide a suitable lift for the completely assembled unit. Provision on the transformer base for skidding and jacking shall be provided as required.

.18 Windows: Infrared windows shall be required for transformers 112.5kVA and larger.

.19 Nameplate: The nameplate shall meet or exceed the requirements of the Canadian Electrical Code and CSA/cUL.

.20 Certifications: All transformers shall bear a CSA or cUL certification label. Alternatively, ensure the equipment has any Nationally Recognized Testing Laboratory (NRTL) member organization's certification label, certifying the equipment for installation in Canada.

.21 Standards: All transformers shall be constructed and tested to CSA C9, C22.2-47, IEEE C57.12.01, IEEE C57.12.91 and NEMA ST-20. In addition to the standards listed prior, K-Factor Rated and Harmonic Mitigating transformers must incorporate IEEE C57.110 and IEEE Std 519 standards.

.22 Warranty: Minimum of 1 year of warranty required.

.23 Approved Manufacturers are:
.1 Schneider Electric / Square D.
.2 Eaton.
.3 Hammond.

.4 Delta.
.5 Rex Power Magnetics.
.6 Marcus

.24 Provide design data and shop drawings for all transformer characteristics for approval by the consultant before proceeding with manufacture.

2.4 Installation Requirements

.1 Location:
- .1 Location shall comply with all applicable codes and standards. This includes requirements set out by the CEC, Technical Safety BC and the BC Building Code.
- .2 Location shall consider the entire life cycle of the transformer. The transformer must be installed in a location that can be easily accessed by maintenance personnel. Access for removal and replacement of the transformer must be considered and any location that will require modification to building infrastructure for removal will not be deemed acceptable.
- .3 The impact of the sound and vibration of the transformer must be considered when finalizing the location. Sensitive business and research operations must be considered.
- .4 If applicable, mechanical protection shall be added in locations that are exposed to an increase risk of damage.
- .5 Any equipment installed above or below the transformer shall not affect access or performance of either piece of equipment, such as:
  - .1 Pull Boxes.
  - .2 Junction Boxes.
  - .3 Cable Tray.
  - .4 Mechanical Equipment - Smoke, Heat, CO2 detectors.
- .6 Transformers are not permitted to be concealed.

.2 Clearance:
- .1 A minimum of 1m (3.28 feet) of clearance is required in front of the transformer as per the Canadian Electric Code.
- .2 The following clearances are required on the sides, back, and top at a minimum:
  - .1 Transformers up to and including 150kVA: 152mm (6 Inches).
  - .2 Transformers over 150kVA to 300kVA: 305mm (12 inches).

.3 Mounting:
- .1 Floor:
  - .1 All floor mounted transformers shallbe on a concrete pad. Mounting directly on the floor is not permitted. For renovations standard feet may be considered with approval from UBC Facilities Electrical if it is determined to not be feasible due to shutdown and/or space restrictions.
  - .2 Concrete pad dimensional requirements:
    - .1 Minimum 4 inch height.
    - .2 Minimum of 6 inches of extension past transformer sides.
- .2 Wall:
  - .1 The largest size permitted is 75kVA.
  - .2 Where applicable utilize manufacturer approved wall mounting kits.
- .3 Ceiling:
  - .1 The largest size permitted is 30kVA.
  - .2 Where applicable utilize manufacturer approved ceiling mounting kits.

.4 Stacked: Stacking of transformers is only permitted if all other options have been exhausted due to lack of space. Stacking is only applicable to floor mount applications and is not permitted for ceiling or wall mount configurations. Stacking shall comply with the following requirements:
  .1 The transformer stacked on top is the same size or smaller than the transformer below.
  .2 The conditions outlined in 2.4.2 have been satisfied.
  .3 The ambient temperature must not exceed 30°C.

.4 Connections:
  .1 Flexible metal conduit shall be utilized for final connections to the primary and secondary sides of the transformer to reduce vibration and sound transmission. Teck cable is an acceptable alternative.

.5 Grounding:
  .1 The ground terminal shall be connected back to the main building ground bus.
  .2 The minimum size grounding conductor shall be #6AWG.

.6 Vibration Isolation:
  .1 All transformers shall have vibration isolation pads between the core and coil assembly and the enclosure.
  .2 Spring based vibration isolation mounts are required to be installed between the transformer and mounting surface. Where possible utilize mounts offered by the same manufacturer as the transformer.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 26

1.2 Coordination Requirements

.1 UBC Energy & Water Services (Vancouver)
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Facility Management (Okanagan)

1.3 Description

.1 UBC requirements for Secondary Power Distribution.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General Requirements:

.1 Two secondary voltage levels are acceptable at the University:
  .1 120/208 Volt, 3-Phase 4-Wire Wye System
  .2 347/600 Volt, 3-Phase 4-Wire Wye System.
  .3 (Vancouver) 600 Volt 3-Phase 3-Wire Wye System. 3 wire supply from EWS can be utilized as long as a solidly grounded system is maintained and tied back to the utility neutral point.

.2 All secondary distribution equipment shall be installed inside conditioned rooms.

.3 The selection of distribution voltage shall be based on building layout. Conditions such as large distribution loads, high building and large footprint shall be used to determine the preferred secondary distribution.

.4 If a 600V secondary distribution is selected, all motors 3/4 hp and over shall be supplied at this level. ECM motors 2HP and below shall be except.

.5 Life Safety, Stand-by, Emergency Power distribution shall not contain any switches between the generator distribution overcurrent device and each transfer switch. All CBs upstream of Life Safety transfer switches shall have auxiliary contacts monitored by the transfer switch or generator or fire alarm system that will notify building maintenance personnel of a “not normal” situation. The monitoring wiring diagram shall form a separate section of the generator submittals.

.6 The electrical distribution shall be designed to limit incident energy to maximum 8 cal/cm^2 at all switches, circuit breakers and MCCs while retaining acceptable coordination selectivity. Incorporate LSI Circuit Breakers, not fuses, where necessary to achieve the desired results.

.7 Secondary power distribution equipment shall have NEMA ratings dependent on the following type of locations:
  .1 General purpose areas: NEMA 1
  .2 Locations where water ingress will occur: NEMA 3R
  .3 Locations where pressurized water ingress will occur: NEMA 4

.4 Wood processing locations and locations subjected to circulating dusts/lints/fibers: NEMA 12

.8 Used or Refurbished distribution equipment is not permitted to be utilized.

.9 Mixing of manufacturers within distribution equipment is not permitted.

.10 The entire electrical system must be fully rated. Series rated systems are not acceptable.

.11 Any new single load added to an existing distribution 36kW or greater requires approval from UBC Facilities Electrical prior to proceeding with design.

2.2 Service Entrance Requirements:

.1 Service Entrance disconnects shall only be circuit breaker type with the ability to be lockable in the open position.

.2 Any building or addition supplied by 208 or 600 Volts shall have entrance switchgear designed and labelled as "Suitable for Service Entrance".

.3 Minimum requirements for breakers at service entrance distributions (unless determined otherwise by coordination study):

.1 LSIG trip units:

.1 Any breaker 600A and larger.

.2 Any breaker 400A and larger that feeds a mechanical distribution.

.3 Any breaker 400A or larger feeding a distribution that contains 2 or more sub distributions/panelboards.

.4 Any breaker feeding a separate building.

.5 Any breaker feeding a bus duct system.

.6 Life safety distributions shall not have LSIG trip units.

.2 LSI trip units are required for other breakers not mentioned in .1.

2.3 Switchboard Requirements:

.1 When a switchboard is fed from a 150kVA transformer or larger the following is required:

.1 The transformer primary breaker shall be LSI complete with arc flash reduction/maintenance mode functionality.

.2 A remote selector switch shall be installed at the same location as the switchboard that can activate the maintenance mode/arc flash reduction. The remote selector switch shall have indicator lights to confirm the status of arc flash reduction/maintenance mode.

.2 Lockout hasps are required on all distribution boards and for all circuit breakers feeding panelboards.

.3 Surge Protective Devices (SPD/TVSS) are required for switchboards feeding laboratory, research and elevator loads.

2.4 Panelboard Requirements:

.1 New Panelboards shall utilize bolt-on molded case circuit breakers. Panelboards shall contain copper buswork. All panelboards shall have phases balanced to within 15% and shall contain a typewritten directory on cardstock. The directory shall include the circuit

number, room(s) number and load description. All new panelboards shall be located on the same floors as the loads they serve.

.2 Panelboards serving laboratory or research spaces where final equipment lists are unknown or the space is designed to have a rotation of researchers shall have a minimum of 50% spare circuit capacity. All other panelboards shall have a minimum of 30% spare circuit capacity.

.3 Tandem/skinny/piggyback circuit breakers shall not be utilized.

.4 All panelboards and loadcentres shall have main lugs only. Panelboards servicing CRUs are exempt and will require a main breaker. Panelboards and loadcentres shall not be back-fed through a circuit breaker.

.5 Where possible every load shall be supplied by a panelboard on the same floor.

.6 Daisy-chaining of electrical panels shall not be permitted. All panelboards shall be fed from separate overcurrent devices.

.7 Panelboards shall not be used as splice boxes.

.8 CTs shall not be installed inside panelboards and shall be located in a separate enclosure.

.9 Surge Protective Devices (SPD/TVSS) are required for panelboards feeding laboratory, research and elevator loads.

.10 The minimum panelboard ampacity shall be 100A. The only acceptable panelboard sizes are the following: 42, 66 and 82 CCT.

2.5 Disconnect Requirements:

.1 Disconnect switches shall not be used as junction boxes.

.2 Fused disconnect switches shall be utilized for single loads of 30kW and greater.

.3 Refer to Section 11 60 00 Cranes and Hoists for disconnect requirements for Cranes and Hoists.

.4 UPS Disconnect Requirements:
- .1 30A or smaller shall be cord connected with twist lock receptacles.
- .2 For all other scenarios a separate disconnect is required for the UPS line side connection.

.5 Fused disconnects with fast acting fuses are required for boilers and other types of loads involving an immersed element in liquid.

3.0 SECONDARY DISTRIBUTION EQUIPMENT IDENTIFICATION AND LABELING

.1 Refer to Section 26 05 53 – Labeling for secondary distribution labeling requirements.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Section 26 16 00 Metering
.2 Section 25 05 00 Building Management System (BMS) Design Guidelines
.3 Section 01 92 00 Monitoring Based Commissioning

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Energy and Water Services BMS (Vancouver)
.3 UBC Facility Management (Okanagan)

1.3 Description

.1 This section details the minimum requirements for the electrical sub meters. Refer to Division 25 05 00 Section 4.6 for additional BMS specific requirements. Any meters required for Service Main and revenue applications shall meet the requirements outlined in Section 26 16 00 Metering.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 The BMS vendor shall provide an approved electrical sub meter assembly as required for the building design. The electrical sub meters shall be integrated into the appropriate BMS system and also into the UBC Sky Spark system.

.2 All electrical sub meters shall meet all required local and national certification requirements.

.3 BACnet network requirements:

.1 BACnet IP requirements

.1 BACnet IP is the only acceptable communication protocol.
.2 UDP port configuration is required (47800 – 47820)
.3 Devices must comply will all other BMS requirements.

.2 Meters shall be ANSI X12.20-2015 class0.2 revenue grade meters.

.4 All electrical sub meters shall comply with section 8.4.3 (electrical energy monitoring) of the most current ASHRAE 90.1 standard, and any other code requirements.

.5 Meter shall support multiple 3-phase metering inputs for monitoring multiple distributions. Allow for a minimum of 1 spare 3-phase input for future use.

.6 Commercial Rental Unit (CRU) shall meet the requirements outlined in Section 26 16 00 Metering.

.7 Approved Manufacturers: Setra or approved equivalent.

.8 Metering is required at the following locations:

.1 Service Entrance Distribution
  .1 Service Main (Vancouver uses PM8240 meter as per 26 16 00).
  .2 All feeders for downstream distributions.

.2 Life Safety (Emergency Power) Distribution
  .1 Main only.
  .2 Additional as required for LEED (mech/lighting)

.3 Standby Distribution
  .1 Main.
  .2 All feeders for downstream distributions.
  .3 Additional as required for LEED (mech/SHW/lighting/plug loads)

.4 Mechanical Distribution
  .1 Main.
  .2 All feeders for downstream distributions.
  .3 Additional as required for LEED (mech/SHW/lighting/plug loads)

.5 Lighting Distribution
  .1 All feeders for downstream distributions.
  .2 Additional as required for LEED

.6 Power Distribution:
  .1 Mains. (if not covered by 1.)
  .2 All feeders for downstream distributions.

2.2 Controls trade responsibilities

.1 Electrical sub meters shall be provided and integrated by the controls trade.

  .1 All network integration shall comply with all other TG requirements outlined in this document.
  .2 All wire from the demark enclosure shall be provided by controls trade.
  .3 BMS must provide direction to the electrical trade for current transducers to meet the requirements for the BMS provided sub meter.

.2 Refer to Standard drawing E4-5c and E4-5d for division of responsibilities between trades.

2.3 Electrical trade responsibilities

.1 Demark enclosure shall be provided by the electrical trade including:

  .1 Circuit breakers (as required).
  .2 Enclosure for demark point.
  .3 Current transducers, as required to connect to the BMS provided sub meter (coordinate with the BMS trade). Rogowski coils shall be utilized.

.2 Refer to Standard drawing E4-5c and E4-5d for division of responsibilities between trades.

2.4 Standard Drawing

.1 Refer to the following Standard Drawings:

.1 E4-5c. Setra Networked Multi-Circuit Power meter 208 or 600V Wiring Connection Diagram – 4 Wire System. This drawing outlines the installation requirements for 208V or 600V 4 wire submetering applications.

.2 E4-5d. Setra Networked Multi-Circuit Power meter 600V Wiring Connection Diagram – 3 Wire System. This drawing outlines the installation requirements for 600V 3 wire submetering applications.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 20 00 05 Mechanical General Requirements

1.2

.1 **Coordination Requirements**

.2 UBC Facilities Electrical (Vancouver)
.3 UBC Facility Management (Okanagan)

1.3 Description

.1 This section outlines electrical requirements of Motor Control which includes Variable Frequency Drives.

2.0 MATERIAL AND DESIGN REQUIREMENTS

.1 Refer to Division 20 00 05 Mechanical General Requirements for mechanical requirements of VFDs.

.2 Variable Frequency Drives (VFD)

- .1 VFDs shall have an adjustable carrier/switching frequency with a minimum adjustment range from 1 - 12kHz.
- .2 VFDs operated at low carrier frequency's can lead to high motor noise. Higher frequencies can reduce noise but may require upsizing the VFD. Another strategy to reduce noise is to install output reactors/sine wave filters.
- .3 It is recommended (at the designer's discretion) that VFDs are selected at a minimum carrier frequency of 8kHz so that the switching frequency can be adjusted upward, if required to reduce noise. However, VFDs should be operated at the lowest possible carrier frequency that produces acceptable noise levels as this will generate the least heat and be the most efficient.
- .4 It is the designer's responsibility to select an appropriate carrier frequency and/or sine wave filters to mitigate the possibility of noise issues.
- .5 Specify matched motors and variable frequency drives with low harmonic content and harmonic filters. Maximum acceptable harmonic content as per IEEE Standard 519 and 1100.
- .6 All VFDs shall have an internal line reactor and DC choke. For motors sized at 5HP and greater, an additional external 3% line reactor is required if the internal line reactor is less than 3%.
- .7 VFD Load side conductors shall always be less than 100 feet from the motor. 3% load reactors are required for all installations greater than 50 feet.
- .8 All VFDs shall include an integral lockable disconnect that is lockable in the open position.
- .9 Installation Requirements:
  - .1 Load side wiring of each variable frequency drives (VFD) shall utilize a dedicated raceway. Load side wiring shall not share raceways or junction boxes with other VFD's or loads. Load side wiring shall be directly connected to the

load without a disconnecting means in the circuit. The only exception shall be air-conditioning and refrigeration equipment. Any other instance will require approval from UBC Facilities Electrical. For any instances where a disconnect is approved for use a lamicoid will be required stating the following: "MOTOR MUST BE STOPPED AT THE VFD PRIOR TO OPERATION OF DISCONNECT".

.2 Flexible conduit shall be used for VFD line and load size conductors. EMT is not acceptable.

.3 Teck cable is permitted to be utilized on load side wiring under the following conditions:

- .1 Mechanical Penthouse / Rooftop VFDs feed Rooftop Units (RTU).
- .2 VFD and motor are located in a space that utilizes cable tray as the primary means of cable transport.
- .3 VFD and motor are located within 5 meters and line of sight of one another.

.4 VFDs shall only be installed in conditioned rooms.

.5 VFDs shall not be mounted on surfaces that are susceptible to vibrations. The only exception is for certified engineered solutions which integrate a VFD and motor/pump together in a prefabricated package.

.6 VFDs mounted adjacent to sources of liquid (i.e. Piping fittings, valves) will require either a rated enclosure for the environment or a barrier such as metal flashing for protection of the VFD from potential water ingress.

.7 Conductors/conduits shall be bottom entry.

.8 Drip hoods are required for all VFDs in sprinklered areas.

.9 VFDs shall be installed such that no operating handle, buttons, displays or switches are greater than 1.8m above the finished floor level.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 27, Section 27 05 05 Communication Rooms Design Guidelines – 2.6
.2 Division 26, Section 26 51 00 Interior Building Lighting – 2.6

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Facilities Management (Okanagan)
.3 UBC Information Technology

1.3 Description

.1 Generator for emergency and stand-by power. Items with (Vancouver) or (Okanagan) only apply to the respective campus.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General Requirements

.1 Generators for emergency and stand-by power shall be installed in buildings as defined in .2 below.

.2 If any of the following are included in building design, then a generator for emergency and standby power shall be installed within the building structure or in an enclosure on the building site.
  .1 10,000 GSM or larger
  .2 Active smoke control
  .3 High Building as defined by the latest edition of BCBC
  .4 Where defined by the Project Design Brief (i.e.: may be required for long-duration research equipment, critical infrastructure, freezer storage or animal care). Required non-life safety power shall be confirmed with user groups early on during the planning stage.

.3 When a generator is installed, the following equipment shall be connected to the emergency/standby source.
  .1 All active smoke control equipment and controls
  .2 Fire Alarm Control Panel
  .3 Emergency and exit lighting
  .4 Heat Trace wiring
  .5 Sprinkler system equipment (dry and pre-action system compressors, excess pressure and fire pumps, heating systems for water service rooms, etc.)
  .6 Sanitary sump pumps and storm sump pumps
  .7 Main electrical, communications and mechanical room lighting and least one convenience receptacle

.4 If a generator is installed then all emergency power shall be supplied from it and battery packs shall not be used other than at the generator/transfer switch location to allow for breakdown maintenance.

.5 In general, fume manifold and bio-hazard hoods should not be supplied from emergency power. Alternate proposals to supply fume and bio-hazard hoods from emergency power may be discussed with UBC Facilities Electrical (Vancouver) / Facilities Management (Okanagan).

.6 In general, elevators not designated as "Elevator for Use by Firefighters" by the BC Building Code should not be powered from generators unless specifically required to be by the BC Building Code. Alternate proposals to supply non-designated elevators from emergency power may be discussed with UBC Facilities Electrical / Facilities Management (Okanagan).

.7 Emergency generators shall be diesel fuel type only.

.8 Emergency generators shall have a minimum 24-hour run time under 100% loading without refueling.

.9 All generators shall be capable of being refuelled from ground level. The refuelling location shall be accessible for fuel trucks to park within 5 meters.

.10 Confirm positive fuel prime to all fuel pumps as required.

.11 See Section 25 05 00 Building Management Systems (BMS) Design Guidelines for requirements for BMS and Section 28 31 00 Fire Detection and Alarm for fire alarm system for generators.

.12 In buildings where generators are installed a 5-20R receptacle supplied by a dedicated over current device shall be installed immediately below each panel that derives its supply from the emergency/standby distribution.

.13 Standby loads may be connected to emergency power circuits provided that the addition of such equipment does not cause the total connected load to exceed 80% of the rated capacity of the emergency generator. The addition of loads with high in-rush current requirements may require the 80% maximum capacity limit to be lowered to maintain a reasonable margin of safety.

.14 Overhead services for generators located exterior of the building is not permitted.

2.2 Generator Housing and Location

.1 Generators to be primarily located at ground level in separate enclosures.

.2 Generators should be housed in areas which are large enough to allow for maintenance, testing and repair, and remove and replace components, without having to remove portions of the structure in which they are mounted.

.3 The areas shall be insulated and heated so as to minimize maintenance on the units.

.4 Generator rooms and transfer switch locations shall be provided with an emergency battery lighting pack for breakdown safety and maintenance on the units.

.5 Sound Attenuation: Generators housings shall be Level III (68 to 70dBA)

2.3 Equipment Type

.1 All generators shall be supplied with remote generator annunciator mounted at transfer switch location.

.2 Generators shall be sourced from original equipment suppliers so that parts are readily available and locally supplied and supported within a 100km radius.

.3 The following are approved manufacturers:

1. Cummins
2. Finning/CAT
3. Blue Star
4. Simmax
5. Generac

System shall be compatible with existing UBC operating control systems.

2.4 Loadbank Requirements

.1 To assist with maintenance, generators shall have a second circuit breaker rated for 100% load on the generator output prior to the transfer switch. This is for tying in load banks for annual testing without disturbing cables and lugs of normal loads, as per CSA C282-05 B18. The load bank breaker shall have a shunt trip that will activate upon operation of the transfer switch. The output of the second breaker shall extend to a 3R outdoor-rated Cam-Lok 1016E female connection box mounted on the generator enclosure or in an accessible location exterior to the building envelope.

2.5 Generator Transfer Switches

.1 Automatic Transfer Switches (ATS) shall be supplied with fully rated double-bypass isolation capability.

.2 Transfer Switch Type:

.1 (Vancouver): Unless requested, all transfer switches shall be Open transition type.

.2 (Okanagan): Unless requested, all transfer switches shall be Closed transition type.

.3 The entire ATS & bypass assembly shall be certified to CSA C22.2 No. 178.

.4 ATS shall have a minimum18 cycle Withstand and Close-on Rating on all equipment rated at 400 amps and greater.

.5 ATS bypass/isolation handles shall be permanently attached & require a maximum of two steps to perform bypass/isolation operation.

.6 ATS main contacts and bypass contacts shall be fully withdrawable on equipment rated at 400 amps and greater.

.7 All components within the ATS shall be supplied, commissioned and supported by the ATS provider.

.8 Closed Transition Transfer Switch Requirements:

.1 Closed Transition Transfer Switches (CTTS) shall include a separate redundant protection relay to prevent any possible back feed to the utility. (Vancouver) All methods of providing this form of protection shall be submitted to UBC Energy & Water Services for approval prior to equipment installation. (Okanagan) UBC Okanagan must coordinate and receive approval from Fortis BC prior to finalizing CTTS specifications.

.2 CTTS redundant backfeed protection may be a reverse power relay set not more than 5% of the generator rating and extended parallel relay set at not more than 1 Second.

.9 Transfer switches shall be motorized or solenoid contact type.

.10 Consultant recommended programmable settings shall be reviewed with UBC as left condition.

2.6 Fuel Tanks

.1 All diesel fuel tanks shall be above ground and double walled unless a single walled tank is contained by a separate containment tank, for example, a day tank.

.2 Underground tanks that are inherited with their piping systems shall be removed as part of any replacement.

.3 Fuel storage tanks shall be protected from freezing.

2.7 Maintenance Manuals

.1 At least two complete sets of manuals, (these shall include operators, owners, troubleshooting, full repair manuals as well as any disks and software diagnostics), shall go to the shop level before sign off and acceptance of units. One digital copy is required.

.2 A complete set of manuals for each Transfer Switch shall be provided. The manuals shall include all schematics and wiring diagrams for actual supplied components and commissioning report. Generic manuals will not be accepted.

2.8 Central Inverter Systems

1. For buildings 2,500 GSM to 10,000 GSM a Central Inverter System shall be provided to supply all BCBC required exit signs and egress lighting.

2. A single piece of Unit Equipment shall be installed at each Central Inverter System location.

3. Total loading shall not exceed 60% of system capacity as calculated for BCBC requirements.

4. The Central Inverter System shall be capable of connecting to the BMS system for monitoring of all inverter alarms using dry contacts.

5. Approved manufacturer is Ready-Lite or approved equal.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Division 7
.2 Division 25
.3 Division 26

1.2 Coordination Requirements

.1 UBC Facilities Electrical (Vancouver)
.2 UBC Facilities Management (Okanagan)

1.3 Description

.1 UBC Requirements for rooftop Solar Photovoltaic (PV) systems

1.4 Definitions

.1 Unless otherwise specified or indicated, electrical terminology used in this specification shall be as defined by the latest EGBC adopted version of the Canadian Electrical Code C22.1, Part I.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 General Requirements

.1 The Solar PV System shall be connected to the UBC electrical grid at 120/208 volts AC.

.2 All design, material procurement, and construction shall be completed in accordance with CSA, IEEE, NEMA, and local codes, as specified in the UBC Technical Guidelines, and as shown in the drawings.

.3 The total nameplate module power (total installed DC capacity) for the Solar PV System shall be 100 kW DC or less, with consideration for host facility loads and limited export. This is determined without estimating bifacial gain.

.4 Proponent shall provide a simulation production report using PVsyst or Helioscope as a part of the bid package. Refer to section 2.9 Simulation Production Report Parameters.

.5 Proponent shall provide ETAP simulation to show impacts of project within existing UBC model. Current model shall be provided by UBC.

.6 The sum of the maximum DC and maximum AC wiring voltage drop from photovoltaic source circuits to the points of interconnection shall not exceed 3.0%.

.7 Voltage drop calculations shall be as outlined in the Canadian Electrical Code and include all vertical and horizontal lengths, resistivity values, and a 7.0% slack factor.

.8 All terminals used for all power conductors within the Solar PV System shall be rated CU9AL.

.9 All equipment exposed to direct sunlight and environmental elements shall be outdoor-rated and sunlight-resistant.

.10 All equipment shall be installed and protected to maintain its enclosure protection rating.

.11 All AC electrical distribution used for the Solar PV System shall be sized for continuous load at 100% of PV inverter nominal AC power.

.12 All female and male PV connector connections shall be mated pairs from the same manufacturer and model family.

.13 Rodent protection of PV conductors is required as per CEC Rule 64-210 5). The proposed solution (enclosed wireway, mesh, split loom, etc.) shall be reviewed and approved by UBC and TSBC during the design phase and prior to procurement. The proposed solution shall be designed and installed with materials and in a manner to last the life of the project. An estimate of bifacial loss due to the proposed solution shall be provided by the design-builder as a part of simulation and performance verification activities.

.14 The Solar PV System shall be designed such that access for maintenance, repair and testing of the system does not require personnel-lifts or fall protection. The entirety of the system shall be located at least 3 meters from a fall hazard or unprotected edge (Any side or edge (except points of access) of a walking/working surface where there is no wall or guardrail system at least 1070mm or parapet at least 1.2m high).

.15 The Solar PV System shall allow for access to other equipment and systems (mechanical, envelope, etc.) for maintenance and replacement without requiring personnel-lifts or fall protection.

.16 Exemptions to design requirements will be considered on a case-by-case basis by UBC.

2.2 DC Wire and Wire Management Specifications

.1 Characteristics of the PV wiring shall be:
- .1 Copper
- .2 RPVU90, XLPE, CSA approved.
- .3 1000V rated.
- .4 Sunlight resistant.
- .5 -40°C to 40°C ambient temperature rated.
- .6 90°C operating temperature rated.
- .7 Red for positive, black for negative

.2 Characteristics of the PV wire management shall be:
- .1 Cables shall be run to connect adjacent panels using the leapfrog method.
- .2 Cables at the source circuit shall be permitted to be routed along PV module frames and racking system with or without a raceway but must be protected from damage.
- .3 Cables beyond 300mm of the array must be in a raceway.
- .4 Cable runs shall be continuous, and splices are not permitted.
- .5 Cables shall be protected from any sharp edges by use of protective grommets.

2.3 PV Combiner Specifications

.1 Solar PV systems incorporating combiners will be evaluated on a case-by-case basis, combiners generally used for larger, utility-scale projects and applications.

.2 Characteristics of PV combiners shall be:
- .1 PV Combiner Type
  - .1 Disconnect Combiner.
  - .2 Ungrounded PV.
  - .3 Positive and Negative Fused.
  - .4 Continuous Rated.
- .2 Safety Features
  - .1 Load Break Rated and Lockable DC Disconnect.
  - .2 Dead Front Over Live Parts.
  - .3 Lockable Cover.
  - .4 Touch-Safe Fuse Holders.
  - .5 Transient Surge Protection.
  - .6 90 °C terminals (source and output).
- .3 Enclosure Protection Rating
  - .1 NEMA 3R or 4X.
- .4 Certifications and Approvals
  - .1 CSA C22.2 107.1 Power Conversion Equipment.
  - .2 UL 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources.
- .5 DC-AC Ratio
  - .1 Rated maximum DC current shall allow for DC-AC ratio of connecting PV inverter to be 1.4 or greater.
- .6 Operating Temperature Range
  - .1 Minimum temperature shall be -25°C or lower.
  - .2 Maximum temperature shall be 40°C or higher.
- .7 Storage Temperature Range
  - .1 Minimum temperature shall be -40°C or lower.
  - .2 Maximum temperature shall be 60°C or higher.
- .8 Manufacturer Warranty
  - .1 Standard shall be 5 years or longer.
  - .2 Optional extensions shall be available.

.3 Approved manufacturers of photovoltaic combiners are as follows:
- .1 SolarBOS.
- .2 Bentek Solar.
- .3 Additional manufacturers will be considered at the discretion of UBC.

.4 Depending on selection of PV inverters, PV combiners may not be required.

2.4 PV Module Specifications

.1 Characteristics of the PV modules shall be:
- .1 Module Type
  - .1 Bifacial or monofacial.
  - .2 Mono-crystalline or poly-crystalline silicon.
  - .3 60 or 72 full-cell modules.
  - .4 Anodized aluminum frame.

.5 Anti-glare glass.
.6 Potential Induced Degradation-free certified.

.2 Module Power
.1 Front-side STC power shall be 375 watts DC or greater.
.2 Power tolerance shall be positively sorted.

.3 Maximum System Voltage
.1 UL rated for 1500 volts DC or greater. IEC ratings are not acceptable.

.4 Junction Box Protection Rating
.1 IP 67 or IP 68.

.5 Certifications and Approvals
.1 ULC/ORD C1703 Standard for Flat-Plate Photovoltaic Modules and Panels.

.6 Module Efficiency
.1 Front-facing STC efficiency shall be 19% or greater.

.7 Bifaciality Ratio
.1 Module power bifaciality shall be 70% or greater.

.8 Temperature Coefficients
.1 Maximum power temperature coefficient shall be higher than -0.36% per °C.
.2 Open-circuit voltage temperature coefficient shall be higher than -0.30% per °C.
.3 Short-circuit current temperature coefficient shall be lower than 0.06% per °C.

.9 Operating Temperature Range
.1 Minimum temperature shall be -25°C or lower.
.2 Maximum temperature shall be 85°C or higher.

.10 Mechanical Loading
.1 Front side maximum static loading shall be rated for 5400 Pa or higher.
.2 Rear side maximum static loading shall be rated for 2400 Pa or higher.

.11 Manufacturer Warranty
.1 Standard product warranty shall be for 12 years or longer.
.2 Standard performance warranty shall be linear and for 25 years or longer.
.3 At the end of year 1, actual power output shall be guaranteed for greater than 97.4% of the front-side STC power. (low Light Induced Degradation)
.4 At the end of year 25, actual power output shall be guaranteed for greater than 80% of the front-side STC power.
.5 For installations lower than -25°C, manufacturer letter required stating extreme minimum that is compliant with warranty

.2 Approved manufacturers of PV modules are as follows:
.1 Canadian Solar.
.2 Hanwha Q Cells.
.3 LG.
.4 Longi Solar.
.5 Trina Solar.
.6 Jinko Solar.
.7 Additional manufacturers will be considered at the discretion of UBC.

2.5 PV Inverter Specifications

.1 Characteristics of the PV inverters shall be:

.1 Voltage

.1 PV inverters shall be 3 phase only.

.2 PV inverters shall be rated for 120/208 volts AC.

.3 AC connection topology shall be grounded-wye, with or without neutral.

.2 Safety Features

.1 DC Reverse Polarity Protection.

.2 DC AFCI Arc-Fault Protection.

.3 Remote Disable for Rapid Shutdown.

.4 DC Ground Fault Protection.

.5 DC Disconnect.

.6 Grid-Interactive Protection Features (IEEE 1547 compliant).

.3 Enclosure Protection Rating

.1 NEMA 3R or 4X.

.4 Interconnection Standards

.1 IEEE 1547-2018 Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

.5 Certifications and Approvals

.1 CSA C22.2 107.1 Power Conversion Equipment.

.2 UL 1699B Standard for Photovoltaic (PV) DC Arc-Fault Circuit Protection.

.3 UL 1741-SA Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources.

.6 Efficiency

.1 California Energy Commission (CEC) determined efficiency shall be 97.0% or greater.

.7 DC-AC Ratio

.1 Rated maximum DC power to AC nominal power shall be 1.4 or greater.

.8 Operating Temperature Range

.1 Minimum temperature shall be -25°C or lower.

.2 Maximum temperature shall be 60°C or higher.

.9 Storage Temperature Range

.1 Minimum temperature shall be -40°C or lower.

.2 Maximum temperature shall be 60°C or higher.

.10 Manufacturer Warranty

.1 Standard shall be 5 years or longer.

.2 Optional extensions shall be 15 years or longer.

.3 For installations lower than -25°C, manufacturer letter required stating extreme minimum that is compliant with warranty.

.4 Manufacturer shall provide letter and custom nameplate labels for de-rated inverters.

.11 Grid Support Features

.1 Low/High Voltage Ride-Through Capability.

.2 Low/High Frequency Ride-Through Capability.
.3 Non-Unity (Reactive) Power Factor Capability.

.12 Monitoring and Control
.1 PV inverters shall have read and write capabilities to communicate with the monitoring and control platform.

.13 Connectivity and Configuration
.1 PV inverters shall communicate with the monitoring and control platform and be configured via ethernet port.
.2 Where an ethernet connection is not possible, Bluetooth connectivity requirements shall be provided to UBC IT for review prior to selection.
.3 Where required, Bluetooth connectivity shall only be enabled for configuration of PV inverters, and shall be disabled once configuration is complete.

.2 Approved manufacturers of PV inverters are as follows:
.1 SMA.
.2 Sungrow.
.3 Fronius.
.4 Additional manufacturers will be considered at the discretion of UBC.

2.6 Weather Station Specifications

.1 Minimum sensor requirements of the weather station shall be, but not limited to the following:
.1 Plane-of-array (POA) Pyranometer.
.2 Ambient Temperature Sensor.
.3 Cell Temperature Sensor.
.4 Wind Direction Sensor.
.5 Wind Speed Sensor.

.2 Approved manufacturers of weather stations are as follows:
.1 Campbell Scientific.
.2 Hoskin Scientific.
.3 Hukseflux.
.4 Kipp and Zonen.
.5 Additional manufacturers will be considered at the discretion of UBC.

.3 Monitoring and Control
.1 Weather station shall have read and write capabilities to communicate with the monitoring and control platform.

.4 Certifications and Approvals
.1 All weather station components to be certified for use in Canada (CSA, ULC, ETLC, or TUVC).

2.7 Monitoring and Control Platform Specifications

.1 Characteristics of the monitoring and control platform shall be to:
.1 Measure and monitor all inverters within the system.
.2 Provide an illustrative display of the status, power flows, and environmental impact of the system.
.3 Provide multi-level fault reporting to UBC personnel based on measured data and reading device fault and alarm registers.

.4 Provide local access to monitoring and control platform via ethernet port for connection to a laptop.
.5 Provide SIM/cellular data connection for internet access where required.
.6 Bluetooth connectivity for configuration and commissioning only shall require UBC IT review.

.2 Approved manufacturers of monitoring and control platforms are as follows:
.1 Fronius Smart Meter
.2 Cachelan
.3 Meteocontrol
.4 AlsoEnergy
.5 Additional manufacturers will be considered at the discretion of UBC.

2.8 Integration with Building Management Systems

.1 Provide a bi-directional meter for each project, refer to requirements listed in Division 25 Building Management Systems (BMS) Design Guidelines.
.2 Provide contact-based connection to BMS to allow for monitoring of PV system.
.3 Provide required information to reprogram existing building protection relays to meet EWS requirements for bi-directional power flows.

2.9 Rooftop Racking Specifications

.1 Characteristics of the rooftop racking system shall be:
.1 Aluminum rails.
.2 Ballested.

.2 Approved manufacturers of racking systems are as follows:
.1 Terragen
.2 Polar Racking
.3 Kinetic

.3 Certifications and Approvals
.1 CSA SPE-900-13 Solar photovoltaic rooftop-installation best practices guideline.

2.10 Simulation Production Report Parameters

.1 The Geographical Site shall be West Point Grey, Canada
.2 Parameters for the simulation production report shall be as follows:

Table 1 Summary of Simulation Report Parameters

MODEL PARAMETER	INPUT/VALUE	NOTES
PVsyst Version	7.2 or newer	Other variants should be verified before use
Project Location	As per design	
Meteorological Data	West Point Grey, Meteonorm 8.0 ,Sat=100% - Synthetic	
Module	As per design	
Inverter	As per design	
DC Capacity	As per design	
AC Inverter Capacity	As per design	
Racking Configurations and Dimensions	As per design	

Tilt Angle	As per design	
Azimuth	As per design	
Horizon	Free Horizon	
3-D Model/Near Shading	2-D Layout	
Transposition Model	Perez	
Bifacial Setting – Albedo	Concrete 0.35	
Bifacial Setting – Height	As per design	
Bifacial Settings - Rear Shading Factor	Industry Standard Value - 8.5%	Update Rear Shading Factor based on design.
Bifacial Settings – Rear Mismatch Loss	Industry Standard Value - 6.0%	Update Rear Mismatch Loss based on design.
Bifacial Settings - Bifaciality Factor	As per design	
Bifacial Settings – Transparency	0%	
String Length	As per design	
Sub Arrays	As per design	
Soiling Loss	As per Table 2 or Townsend model	
IAM	Default or Module manufacturer provided	
Thermal Loss Factor	Constant Value - 29.0 W/m^2k Wind Value – 0 $W/m^2k/m/s$	
LID (Light Induced Degradation)	2%	
Module Quality Loss	Module datasheet	
Module Mismatch	2%	
Global DC Losses at STC	As per design	
AC Losses at STC	As per design	
Transformer Losses – Iron Loss	Transformer datasheet	
Transformer Losses – Resistive/Inductive Losses	Transformer datasheet	
Auxiliaries Losses	As per design	
Availability Loss	0%	To be accounted for by Owner
Grid Power Limitation	As per design	
Power Factor	As per UBC requirements	

Table 2 Array Soiling Losses

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16.4%	7.7%	2.6%	2%	2%	2%	2%	2%	2%	2%	5.7%	17.9%

The above soiling losses are to be used for projects where soiling is not estimated on a site-specific basis. The above soiling losses are not applicable for ground-mount projects.

3.0 ACCEPTANCE TESTING

.1 Photovoltaic module manufacturer, photovoltaic combiner manufacturer, inverter manufacturers, and weather station manufacturer shall provide factory test reports for the procured equipment for UBC's review and approval.

.2 Acceptance testing shall include, but not limited to the following:
  .1 IV Curve Tracing

.1 Commissioning personnel shall IV curve trace each PV string to demonstrate acceptable performance of the photovoltaic modules across the possible range of voltage and current levels.

.2 System Performance Testing

.1 Commissioning personnel shall demonstrate over 3 separate days that the measured exported energy from the solar photovoltaic system is greater than 90% of the modeled exported energy determined by the as-built solar simulation model using the same meteorological dataset.

.2 During the testing period, the following variables shall be measured and recorded:

.1 Weather conditions
.2 Time
.3 Irradiance
.4 Temperature
.5 Output power

.3 The expected output power shall be calculated from the following formula:

$P_E = P_{STC} \times (I_{MEASURED} / I_{STC}) \times [1 + (C_T \times (T_C – T_{STC}))] \times PF \times D_T$

where:

P_E = the expected instantaneous output power
P_{STC} = the module power rating at STC multiplied by the number of modules
I_{STC} = the irradiance at STC (1000 W/m2)
C_T = the module temperature coefficient
T_{STC} = the module temperature at STC (25°C)
PF = power factor set (as required by UBC)
D_T = total calculated system derate factor

D_T is determined as a sum of the following derate factors:
Average Module Quality
Module Mismatch
CEC Inverter Efficiency
DC Wire Losses
AC Wire Losses
Weighted Transformer Efficiency
Annual Average Soiling
Light Induced Degradation
Yearly Degradation

For an example of how D_T is calculated, see Table 3 below:

Table 3 Example Derate Factors

Description	**Loss**
Average Module Quality	-0.98%
Module Mismatch	0.4%
Inverter Efficiency Loss	3.5%
DC Losses	1.5%
AC Losses	1.0%
Transformer Loss	2.0%
Annual Average Soiling	2.0%
Light Induced Degradation	1.5%
Yearly Degradation	0.7%
Total Calculated System Derate D_T	**88.38%**

.4 All system derate factors shall be approved by UBC prior to their use in performance testing.

.3 Local Command Testing
.1 Commissioning personnel shall demonstrate that the solar production system can accept commands to transfer between grid-interactive and standalone modes.

.4 Power Quality Testing
.1 Commissioning personnel shall demonstrate that the solar photovoltaic system complies with the frequency, voltage, power factor, and harmonic distortion requirements of UL 1741 in both grid-interactive and standalone modes.

.5 Anti-Islanding Testing
.1 Commissioning personnel shall demonstrate that the solar photovoltaic system complies with the anti-islanding requirements of UL 1741 in both grid-interactive and standalone modes.

.3 Deliver the following documents on completion of the project:
.1 As-built drawings
.2 Shop drawings
.3 Manufacturer Operating and Installation Manuals
.4 Datasheets
.5 Warranties
.6 Additional Maintenance instructions, as applicable.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 Section 27 05 05 Communication Rooms Design Guidelines – 2.13

1.2 Coordination Requirements

.1 UBC Energy & Water Services (Vancouver)
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Information Technology.
.4 UBC Learning Space Design Guidelines
.5 UBC Facility Management (Okanagan)

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 General

.1 All interior building lighting shall be supplied from 120 volt power systems.

.2 Lighting design shall incorporate the principles of sustainability (environmental & financial) and its products and systems shall be energy conserving, long life, have a low cost of ownership and be accessible for service and maintenance.

.3 For interior building lighting solutions, preference shall be given to Light Emitting Diode (LED) light sources. HID lighting shall not be permitted.

.4 Daylight harvesting opportunities shall be implemented in areas where natural daylight is available. Where required by code, all classrooms, lecture theatres, large offices, corridors, stairways and other public spaces shall incorporate daylight harvesting via use of interior mounted photocells and arranged to take advantage of free illumination while maintaining acceptable minimum illumination levels within the space.

.5 Uniformity and low brightness contrast shall be achieved by judicious use of luminaires and their locations.

.6 All lighting shall be designed to suit the task and task location rather than the general lighting. ASHRAE 90.1, IESNA and WorkSafeBC guidelines shall be taken into consideration and calculations submitted where requested.

.7 As a general rule, the following task lighting levels shall be used:

.1	Offices	500 lux maintained.
.2	Classrooms and Seminar Rooms	500 lux maintained.
.3	Corridors	100 lux maintained.
.4	Washrooms	150 lux maintained.
.5	Special areas such as laboratories, Audio/Video rooms, drafting rooms, etc., in accordance with the user's task requirements and IESNA recommendations.	

.8 When mounting luminaires in high ceiling spaces, consideration must be given to ensure access for maintenance such as fixture, driver, lamp and ballast replacement. The use of scaffolding is discouraged. Indoor lighting shall be accessible either from ladders on flat surfaces such as floors or stair landings or from powered lifts with a maximum lift of 6.1

m. Building access, floor construction, and elevators shall permit entry and use of existing UBC lift equipment for proper and safe maintenance (Genie GR20 with weight of 1,112 kg (2451 pounds) and able to pass through a standard 3'x7' door opening.) If special equipment is required for lighting maintenance, then the consultant shall present a preliminary Lighting System Maintainability Plan to UBC Facilities Electrical (Vancouver) / Facility Management (Okanagan) for review and approval. The preliminary plan shall contain a high-level overview of the special equipment and processes required for maintenance of the system. Architectural, Structural and Conveyancing requirements must be confirmed for moving special equipment to and from the locations after construction is completed. The finalized plan will be submitted by the contractor and it shall contain detailed documentation describing the special equipment, maintenance procedure/schedule and spare parts list. Existing operations and Work Safe BC Fall Protection procedures shall be minimized by the design. Refer to Section 11 81 29 Facility Fall Protection for more details.

.9 The lighting design proposed for all public areas such as corridors and stairways shall ensure the life safety of building occupants at all times and shall also minimize lighting energy required to maintain BCBC minimum levels (i.e. lights off until occupancy has been detected or an emergency has occurred). A portion of the lighting fixtures shall be wired to a Life Safety power panel if an emergency generator or Central Inverter is available. Lighting circuits fed from emergency power panels shall be arranged so that they may be switched or dimmed during normal operation.

.10 Suspended luminaires shall be direct/indirect. Full indirect suspended luminaires are not acceptable. Suspended luminaires shall be avoided in rooms with audio-video projection systems.

.11 Non-linear specialty fixtures and other decorative lighting shall be minimized and shall not exceed 10% of the total quantity of fixtures in the building project. Specialty/decorative lighting includes the following: cylinders, sconces, wall washers, pendants, chandeliers, cove light, track light (monorail), spot light, pin hole light, fiber optic lighting and LED strips.

.12 Metal Halide (MH) lighting solutions are not acceptable. LED solutions, especially for high bay applications, shall be pursued.

.13 Banks of multiple switches shall be labeled to avoid confusion.

.14 All light fixtures provided shall be stock items (no custom made fixtures) readily available from local suppliers. The fixtures are required to be in current production with no plans to cease production and support within a 5 year period.

.15 Light fixtures shall not contain batteries.

.16 All light fixtures shall be attached to building structure using mechanical fasteners. Tape and or adhesive methods shall not be used.

.17 Stage lighting fixtures and control for audio-video enabled spaces shall be provided by Division 27 Audio-Video.

.18 Lighting integrated into handrails is not permitted.

2.2 Lamps (Renovations Only)

.1 Preference will be given to LED linear T8 lamps, linear fluorescent T8 lamps shall not be used.

.2 T8 LED lamps shall be rated for at least 50,000 hours operation with 3 hours per start. Acceptable manufacturers are: General Electric, Osram, Sylvania, or Philips.

.3 T8 - 15 watt (maximum) LED lamps with 3500' K color temperature operating from 120 volt instant start ballasts with standard ballast factors shall be the standard.

.4 T8 LED lamps shall not be line-voltage connected.

.5 LED lamps shall be used as substitutes for traditional applications involving CFL, MR-16, PAR 20, PAR 30, PAR 38 lamps. LED lamps shall be Energy Star rated. Acceptable manufacturers are: General Electric, Osram, Sylvania, or Philips.

2.3 Ballasts (Renovations Only)

.1 If fluorescent lighting must be used, the ballasts specified shall be compatible with GE and Philips T8 LED lamps. Ballasts shall have parallel lamp operation. Acceptable manufacturers are: General Electric, Osram, Sylvania, Philips/Advance or Universal.

.2 Ballast output frequency shall be greater than 42 kHz.

.3 Dimming ballasts shall be instant start with 0-10 volt control.

.4 Ballasts shall have lamp end-of-life detection and shutdown circuitry that meets ANSI standards.

2.4 Lighting Controls

.1 Design Philosophy:

.1 Lighting Control Panel(s) shall be used in the following areas: Entrances, Vestibules, Lobbies, Atriums, Corridors, General/Public/Circulation Areas

.2 Room Controllers shall be used in areas that require zoning, dimming, occupancy sensing and daylight harvesting (if applicable). This includes but is not limited to the following areas: Meeting Rooms, Classrooms, Offices, Restrooms, Gymnasiums, Laboratories (Dry, Wet) and Reception Areas.

.3 Service rooms shall utilize ON/OFF switching only. This includes but is not limited to the following areas: Electrical Room, Mechanical Room, Generator Room, Elevator Machine Room.

.4 Areas that require single zoning, dimming and occupancy sensing shall utilize standalone line or low voltage control with wall or ceiling occupancy sensors.

.5 Areas that require single zoning and occupancy sensing shall utilize standalone line or low voltage control with wall or ceiling occupancy sensors.

.6 Stairwells shall utilize standalone line voltage control with fixture mounted occupancy sensors.

.2 The following lighting control protocols shall be utilized at UBC:

.1 0-10V - All spaces shall utilize 0-10V control systems except for the locations described in the subsections .2 and 3.

.2 DALI - Locations with specific lighting requirements that cannot be satisfied by 0-10V. IE: Research, Animal care.

.3 DMX - Theatrical Spaces.

.3 Manufacturers:

.1 The following product lines are approved for use by UBC. Alternative product lines are not approved (including alternative lines from a manufacturer listed below) and must be reviewed by UBC Facilities Electrical (Vancouver) / Facility Management (Okanagan):
- .1 Legrand Wattstopper
- .2 Copper Greengate
- .3 Hubbell Current

.4 Lighting Control Panels and Controllers:

.1 Control Panels and Room controllers are required to operate standalone. Networking between panels and controllers will only be permitted in instances required by ASHRAE or where specific operational requirements of a building deem it a necessity.

.2 Where low voltage lighting controls are provided they shall include a BACNET compatible BMS interface device.

.3 The lighting control system shall have the capability of being controlled by the BMS system however will not be connected to it and will operate independently. A 1" conduit (with pull string) between the lighting control panel(s) and BMS system will be required for future connection between systems.

.4 Wireless controls and programming solutions shall not be utilized unless approved in writing by UBC IT information security office and UBC Facilities Electrical (Vancouver) / Facilities Management (Okanagan).

.5 Hardwired programming is required for all panels and controllers. Systems that require special software and/or licensing fees are not acceptable. Main control panels or controllers shall have the ability to access the programming or firmware updating through an IP based web browser method.

.5 Occupancy Sensors, Switching and Dimming:

.1 Occupancy sensors shall meet the following requirements:

- .1 Dual technology type with both Passive Infrared (PIR) and acoustic/ultra-sonic sensors,
- .2 Line voltage or low voltage types.
- .3 Low voltage occupancy sensors shall have 1 or 2 poles, local power packs and Form C dry contact isolated relays for BMS connection. Slave power packs are not acceptable.
- .4 Occupancy sensor time delay settings shall be adjusted to 20 minutes for offices, classrooms, theatres and washrooms.

.5 Occupancy sensors shall be positioned, masked and calibrated to prevent triggering by motion in adjacent areas.

.6 In classrooms and lecture theatres, occupancy sensors shall cover 100% of the seating area and instructor area. The occupancy sensor shall be able to detect the lower activity levels of seated occupants.

.7 Where cubicles exist occupancy sensors shall be placed to cover all workstations.

.2 ASHRAE requirements for occupancy sensors and timers shall be overridden in interior spaces where a hazardous situation may be introduced to building users due to the absence of light. This includes but is not limited to spaces such as Laboratories and Service Rooms. Designers shall consult with users to confirm specific space requirements that require omission.

.3 Offices, classrooms, and lecture theatres shall have light control switches at all entrances, exits and vestibules. These interior spaces shall also have occupancy sensors, mounted at a high level in a corner and arranged for semi-automatic operation such that manual operation of the local switches is required to energize the lighting while occupancy sensors and local switches will de-energize the lighting. Large spaces may need more than one sensor.

.4 Entry/Vestible/Corridor switches shall not be located in publicly accessible locations and shall be in areas accessible by maintenance personnel. Custodial rooms are preferred. Switches shall not be located in electrical or mechanical service rooms.

.5 LED dimmers shall be compatible with the LED lamps used and their drivers.

.6 Installation Requirements:

.1 Lighting controllers shall be installed in locations that do not exceed 4 meters of elevation and are easily accessible by maintenance personnel. The preferred location is adjacent/above entrance doorways.

.2 Concealed lighting controllers must be accessible by a removable tile, panel or hatch. The access must be sized large enough to allow for all tasks that will be required for replacement and maintenance of the controllers. Controllers shall not be concealed behind equipment that may require removal for proper access to controllers.

.3 The following is required for control wiring:

.1 Wiring shall utilize an independent, dedicated raceway.

.4 The following is required for Cat5/Cat5e/Cat6 communication cables used for connections between devices and controllers:

.1 Purple/Violet coloured jacket.

.2 Cable shall not be in free air in excess of 300mm.

.3 Cable shall utilize an independent raceway. Usage of cable ties and supporting off other raceways is not acceptable.

.4 Cable cannot be utilized in the same raceway as IT.

2.5 Lighting Controls – AV Enabled Space Requirements

.1 Lighting in audio/video enabled spaces, including theatre (type 1), classroom (type 2), seminar room (type 3), and video-conferencing/AV capture enabled shall be controlled by Crestron lighting control or equivalent. Equivalents will be evaluated by UBC IT Audio

Visual. Approval of equivalent equipment will be provided in writing by UBC IT Audio Visual Technical Specialist. Refer to UBC Learning Space Design Guidelines for space type definitions and further lighting requirements.

.2 Each lighting controller in an audio/video enabled space shall have an IT network data drop in order to allow control from the AV system. Firewall rules shall be arranged with UBC IT to allow communication between lighting controller and AV system controller as required. Refer to Section 27 05 08 for IT cable infrastructure requirements.

.3 Lighting in audio/video enabled spaces, including informal learning spaces (type 4) and dry and wet labs (type 5) do not require audio/video integration and can match other controller solutions in the building.

.4 Audio/video enabled spaces shall have lighting zones to accommodate the use-cases of the spaces. The extent of zoning will vary depending upon the size and geometry of the spaces.

.1 Spaces with 75 seats or more shall have, at minimum, the following zones:

.1 Zone 1 – Marker boards/blackboards should have uniform lighting with sufficient illumination for legibility of writing from all seats.

.2 Zone 2 – Front of the room should have uniform lighting for the front of room instructor area with sufficient illumination to support visibility of instructor, other front of room participants, and anticipated demonstrations, without directing light onto the screen surface.

.3 Zone 3 – Front seating should have uniform lighting for the front rows of seats with sufficient illumination to support reading, note-taking and visibility of seat occupants by the instructor and by other room occupants.

.4 Zone 4 – Back seating should have uniform lighting for the back rows of seats with sufficient illumination to support reading, note-taking and visibility of seat occupants by the instructor and by other room occupants.

.5 Refer to UBC Learning Space Design Guidelines for additional lighting zone guidelines.

.2 Spaces with less than 75 seats shall have, at minimum, the following zones:

.1 Zone 1 – Front of the room should have uniform lighting for the front of room instructor area with sufficient illumination to support visibility of instructor, other front of room participants, and anticipated demonstrations, without directing light onto the screen surface.

.2 Zone 2 – Seating should have uniform lighting for all rows of seats with sufficient illumination to support reading, note-taking and visibility of seat occupants by the instructor and by other room occupants.

.3 Refer to UBC Learning Space Design Guidelines for additional lighting zone guidelines.

.3 Video conferencing enabled spaces shall have, at minimum, the following zones:

.1 Zone 1 – Front of the Room should have uniform lighting for the front of the room area with sufficient illumination to support visibility of the presenter, without directing light onto the screen surface.

.2 Zone 2 – Primary seating should have uniform lighting for all seats with sufficient illumination to support reading, note-taking and visibility of seat occupants by the instructor, and by other room occupants. Each occupant location shall have an average of 1.2:1 to 2.5:1 key:fill luminance ratio to allow for optimal facial rendering by the video conferencing camera.

.3 Zone 3 – Rear and side walls should have uniform lighting with sufficient illumination to provide an average of 0.7:1 to 1.8:1 wall:occupants luminance ratio to allow for optimal depth rendering by the video conferencing camera.

.4 For all other audio/video enabled spaces, the lighting zones shall be designed to meet the application of the space and shall take into account audio/video technology being used. The design shall be approved by UBC IT Audio Visual in writing.

.5 Low-voltage lighting button panels in audio/video enabled spaces shall confirm to the following guidelines:

.1 Lecture theatres shall have a button panel at each entrance/exit with the following button and label:
.1 ALL ON

.2 All other spaces with an audio/video touch panel shall have a button panel at each entrance/exit with the following button and label:
.1 ALL ON
.2 ALL OFF

.3 All other spaces without an audio/video touch panel shall have a button panel at each entrance/exit with buttons and labels for each zone's "ON" and "OFF" control.

.6 For spaces with an audio/video touch panel and integration to the local lighting controller, the lighting system shall implement simple button panel switches and not touch panels for every location defined in this section.

.7 Lighting equipment dedicated to AV spaces shall only be installed in AV rooms/closets.

.8 Refer to Section 2.4.6 for Installation requirements.

2.6 Exit Signage

.1 Exit lighting shall be provided in accordance with the BC Building Code and the Canadian Electrical Code as amended by BC Electrical Safety regulations.

.2 All exit signs shall be illuminated by LED light sources.

.3 Exit signs shall be powered at 120 volts from Life Safety power panels or central inverter power panels if available. If not available, Exit Signs shall be AC/DC compatible and be fed from Unit Equipment DC supply.

.4 Approved manufacturers are Ready-Lite, or approved equal.

.5 Exit signs shall not incorporate batteries or any other type of stored energy source.

2.7 Emergency Lighting

.1 Emergency lighting shall be installed in accordance with the B.C. Building Code and the latest edition of the Canadian Electrical Code.

.2 Emergency lighting Unit Equipment shall only be installed in buildings less than 2,500 GSM. In no case shall the total pieces of Unit Equipment installed in a single building exceed 10.

.3 Emergency lighting installed as part of renovations or tenant improvements shall be designed to incorporate the existing emergency lighting system in the building.

.4 Individual light fixtures shall not contain batteries.

.5 All Unit Equipment lighting, remote heads and exit lights shall be manufactured by 'Ready-Lite' or approved equivalent.

.6 The Unit Equipment shall be 360 Watt battery pack capacity, 12V DC or approved equivalent. The Unit Equipment shall not be self-testing.

.7 Unit Equipment shall be mounted on a manufacture-supplied shelf specifically design for the purpose.

.8 Main electrical rooms, life safety electrical rooms and rooms with generators or transfer switches shall be provided with unit equipment. The unit equipment shall be sized to run for a minimum of 4 hours.

.9 Unit Equipment and remote heads shall be 12V, minimum 5W LED lamps.

.10 Unit Equipment shall be inclusive of a cord-set for cord-connection to a 120V receptacle mounted adjacent to the unit. Receptacle shall be connected to a local, un-switched 120V lighting circuit. In buildings with existing 347V lighting, 120V receptacle shall be connected to a dedicated circuit from a local panel.

.11 Unit Equipment is not permitted to be installed above ceiling tiles or architectural panels.

*****END OF SECTION*****

1.0 GENERAL

1.1 Related UBC Guidelines

.1 UBC Vancouver Campus Plan Lighting Guidelines
.2 UBC Okanagan Campus Plan

1.2 Coordination Requirements

.1 UBC Energy & Water Services (Vancouver)
.2 UBC Facilities Electrical (Vancouver)
.3 UBC Facility Management (Okanagan)

1.3 Description

.1 UBC requirements for Exterior Lighting, Street Lighting and Landscape Lighting.

2.0 MATERIAL AND DESIGN REQUIREMENTS

.1 For each project, exterior lighting must be provided for all lanes, roadways, plazas, walks, steps, etc., to a level sufficient to meet safety requirements of all users. The requirements outlined in UBC Vancouver Campus Plan Lighting Guidelines (Vancouver) and UBC Okanagan Campus Plan (Okanagan) shall be utilized for lighting design requirements in the public realm. The IESNA published standards shall be utilized for areas not covered under the Campus Plans. Where public use of the project at night is required, this lighting shall extend beyond the boundaries of the project site to include contiguous access and parking areas.

.2 Lighting design shall incorporate the principles of sustainability and its products and systems shall be energy conserving, long life, have a low cost of ownership and shall be easily and safely accessible for service and maintenance. If special equipment is required for lighting maintenance then the consultant shall, prior to tender, present a preliminary Lighting System Maintainability Plan to UBC Electrical (Vancouver) / Facility Management (Okanagan) for review and approval. The preliminary plan shall contain a high-level overview of the special equipment and processes required for maintenance of the system. Architectural, Structural and Conveyancing requirements must be confirmed for moving special equipment to and from the locations after construction is completed. The finalized plan will be submitted by the contractor and it shall contain detailed documentation describing the special equipment, maintenance procedure/schedule and spare parts

.3 Exterior lighting is supplied with electrical energy from nearby buildings. For each project where existing exterior lighting will be impacted by planned new construction, the new project scope shall include all needed adjustments, removals or relocations to the existing systems to ensure continued operation of existing exterior lighting systems beyond the project boundaries, as well as new exterior lighting for the new project. The scope for remediation of existing lighting systems shall be as per the original design intent. All impacted existing systems shall require coordination with UBC Facilities Electrical (Vancouver) / UBC Facility Management (Okanagan). UBC Facilities Electrical / Facilities Management Policies and Procedures shall be followed when investigating and/or modifying existing systems.

.4 Lighting equipment shall be vandal proof by use of proper design and sufficient mounting height. Specifically, post top units at low mounting height (below 5m) and bollards shall not be used. Refer to UBC Vancouver Campus Plan Lighting Guidelines for height requirements.

.5 Retrofits of existing streetlights, where full replacement is not feasible, should provide light of similar quality, color, and illuminance as specified in the lighting plan. When new streetlights are added between existing ones, the luminaires shall be adjusted to ensure appropriate light levels are achieved.

.6 When existing non-compliant light fixtures are identified for repair or replacement, it is expected that the appropriate compliant fixture will be installed. The only exception is in instances where multiple obsoleted fixtures are contained within a row. In this instance the same non-compliant fixture may be installed and used until there is funding to replace the entire row to the new standard.

.7 Building highlighting/floodlighting is not permitted. Where feasible, floodlighting of high quality, low glare design installed on building areas inaccessible to the public can be used.

.8 Landscape (garden-shrub-lawn) type lighting is not acceptable.

.9 Fixtures that are cast in place into concrete or other permanent finishes are not permitted. Only surface mounted fixtures are permitted in these instances.

.10 Lighting integrated into handrails and stairs is not permitted.

.11 Exterior lighting that is powered by a building shall be under the control of the BMS scheduling system. The areas shall be divided into the following (as applicable):

.1 Building Mounted Exterior Lighting
.2 Walkway/Landscape/Area Lighting
.3 Street Lighting
.4 Street Lighting Receptacles (Mounted on the pole base)

Each area shall contain its own set of HOA, contactors, relay and pilot light for independent control via the BMS. Refer to Standard Detail E12-1 for an example of 2 areas.

.12 Exterior lighting shall not be dimmable. DMX, DALI and other lighting control systems shall not be used without an approved variance from UBC Electrical (Vancouver) / Facility Management (Okanagan).

.13 All conduit systems for street lighting shall be sized for designed conduit fill then increased by 1 trade size. Minimum conduit size shall be 37mm. All conduit and fittings shall be RPVC.

.14 All conductors for street lighting shall be minimum #8AWG RW90XLPE 1000V rated. Control and power conduits shall not share the same conduit system.

.15 Boxes used for street or landscape lighting shall be sized as per the CEC. All boxes shall be of concrete construction, come with galvanized steel covers labeled “ELEC” and incorporate a bonding lug.

.16 No electrical equipment such as transformers, ballasts, starters, drivers, etc. shall be installed in in-ground boxes or any below grade installations.

.17 Exterior lighting pole bases to be installed minimum 13mm above hard scape and 50mm above soft scape. New light fixture base shall project minimum 50mm above finished soft scape grade.

.18 Poles shall be steel and be painted with one coat of primer and 2 coats of paint.

.19 Poles complete with luminaries shall be able to withstand 160 km/h winds.

.20 All light fixtures provided shall be stock items (no custom made fixtures) readily available from local suppliers. The fixtures are required to be in current production with no plans to cease production and support within a 5 year period.

.21 The following fixtures are required for to be used in the public realm as per UBC Vancouver Campus Plan Lighting Guidelines:

.1 Roads:

- Lumenpulse Pure 100
  Colour Temp: 3000 Kelvin
  CRI: 92 or higher
  Paint Colour: UBC grey (RAL 7043)

.2 Pedestrian Areas:

- Saturn 2 Cutoff by Se'lux
  Pole Type S35; Base Type: S35
  Paint Colour: UBC grey (RAL 7043)

.3 Ceremonial Routes:

- Match existing
  Pain Colour: UBC Grey (RAL 7043)

*****END OF SECTION*****