

SECTION 16010

ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. General requirement specifically applicable to Division 16 in addition to provisions of General Conditions, Supplementary Conditions, and Division 1.

1.02 SYSTEM DESCRIPTION – WIRES AND CABLES

- A. Color Coding for branch circuits and feeders.
 - 1. 120/208 volt, 3 phase, 4 wire Wye system.
 - a. Phase A Black
 - b. Phase B Red
 - c. Phase C Blue
 - d. Neutral White
 - e. Grounding Conductor Green
 - 2. 227/480 volt, 3 phase, 4 wire, Wye system
 - a. Phase A Brown
 - b. Phase B Orange
 - c. Phase C Yellow
 - d. Neutral Gray
 - e. Grounding Conductor Green
 - 3. 120/240 volt, 3 phase, 4 wire, Delta system
 - a. Phase A Black
 - b. Phase B Orange (wild leg)
 - c. Phase C Blue
 - d. Neutral White
 - e. Grounding Conductor Green
 - 4. Identify grounded (neutral) conductors in accordance with NEC Article 200 when it is in shared or common raceways and enclosures.
- B. Number code all control and instrumentation wiring at termination points.

1.03 MATERIALS – WIRES AND CABLES

- A. Conductors shall be annealed copper; 98% conductivity.
- B. Minimum size conductor for general wiring shall be #12.
- C. THHN or THWN shall be used in interior dry locations.
- D. XHHW or THWN shall be used in wet locations for all sizes.
- E. Conductors for building feeder and branch feeder and branch circuit shall be insulated for 600 volts. Conductors for signal circuits operating at less than 50 volts to ground shall be insulated for 300 volts.
- F. Aluminum conductors shall not be used without the written approval of the Facilities Management Department.

1.04 WORK INCLUDED – BOXES

- A. Boxes shall be sized to allow needed conductors in box without exceeding maximum allowed by NEC.
- B. No extension boxes permitted on existing surface boxes for new work.
- C. Where fixture is mounted over box, box shall be accessible without removing fixture.
- D. Outlet, junction, and pull boxes shall be so installed so that the wiring contained in them can be rendered accessible per NEC code.

1.05 OUTLET DEVICE TYPE BOXES

- A. Switch and receptacle boxes in masonry walls and partitions where wiring is concealed shall be a standard 4" square, 1 ½" or greater in depth with extension cover for the particular device they will receive.
- B. Use plaster extension covers not less than ¾" deep for boxes installed in plastered or sheetrock walls.
- C. Use 1 ½" deep square corner tile wall extension for boxes installed in tiles, exposed brick, or exposed block masonry walls.
- D. Boxes shall be securely fastened to structure.

- E. Boxes shall be set plumb and square with building lines.
- F. Wiring device boxes shall NOT be installed back to back in walls.
- G. No boxes shall be mounted in floor or baseboard level where subjected to wet mopping operations unless approved type.
- H. Octagon boxes that are installed to support lighting fixtures shall not support lighting fixtures that weigh more than fifty pounds.
- I. Outlet boxes shall not be used as the sole support for ceiling suspended (paddle) fans. Exception: Boxes listed for the application shall be permitted as the sole means of support.

1.06 WIRE CONNECTIONS AND CONNECTING DEVICES

- A. All devices, light switches, and convenience receptacles shall be specification grade and be 20-amp minimum.
- B. Splices:
 - 1. Wires #8 and smaller: Pre-insulated solderless connectors.
 - 2. Wires #6 through #4/0: Compression or split bolt type connectors as manufactured by Dossert, Burndy, or T & B.
 - 3. Wires larger than #4/0: Compression or split bolt type connectors with minimum two pressure points per conductor.
 - 4. Wire connectors or splicing means installed on conductors for direct burial shall be UL listed for such.
- C. The temperature rating associated with the ampacity of a conductor shall be selected and coordinated so as not to exceed the lowest temperature rating of any connected termination, conductor, or device.
- D. All receptacle covers shall have panel and current numbers labeled on them
- E. If the receptacle is on the emergency or auxiliary operators, the receptacle shall be colored in red.

1.07 SUSTAINABLE BUILDING REQUIREMENTS

- A. Minimum Energy Performance: LEED, Contractor shall comply with both the Mandatory Provisions Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4 of ASHRAE/IESNA Standard 90.1 – 2004 (without Amendments): and the Prescriptive Requirements Section 5.5, 6.5, 7.5 and 9.5 or Performance Requirements Section 11 of ASHRAE/IESNA Standard 90.1 – 2004 (without Amendments).

1.08 REGULATORY REQUIREMENTS

- A. Comply with requirements of the following codes as adopted and supplemented by authority having jurisdiction:
 - ANSI/NFPA 70 –National Electric Code
 - NFPA 101 – Life Safety Code
 - IBC – International Building Code
 - IMC – International Mechanical Code
 - WAC 296-46B – Washington State Electrical Safety Standards, Administration, and Installation
 - Washington State Energy Code
- B. Comply with additional codes and regulations referenced in other sections.
- C. Comply with additional codes and regulations required by authority having jurisdiction.
- D. Obtain and pay for permits and inspections from authorities having jurisdiction over work included under Division 16.
- E. Include all testing, shop drawings, and documentation required by the inspection authorities for permitting and final approval.
- F. Include Washington State Energy Code chapter 15 lighting and motor inspection by a WABO registered energy code Special Inspector where required by local jurisdiction.

1.09 SUBMITTALS

- A. Comply with requirements of Division 1. Unless otherwise specified, furnish product data and shop drawings to Construction Management within 30 calendar days from date of contract signing, in six (6) complete, indexed, and bound sets as follows:
 - 1. To the greatest extent possible all product submittals shall be delivered at the same time.

2. Product information sheets shall be neat, readable, and clean, 8-1/2" x 11" in size; larger sizes shall be folded to 8-1/2" x 11" size.
 3. Furnish product submittals in a 3-ring notebooks having divider sheets with typewritten index tabs between categories that correspond to each section of the specifications. The front cover and spine of each notebook shall be labeled with the name of the Job, Owner, Architect, Engineer, Contractor, and Date of Submittal.
 4. Furnish shop drawings in full sized bound sets drafted in AutoCAD Release 2002 unless otherwise approved. Title block shall include Job, Owner, Architect, Engineer, Contractor, and Date of Submittal.
 5. Furnish product data and shop drawings specifically indicating any deviation from requirements of contract documents.
- B. Confirm dimensions, ratings and specifications of equipment to be installed, and coordinate these with site dimensions and other sections.
- C. Do not order materials or commence Work until applicable submittal has been reviewed and the Architect/Engineer has approved or taken other appropriate action.

1.10 **SUBSTITUTIONS**

- A. Comply with requirements of Division 1. Products specified by naming one or more manufacturers establishes a basis for quality, styling, capacity, and function. Unless otherwise specified, written requests for substitution must be received at least fourteen (14) days prior to Bid Opening by Architect/Engineer who will determine acceptability of proposed substitution. Written acceptance must be obtained from Architect/Engineer prior to Bid Opening.
- B. Substitution requests may be submitted for any manufacturer or named product unless specified as "no substitute".
- C. Substitution approval does not relieve the Contractor of complying with the work requirements or the concept and intent of the project documents. Pay for any and all additional project costs that may be caused by Contractor requested substitutions, regardless of whether or not additional costs are overlooked, missed, or unforeseen, and regardless of when substitutions may be approved.

1.11 **RECORD DOCUMENTS**

- A. Comply with requirements of Division 1. Maintain at project site one (1) set of clean, dry, and legible red-lined record drawings for submittal at Contract Close-Out. Record information concurrently with construction progress.
- B. Indicate electrical changes in the contract documents. Include change orders, revised branch circuit and feeder wiring layouts, revised circuit identification, pull & junction boxes added during construction, and actual dimensioned location and routing of each underground conduit on record drawings.
- C. Provide one (1) complete hard copy set of As-Built drawings and two (2) CD-ROMs with complete set of As-Built drawings on each CD in AutoCAD 2002 dwg format.

1.07 LABELING

- A. Where labeling that includes room names and numbers is required for any system to identify devices for programming purposes, use final room names and numbers determined during construction. Verify room names and numbers with Architect prior to manufacturing labels or programming software.

1.08 OPERATION AND MAINTENANCE MANUALS

- A. Comply with requirements of Division 1. Unless otherwise specified, furnish three (3) complete, indexed, and hard back bound sets of Operation and Maintenance Manuals and one (1) CD-ROM prior to completion of contract.
- B. Include the following information where applicable:
 - 1. Names, addresses, and telephone numbers of the contractor, the installing sub-contractor, and the local representative for each system or equipment.
 - 2. All approved product data and shop drawings.
 - 3. Identify all manufacturer warranties which exceed one (1) year.
 - 4. Model number and serial number of each piece of equipment provided.
 - 5. Data from test results performed under the Contract.
- D. Operation and maintenance data shall include complete parts lists, installation and maintenance instructions, safety precautions, operation sequence describing start-up, operation, and shut-down, internal and interconnecting

wiring and control diagrams with data to explain detailed operation and control, and testing methods for each system and item of equipment.

- E. Furnish a draft copy of Operations and Maintenance Manual for Architect/Engineer review and incorporate comments prior to final submittal. Allow fourteen (14) days for Architect/Engineer review.

1.09 **CONFLICTS**

- A. Where conflicts or variances occur between drawings and specifications, or within either document, include highest construction cost in the Contract price. Architect/Engineer will determine which work is to be performed.

1.10 **WARRANTY**

- A. In addition to requirements covered under General Conditions or Division 1, include manufacturer product warranties that exceed one (1) year. Assemble or list warranties that exceed one (1) year in Operation and Maintenance manuals indicating start date.

1.11 **INTENT OF DRAWINGS**

- A. Drawings are diagrammatic and do not attempt to show all features of work, exact construction details, or actual routing of conduit and cable. Provide wiring with necessary supports, off-sets, bends, risers, and boxes required for complete installation.

1.12 **COORDINATION**

- A. Examine architectural, civil, structural, and mechanical drawings and specifications and consult with other trades, as required to coordinate use of Project space and sequence of installation.
- B. Arrange wiring and equipment to avoid interference with other work and to maximize accessibility for maintenance and repairs.

1.13 **REQUIREMENTS FOR EQUIPMENT FURNISHED UNDER OTHER SECTIONS OR BY OWNER**

- A. Provide power wiring; disconnect switches, and electrical connection of equipment. Provide field wiring for control circuits, except Automatic Temperature Control (ATC) wiring. ATC shall be responsibility of Division 15 unless specifically noted otherwise.

- B. Provide motor controllers and operator stations unless otherwise indicated on the drawings.

1.14 **DEFINITIONS**

- A. Electrical terms used in these specifications are as defined in NEC Art. 100 unless otherwise noted.
- B. Concealed: Hidden from view as in walls, trenches, chases, furred spaces, crawl spaces, unfinished attics, and above suspended ceilings.
- C. Exposed: Exposed to view in any room, hallway, passageway or outdoors.
- D. Furnish: Obtain and/or prepare and deliver to the project.
- E. Indicated: Shown, scheduled, noted, or otherwise called out on the drawings.
- F. Install: Enter permanently into the project complete and ready for service.
- G. Provide: Furnish and install complete and ready for service.
- H. Equipment Connection: Make branch circuit connection, mount and connect control devices as required. Provide disconnect and over current protection when required by NEC and IMC, if not otherwise indicated or furnished with equipment.
- I. Wiring: Conductors in raceway or an approved cable assembly.
- J. Open Cable or Wiring: Conductors above grade not installed in conduit or raceway.

1.15 **SCHEDULE OF VALUES**

- A. Provide Schedule of Values for use by Architect/Engineer to evaluate progress payment requests during construction.
- B. Submit Schedule of Values using the line items included at the end of this Section.

PART 2 – PRODUCTS

2.01 **MATERIALS, EQUIPMENT**

- A. General: furnish only products that are new and free from defects with a manufacture date that is less than six (6) months from date of installation. Where product and applicable software updates or upgrades are available from the manufacturer, furnish the latest version unless otherwise specified.
- B. Listing and Labeling: Furnish and install only products that are listed and labeled by one (1) or more of the following testing laboratories as approved by the Authority Having Jurisdiction:

Underwriter's Laboratories, Inc.	(UL)
ETL Testing Laboratories, Inc.	(ETL)
Factory Mutual	(FM)

PART 3 – EXECUTION

3.01 WORKMANSHIP

- A. Install work using procedures defined in ANSI/NECA 1-2000, Standard Practices for Good Workmanship in Electrical Construction.

3.02 INSTALLATION

- A. Provide all labor, equipment, material, accessories, and testing for electrical systems complete and operating. Include required software applications and associated system programming for electronic products.
- B. Provide testing, documentation, and filing required to comply with commissioning requirements of Chapter 15 of the Energy Code. Include documentation in Operation and Maintenance Manuals.

3.03 CUTTING AND PATCHING

- A. Provide cutting and patching to complete electrical work and to provide openings in elements of Work for electrical penetrations. Comply with requirements of Division 1.
- B. Locate and execute cuts so as not to damage other work or weaken structural components. Core drill or saw cut rigid materials.
- C. Patch to restore to original condition. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

3.04 **EQUIPMENT FURNISHED UNDER OTHER SECTIONS OF BY OWNER**

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, rating, size, and type of connections. Coordinate field wiring requirements and details with supplier and installer. Notify Architect/Engineer of conflicts between requirements for actual equipment being furnished and equipment indicated in contract documents prior to commencing Work.
- B. Install controllers, operator stations, and control devices such as limit and temperature switches furnished with equipment.
- C. Make final connections to equipment. Provide cord and plug where required for plug-in connection.

3.05 **Division 16 Schedule of Values**

- A. Division 16 Mobilization and Temporary Facilities
- B. Utility Company Charges
- C. Electrical Site Work
 - 1. Lighting Systems Rough-in (Conduit, Handholds, Wire, Pole Bases – Material & Labor)
 - 2. Lighting Fixtures & Poles (Materials & Labor)
 - 3. Power & Signal Rough-in (Conduit, Vaults, Wire – Material & Labor)
- D. Lighting Systems
 - 1. Fixtures & Lamps Material
 - 2. Fixtures & Lamps Labor
 - 3. Branch Circuit Rough-In (Conduit and Wire – Material & Labor)
 - 4. Devices and Trim (Material and Labor)
- E. Power Systems
 - 1. Distribution Equipment Material (Switchgear, Panels, Starters, TVSS, Disconnects)
 - 2. Distribution Equipment Labor

3. Feeder Rough-In (Distribution Conduit and Wire – Material & Labor)
 4. Branch Circuit Rough-In (Conduit and Wire for Devices – Material & Labor)
 5. Devices and Trim (Material & Labor)
 6. Equipment Circuit Rough-In (Conduit and Wire for Scheduled Equipment – Material & Labor)
 7. Equipment Connections (Materials & Labor)
 8. Generator Package (Generator, Transfer Switch, Start-Up – Material and Labor)
- F. Signal Systems
1. Fire Alarm Rough-In (Conduit and Wire – Material & Labor)
 2. Fire Alarm Trim (Equipment, Devices, Testing – Material & Labor)
 3. Clock Rough-In (Conduit & Wire – Material & Labor)
 4. Clock Trim (Equipment, Devices, Testing – Material & Labor)
 5. Telecommunications Pathway (Material & Labor)
 6. Telecommunications Premises Wiring (Material & Labor)
 7. TV System Rough-In (Conduit & Cabling – Material & Labor)
 8. TV System Trim (Equipment, Devices, Testing – Material & Labor)
 9. Sound System Rough-In (Conduit & Wire – Material & Labor)
 10. Sound System Trim (Equipment, Devices, Testing – Material & Labor)
 11. Security Systems Rough-In (Conduit & Cabling – Material & Labor)
 12. Security Systems Trim (Equipment, Devices, Testing – Material & Labor)
- G. Electrical Closeout (Punchlists, O&M Manuals, Record Drawings, Training)

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Conduit and fittings.
- B. Surface Metal Raceway.
- C. Building wire and cable.
- D. Wiring connections and terminations.
- E. Boxes.
- F. Wiring devices.
- G. Cable tray.
- H. Supporting devices.
- I. Requirements for fire rated construction.
- J. Earthwork for underground electrical.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Excavation and Backfill for Underground Conduit: Comply with Division 2 – Site Work.
- B. Concrete for Encased Conduit: Comply with Division 3 – Concrete.

1.04 SUBMITTALS

- A. Submit product data for conduit fittings, surface metal raceway, wire and cable, watertight connections, wiring devices, floor boxes, and cable tray.

1.05 **OPERATION AND MAINTENANCE DATA**

- A. Include data for devices, floor boxes, and cable tray in Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 **CONDUIT**

- A. Rigid Steel Conduit (RGS): ANSI C80.1; hot dipped galvanized.
- B. Intermediate Metal Conduit (IMC): Hot dipped galvanized.
- C. Electric Metallic Tubing (EMT): ANSI C80.3; galvanized tubing.
- D. Flexible Metal Conduit: Galvanized steel.
- E. Liquid Tight Flexible Metal Conduit: Galvanized steel, integral copper bonding conductor, PVC jacket.
- F. Non-Metallic Conduit: NEMA TC-2; EPC-40-PVC.

2.02 **FITTINGS**

- A. RGS and IMC Conduit: ANSI/NEMA FB 1: threaded type. Provide hubs and connectors with insulated throat.
- B. EMT Conduit: ANSI/NEMA FB 1; steel, compression type. Crimp-on, drive-on, indenter, and set screw type prohibited. Provide connectors 1 inch and larger with insulated throat.
- C. Flexible Conduit: ANSI/NEMA FB 1; steel, single screw squeeze type.
- D. Liquid tight Flexible Conduit: ANSI C33.84, steel. Provide PVC coated fitting where installed outdoors.
- E. PVC Conduit: NEMA TC 3; solvent welded type, same manufacture as conduit.
- F. Corrosion Protection: Galvanized or zinc plated for all metal fittings and accessories.

2.03 SURFACE NON-METAL RACEWAY (SNMR)

- A. Non-Metallic SMR: Panduit surface raceway system complete with divider, fittings, supports, and accessories designed or recommended by product manufacturer. Provide Panduit Pan-way TG70 series with TG70HB3 matching device brackets and one gang device plates. Match wiring devices installed unless otherwise noted. Provide with TGBF wall box connector. Ivory finish unless otherwise noted.

2.04 WIRE AND CABLE

- A. Copper Building Wire, Interior: Type THWN-2, 600 volt insulation; conductors 8 AWG and larger shall be stranded. Type XHHW-2 may be substituted for conductor sizes 4 AWG and larger.
- B. Cooper Building Wire, Outdoors: Type RHW/USE-2, 600 volt insulation; conductor 8 AWG and larger shall be stranded.
- C. Flexible Cords: Oil resistant thermoset insulated Type SO multiconductor with identified equipment grounding conductor, sized for connected load or equipment and rating of branch circuit over current protection.
- D. Metal Clad (MC Cable): UL 1569; copper conductors, 600 volt 90 degree C rated conductor insulation, phase identified, with green insulated grounding conductor and metallic outer covering. Provide PVC jacketed MC cable listed for the purpose where used in damp or wet locations or where otherwise indicated.

2.05 WIRE CONNECTORS

- A. Connectors for Wire Size 8 AWG and Smaller: Insulated steel spring twist-on pressure connector with plastic cap. Outdoors use watertight type with prefilled sealant get.
- B. Connectors for Wire Size 6 AWG and Larger: Solderless pressure of compression type with pre-formed insulated cover. Outdoors make watertight using in line shrink sleeve or pigtail cap and sealing mastic.

2.06 BOXES

- A. Outlet Boxes: ANSI/NEMA OS 1; galvanized sheet steel, with ½ inch male fixture studs or plaster rings as required.

- B. Surface Outlet Boxes Below 8 Feet: Cast aluminum or malleable, iron, threaded hubs.
- C. Surface Outlet Boxes for Outdoor and Wet Locations: Cast aluminum with baked enamel or epoxy finish, gasketed cover, stainless steel hardware. Outlet boxes shall have threaded hubs.
- D. Concrete and Masonry Boxes: Galvanized steel, suitable for the purpose.
- E. Junction and Pull Boxes: Outlet box with blank cover except boxes larger than 4 inch square shall be screw cover type, galvanized steel with grey enamel finish, NEMA 1 indoors and NEMA 3R outdoors, unless otherwise indicated.
- F. In-Ground Boxes: Concrete or structural plastic type with locking cover. Provide traffic ratings, dimensions, features, and installation requirements indicated.
- G. Concealed Service Floor Boxes: Hubbell HBLCFB series for concrete floors, with steel flush cover/carpet flange assembly. Provide 301-base for maximum 4-gang device applications. Where large capacity box is indicated, provide 501 base for maximum 8-gang applications.
- H. Fire Rated Construction: Recessed outlet boxes and rough-in cans that are installed in 2 hour rated area separation walls shall be UL listed with 1-1/2 hour rating label.
- I. Color Coding of Device and Junction Boxes for Special Systems: Field painted or otherwise manufactured in the specified color, both inside and outside of box and cover. Provide color identification for the following electrical systems: Fire Alarm system – RED, Emergency Systems (NEC 700) – ORANGE.

2.07 WIRING DEVICES

- A. Wall Switches: Hubbell 1221, Leviton 1221, Pass & Seymour 20AC1, Cooper 2221; specification grade, 20 ampere, 277 volt, quiet type. Single pole, double pole, 3-way, 4-way as required. Color: Ivory.
- B. Duplex Receptacles: Specification grade 5362 series, NEMA 5-20R, grounding type, as manufactured by Hubbell, Leviton, Pass & Seymour, Cooper. NEMA 5-15R devices may be substituted for multi-outlet general purpose circuits. Color: Ivory.
- C. Ground Fault Circuit Interrupter (GFCI) Receptacles: Same manufacture, rating, and color as duplex receptacles except devices shall comply with UL 943, Class A, for 2006.

- D. Isolated Grounding Receptacles: Same manufacture, design, and color as duplex receptacles except ground terminal shall be isolated from device mounting strap and permanent special purpose identification shall be visible on the device.
- E. Special Purpose Receptacles: NEMA WD 5, same manufacture as duplex receptacles; premium specification grade, grounding type, NEMA configuration indicated black color. Provide matching plug for each receptacle.
- F. Flush Mounted Device Plates: Super heavy duty for high abuse application, rigid high impact thermoplastic, smooth finish. Thermoset, phenolic, urea, and flexible polycarbonate not approved. Color: Ivory, except that device plates for receptacles on Generator power shall be Orange, and device plates for receptacles on UPS power shall be Blue.
- G. Surface Mounted Device Plates: Raised galvanized steel on steel boxes; cast or stamped sheet aluminum on cast boxes.
- H. Damp and Wet Location Device Plates: Gasketed opaque polycarbonate cover assembly, listed as weatherproof when in use, stainless steel mounting hardware. TayMac Corporation specification grade of approved equal.
- I. Floor Box Service Fittings, Concealed Service: Screw type modular face plates offered by product manufacturer, configuration to match wiring devices provided. Provide blank plates for unused outlets. Provide raceway connection between outlets on opposite side of the box where required to meet application requirements.
- J. Cord Plug & Connectors: Hubbell Insulgrip, GE Gator Grip; premium specification grade grounding type cord connector and matching plug, NEMA configuration indicated. Provide with weatherproof boot in damp and wet locations.
- K. Incandescent Wall Dimmers: Lutron Nova Series, linear slide or touch, preset on/off control, solid state, rating to accommodate connected load except 1500 watt minimum for track lighting circuits. Provide low voltage type dimmers when controlling low voltage track lighting circuits or low voltage fixtures (separate neutral may be required for each dimmer circuit). Color: Ivory or white.
- L. Clock Receptacle: Same manufacturer and color as duplex receptacles except receptacle shall be in recessed compartment as indicated on plans, 1st and 2nd floor only. Leviton 688.

2.08 CABLE TRAY FOR COMMUNICATIONS CIRCUITS

- A. Description: High strength galvanized steel wire mesh cable tray, 3 inch deep x 24 inch wide unless otherwise indicated. Cablofil.
- B. Accessories: Provide manufacturer's standard elbows, tees, clamps, hangers, brackets, splices plates, and connectors. Elbows and tees shall have 24 inch radius.

2.09 **SUPPORTING DEVICES**

- A. Metal Conduit Clamps & Straps: Steel, screw type; galvanized, zinc or cadmium plated.
- B. Support Channel: Slotted 12-gauge steel channel with fittings, fasteners, brackets, clamps, floor plates, and accessories required; ASTM 164 electroplated zinc plus yellow chromate or zinc dichromate corrosion protection.
- C. Fasteners: Expansion anchors in concrete and solid masonry; toggle bolts in hollow masonry, plaster, or gypsum board wall construction; sheet metal screws in metal construction; wood screws in wood construction; set screw type beam clamps on steel columns and beams; UL listed clips for metal studs. Metal parts and accessories to be galvanized, zinc and cadmium plated.
- D. Roof Supports: Do not install conduit exposed on roofs.

2.10 **FIRE RATED CONSTRUCTION**

- A. Products for Fire Stopping Around Conduit Penetrations: Comply with testing requirements of UL 1479. Comply with requirements of Division 7.
- B. Products for Cable Tray Penetrations: KBS reusable heat expanding fire rated seal bags.

PART 3 – EXECUTION

3.01 **WIRING METHODS**

- A. GENERAL
 - 1. Fixed wiring shall be conductors installed in conduit except where cable is specifically permitted in this specification.

2. Conceal all wiring within construction unless otherwise noted on drawings or specifically authorized by the Architect/Engineer.

B. CONDUIT REQUIREMENTS

1. Rigid Steel Conduit (RGS): May be used in all areas. Required at penetrations thru fire rated construction rated greater than 1 hour.
2. Intermediate Metal Conduit (IMC): May be used in all areas except where RGS is required.
3. Electrical Metallic Tubing (EMT): May be used in dry and damp locations where not subject to damage. May not be used in concrete, where in contact with earth, or where RGS is required. May not be used for service entrance conductors inside a building.
4. Flexible Conduit: May be used concealed in casework and where concealed in walls, up to 1 inch maximum trade size. Required for final equipment connections (maximum length 36 inches), to recessed lighting fixtures from an outlet box (maximum length 72 inches), and where raceway passes thru seismic joints. Use liquid tight in damp or wet locations.
5. Rigid Non-Metallic Conduit (PVC): May be used underground. May be used within buildings where encased in not less than 2 inches of concrete. Terminate inside building using RGS or IMC elbow and riser to first coupling above slab on grade.

C. ELECTRICAL CONDUIT ISOLATION (AIR CONTROL AND PRODUCTION STUDIOS)

1. Use flexible conduit to isolate all electrical connections between acoustical walls and all other walls and structure (minimum length 36 inches).

D. WIRE AND CABLE REQUIREMENTS

1. Use copper conductors except Contractor may use aluminum conductors only for copper conductors sizes 3 and larger providing conductor and conduit sizes are increased to equal ampacity of copper sizes. Submit list indicating conduit and aluminum conductor sizes proposed for Engineer's approval. Engineer's decision as to equivalent sizes for aluminum conductors and conduit will be final.

2. Metal Clad (MC) Cable: May be used for branch circuit wiring where concealed above plasterboard ceilings, in walls, and 48 inches maximum to first junction box above accessible ceilings in casework. May be exposed in electrical and mechanical equipment rooms. May not be used in mechanical ducts and fabricated air plenums. May not be used in concrete or below concrete slabs on grade. May not be used for services. May not be used for feeders. May not be used for branch circuit home runs. May not be used for exposed wiring in finished spaces open to structure.

3.02 SUPPORT – GENERAL

- A. Support wiring, conduit, raceways, boxes, equipment, and fixtures from building structural members. Provide additional framing, channel, or listed support attachments, as required to span or support between structural members and to avoid inference from pipes, ducts, and other equipment.
- B. Do not install support anchors to penetrate thru roof deck.
- C. Do not violate the integrity or exceed the capacity of the building structure used for support. Provide/fabricate additional support elements to transmit loads to the floor or other parts of the building structure that can carry the load as approved by the Architect/Engineer.
- D. Studio Walls: Do not attach supports to hangers to wallboard. Maintain minimum ½ separation between supports or hangers attached to studs and wallboard.

3.03 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. Minimum conduit trade size ½ inch except ¾ inch for all homeruns and ¾ inch where installed below grade outdoor. Prewired 3/8 inch flexible conduit not to exceed 72 inches may be used for fixture whips from an outlet box to recessed light fixture.
- B. Arrange conduit to maintain headroom and present a neat appearance.
- C. Route conduit parallel and perpendicular to walls and adjacent piping.
- D. Maintain 12-inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

- E. Locate holes in joists within center third of member depth measured from the edge and at least 24 inches from load bearing points. Maximum hole diameter 1-inch.
- F. Support conduits from building structure with conduit straps or rods and hangers. #8 solid wire and CADDY clips may be used to hang conduit ¾ inch and smaller above accessible ceiling spaces.
- G. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- H. Do not support conduit with perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
- I. Do not bore holes in truss members or notch structural members.

3.04 CONDUIT INSTALLATION

- A. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp locations.
- B. Use conduit bodies to make sharp changes in direction, as around beams.
- C. Use factory elbows for bends in conduit larger than 1-inch.
- D. Install insulated bushings on each end of conduit larger than 1-inch. Conduit bends for signal systems that are greater than 45 degrees shall be minimum radius sweeps as follows:

Under 2 inches	Standard radius
2 inches – 3 inches	24 inch radius
Over 3 inches	36 inch radius
- E. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- F. Install pull wire in empty conduits.
- G. Conduit in Concrete Slabs Above Grade: Do not install in concrete slabs above grade except where written approval and installation requirements are provided by the Architect/Engineer.

- H. Metal Conduit Installed Below Grade: Provide 20 mil thick factory PVC coating, field wrapped 10 mil thick pressure sensitive plastic tape with 50 percent overlap, or paint with bitumastic compound; extend 8 inches above grade at risers.
- I. Underground Conduit for Site Power (Below 600 Volts) and Signal Systems: Install to provide 24 inches minimum cover up to final grade unless otherwise indicated or specified. Maintain minimum 7.5 inch on center spacing between power conduits; maintain minimum 12 inch spacing between power conduits and signal conduits; maintain minimum separation from public utilities established by regulation.
- J. Do not install conduit in concrete slab on grade.
- K. Do not install conduit in direct contact with underside of roof deck.

3.05 CONDUIT PENETRATIONS

- A. Roof Penetrations: Provide flashing around each conduit which penetrates a roof. Materials and installation shall comply with applicable provisions of Division 7 roofing. Seal top of flashing around conduit with a weatherproof non-hardening mastic.
- B. Exterior Walls: Core drill or cast sleeve for each conduit one size larger than conduit diameter. Seal all openings at each penetration with acrylic weatherproof caulking suitable for painting. Below grade seal with "Chase-Foam" silicone sealant or other approved method acceptable to Architect/Engineer.
- C. Fire Rated Construction: Comply with requirements of paragraph, FIRE RATED CONSTRUCTION, this specification.

3.06 METAL CLAD CABLE

- A. Arrangement and Support: Comply with requirements specified for conduit. Provide maximum support spacing of 6 feet on center and within 12 inches of terminations.

3.07 CONDUCTOR INSTALLATION

- A. Minimum Conductor Size: #12 AWG, except #10 AWG minimum for outdoor and exterior building lighting circuits and #14 AWG minimum for control circuits and for lighting fixture taps not to exceed 72 inches.

- B. Splice conductors only in junction or outlet boxes and hand holes.
- C. Arrange conductors neatly at termination such that a clamp-on ammeter may be used.
- D. Clean conduit free of debris before conductor installation; install conductors using pulling lubricant.

3.08 **ALUMINUM CONDUCTORS**

- A. Aluminum conductors shall not be used.

3.09 **CONDUCTOR IDENTIFICATION**

- A. Provide non-metallic wire markers on each conductor in panel boards and in junction boxes having more than six (6) conductors. Identify branch circuit or feeder number for power and lighting circuits.
- B. Color Coding of Insulated Equipment Ground: Solid green.
- C. Color Coding of 208/120 Volt System: Phase A – black, Phase B – red, Phase C – blue, Neutral – white.
- D. Color Coding of Switch Legs: Pink.
- E. Color Coding of Travelers (3-Way and 4-Way Switching): Purple.
- F. Provide color tracers on neutrals to differentiate circuits on multi-wire branch circuits with separate neutrals.

3.10 **BOX LOCATIONS**

- A. Provide electrical boxes for outlets, junctions and equipment connections as shown and as required for splices, taps, wire pulling, and code compliance.
- B. Electrical box locations shown are approximate unless dimensioned. Obtain equipment outlet locations from equipment manufacturer prior to rough-in. Coordinate outlet and wall switch locations with casework and finish elements shown on Architectural drawings. Install to fit conditions or as directed.
- C. Change location of wall outlets, wall switches, and lighting outlets up to fifteen (15) feet without charge when requested by Architect/Engineer prior to installation.

- D. Height of outlets unless otherwise directed: See Drawings.

3.11 **BOX INSTALLATION**

- A. Set wall outlet and wall switch boxes vertically.
- B. Support boxes independently of conduit, piping, and ductwork; securely fasten in place.
- C. Provide recessed outlet boxes in finished areas. Flush front edge of box or plaster ring even with finished surface.
- D. Provide blank cover plate over all boxes that do not contain devices or are not covered by equipment.
- E. Do not install flush boxes on opposite sides of a wall within the same stud space. Maintain 24-inch minimum box separation in fire rated wall assemblies.
- F. In-Ground Boxes: Set on 9-inch minimum deep gravel base extending 6-inches minimum beyond each side. Set flush with final grade.

3.12 **CABLE TRAY FOR COMMUNICATIONS CIRCUITS**

- A. Install in accordance with manufacturer's instructions.
- B. Unless otherwise indicated support tray from building structure with center support using ½ inch threaded rod. Provide supports at each end, each connection point, and other points required to maintain, maximum support spacing of 12 feet on center.
- C. Seismic Restraint: Provide seismic bracing of suspended cable tray. Comply with product manufacturer's standard installation details and recommendations for Seismic Design Category F.

3.13 **FIRE RATED CONSTRUCTION**

- A. Verify location of fire rated walls and ceilings with Architectural plans prior to rough-in.
- B. Installation of boxes, rough-in cans, conduits, and cable trays that result in membrane or through penetrations shall comply with IBC 712.1 through 712.4 as required to maintain fire rating of construction assembly. Coordinate locations and construction requirements with General Contractor.

3.14 EARTHWORK FOR UNDERGROUND ELECTRICAL

- A. Locating and Protecting Existing Utilities: Existing utilities in areas of new construction must be identified and located by the Contractor prior to commencing Work. Locations of underground utilities shown on plans are diagrammatic and shall not be considered as a complete representation of all utilities that may exist on site.
 - 1. Coordinate with Owner to identify and locate existing underground utilities including landscape irrigation in areas of Work.
 - 2. Prior to excavation, contact and coordinate with local Utilities Underground Location Center to identify and locate existing underground public utility services in areas of Work, including power, water, sewer, telephone, gas, and cable TV.
 - 3. Prior to excavation, obtain services of a utility locator service to scan areas of Work and to locate and mark where known and unknown private underground utilities or other interfering obstructions exist.
 - 4. Existing active utilities damaged or interrupted by the Contractor during construction shall be replaced at the Contractor's expense. Repairs to power and signal systems using junction boxes or splices will not be accepted.
- B. Excavation and Backfill: Comply with requirements of Division 2.
- C. Finish Operations:
 - 1. Restore all surfaces disturbed by new construction to its original grade and condition unless otherwise indicated. Comply with requirements of Division 2.
 - 2. Correct settling that occurs during the project warranty period. Restore grade, appearance, quality, and condition of surface or finish to meet original Contract requirements.

3.15 LABELING

- A. Outlets: Identify panel and circuit number on faceplate of convenience and special purpose outlets. Use self-adhesive, polyester or vinyl laminated labels with machine generated alpha-numeric circuit identification, ¼ inch high black

letters on clear background. Exception: Use white letters on black or brown color device plates.

- B. Junction Boxes: Label or mark cover with panel and circuit number. Locate on inside of cover except locate on outside of junction box cover in attics, crawl spaces, equipment rooms and above accessible ceilings.

3.06 TESTS

- A. Perform continuity test on all feeder and branch circuit conductors. Verify proper phasing and that no short circuits or accidental grounds exist.
- B. Check all convenience outlets for correct wiring connections using a polarity circuit tester.
- C. Torque test conductor lug terminations to manufacturers recommended values.

END OF SECTION

SECTION 16148

OCCUPANCY SENSORS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Occupancy sensors for automatic on/off control of lights and other electrical loads.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this Section.
- B. Submit shop drawings to include floor plans showing location, mounting height, type of mounting (wall or ceiling), and coverage for each sensor. Indicate location and quantity of required transformer/relays. Typical room plans may be provided for spaces with similar installation requirements.

1.04 OPERATION AND MAINTENANCE DATA

- A. Include submittal data along with installation and operating instructions in Operations and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Room Sensors: Watt Stopper.
- B. Wall Switch Sensors: Watt Stopper.

2.02 ROOM SENSORS

- A. Sensor: Dual technology (ultrasonic/passive infrared) occupancy detector, adjustable sensitivity, adjustable OFF time delay up to 12 minutes minimum, manual override, LED motion indicator, compatible with fluorescent electronic ballasts. Rated area coverage shall conform to manufacturer's recommendation for complete room coverage without gaps, using single or multiple sensors as required. Sensors may be wall or ceiling mounted type. Exception: In restrooms and toilets with privacy partitions or showers, provide ultrasonic type without passive infrared feature.
- B. Transformer/Relay: 120/277 volt control interface providing NEC class 2 input/output to occupancy sensor(s) and automatic line voltage switch control. Relay contacts shall be isolated, normally open, rated 20 amperes for ballast loads and 1 HP. Provide auxiliary isolated dry contact set to allow for air temperature control (ATC) interface with the occupancy sensor control system; a slave relay may be provided for this purpose.

2.03 WALL SWITCH SENSORS

- A. Wall box mounted passive infrared occupancy sensor, automatic ON/OFF, manual OFF, adjustable sensitivity, adjustable OFF time delay up to fifteen (15) minutes, LED motion indicator, compatible with magnetic ballast, electronic ballast, and motor loads, 170 degree minimum field of view. Minimum load rating shall be 600 VA and 1/6 HP at 120 volts and 1000 VA and 1/3 HP at 277 volts. Minimum rated area coverage shall be 900 square feet.
- B. Two Level Switching: Where indicated, provide wall switch sensor with independent dual switching control, user selectable for control of one or two switch legs to provide two levels of room illumination.
- C. Color: Ivory for device and matching face plate.

2.04 MATERIALS

- A. Line Voltage Wire: Comply with Section 01650.
- B. Low voltage wire: UL type CL2, NEC class 2, with PVC jacket overall, (UL type CL2P, NEC Class 2P, with Teflon jacket overall and listed for use in ducts, plenums, and other air handling spaces); #18 AWG, copper conductors, color coded.
- C. Conduit and outlet boxes: Comply with Section 16050.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Install in accordance with manufacturers' instructions.
- B. Room Sensors: Provide number and location required for complete coverage within room (including toilet and shower stalls) and to minimize false activation thru open doors as recommended by manufacturer. Sensors shall not be located above 12 feet. Provide additional transformer/relays as required where multiple branch circuits are controlled.
- C. Areas with Accessible Ceiling Space: Locate transformer/relay above ceiling within 6 feet of ceiling sensor. Low voltage wiring between sensor and relay may be installed without conduit.
- D. Areas with Inaccessible Ceiling Space: Install transformer/relay in same outlet box for ceiling sensor. Provide box depth, trim ring, and high/low voltage divider as required.
- E. Coordinate with Division 15 contractor to identify auxiliary relay contacts provided for air temperature control (ATC) interface.
- F. Manual OFF: Wall switches shall be wired on load side or relay/transformers to provide manual off control of room lighting.

3.02 **DEMONSTRATION AND INSTRUCTIONS**

- A. Demonstrate operation and adjustment of each type of sensor to Owner's personnel prior to contract closeout.
- B. Provide initial adjustment of sensors prior to substantial completion. Set time delay for eight (8) minutes. Set sensitivity per manufacturer's checkout and adjustment instructions.
- C. Provide final adjustment of sensors as required to satisfy Owner comments prior to contract closeout.

END OF SECTION

SECTION 16149

LOW VOLTAGE SWITCHING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Components, wiring, and accessories for remote control switching of lighting and general purpose branch circuits using energy limited control power.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 16995 Commissioning: Electrical Systems.

1.04 SUBMITTALS

- A. Submit product data for all components specified under Part 2 of this Section.
- B. Submit shop drawings showing low voltage control wiring diagrams and control sequence.

1.05 OPERATION AND MAINTENANCE DATA

- A. Include data for all low voltage switching components in Operation & Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Watt Stopper.

2.02 BASIC SYSTEM COMPONENTS

- A. Transformers: ANSI/NFPA 70; Class 2 energy limited, 120/15-24 volt, sized for load. May be integral with low voltage relay.
- B. Low Voltage Relays: Mechanical or magnetic latching remote control relays rated 20 amperes at 120/277 volts. Shall have isolated pilot contacts where required.
- C. Switches (Three-Wire Systems): Heavy duty, three position, momentary contact, toggle switch, ivory color, rated 3 amperes at 25 VAC.
- D. Switches (Two-Wire System): Three position, momentary contact, toggle operation, ivory color, rated 3 amperes (.25 amperes min. for single relay control) at 30 VAC. Single relay control switches shall include integral diodes for transformer/relay operation.
- E. Switch Plates: Type as specified in Section 16050 for device plates.
- F. Master Controllers: solid state device allowing group control of more than three relays by a momentary and/or maintained contact input from manual switch, photo controller or time switch. Installed configuration shall have 20% minimum spare relay capacity. Separate modules may be used for momentary and maintained contract switch control.
- G. Photo Controllers: Solid state device for operating relays and/or auxiliary contacts to control remote master controllers using a remote low voltage photo sensor. An override input shall allow a remote switch or time clock to enable or disable the photo control function.
- H. Remote Photo Sensors, Outdoors: Weatherproof, watertight sensor head suitable for outdoor mounting to an outlet box, auto ranging 1 to 10,000 FC, + or – 5%, compatible with controllers specified.
- I. Relay Control Cabinets: NEMA ICS6 Type 1: shop fabricated and wired sheet metal box with screw on flush cover, side hinged flush locking door, and painted enamel finish. Assembly shall include labeled terminal blocks, line voltage – low voltage separation barriers, mounting provisions for 20% or more additional relay and associated transformer capacity, and removable circuit index card inside protective pocket on inside of front cover. Key all relay cabinets alike. Furnish two (2) keys. (Cabinets shall be flush mounted where indicated.)
- J. Remote Time Controllers: Programmable solid state 365 day, 600 events per week with week day and holiday scheduling, provided under Division 15900, Automatic Temperature Controls. Allow for 8 time control groups minimum.

2.03 **CONTROL SEQUENCE OF OPERATION**

- A. See Lighting Control Center panel schedule(s) on drawings for sequence of operation for interior, building, sign, and parking lot lighting.

2.04 **MATERIALS**

- A. Low Voltage Wire: UL Type CL2, NEC Class 2, with PVC jacket overall (UL Type CL2P, NEC class 2P, with Teflon jacket overall and listed for use in ducts, plenums, and other air handling spaces); multi-conductor, stranded copper cable, #20 AWG minimum, color coded.
- B. Conduit and Outlet Boxes: As specified under Section 16050.
- C. Cable Supports: Molded nylon clamps, heavy duty nylon ties, or galvanized steel bridle rings; sized to match cables supported. Tyton, Brady, Burndy, or Thomas & Betts manufacture.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Install in accordance with manufacturer's instructions. Control sequence shall be as scheduled on drawings. Provide initial programming of system control components.
- B. Install low voltage wiring in conduit except cable may be installed without conduit above accessible ceilings. Install open cable parallel and perpendicular to building lines; support cable from structure at intervals not to exceed 4-1/2 feet. Do not splice open cable.
- C. Provide silicon diode rectifiers as required for proper system operation.
- D. Provide typewritten circuit index in each relay cabinet identifying relay numbers, line voltage, circuit numbers, loads controlled, and master/local/special sensor switch control information.

3.02 **DEMONSTRATION AND INSTRUCTIONS**

- A. Demonstrate operation and maintenance of system to Owner's personnel prior to contract closeout. Allow one site visit and two hours of total instruction scheduled and convenience of Owner.

- B. Use operation and maintenance manuals as basis of instruction, reviewing contents of manual with personnel in detail.

3.03 **COMMISSIONING**

- A. The equipment and systems referenced in this Section are to be commissioned per Section 01810 – Commissioning General Requirements and Section 16995 – Commissioning; Electrical Systems. The contractor has specific responsibilities for scheduling coordination, start-up, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION

SECTION 16420

ELECTRICAL SERVICE

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Electrical Service Requirements.
- B. Telephone Service Requirements.
- C. Cable Television Service Requirements.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 REGULATORY REQUIREMENTS

- A. Contact and coordinate with Parkland Light and Water, regarding electrical service requirements, including entrance fittings, meter enclosures and socket arrangement, and current transformer provisions.
- B. Contact and coordinate with Qwest regarding telephone service requirements. Alex Harb (253) 597-5208.
- C. Contact and coordinate with Comcast regarding cable television service requirements.
- D. Obtain, prepare, and file application forms required by the serving utilities for obtaining temporary and permanent services.

1.04 UTILITY CHARGES

- A. Utility company charges for installing power, telephone, and cable television service shall be paid by the Owner and are not included in the Contract.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Conform to requirements of the Utility companies.
- B. Meter test switch block and current transformers must be purchased by the Contractor from the electric utility.
- C. Raceway: Schedule 40 PVC below grade; rigid galvanized steel for sweeps, risers, and for conduit above grade.
- D. Telephone Terminal: $\frac{3}{4}$ " plywood painted with class A fireproofing unless otherwise indicated.
- E. Cable Television Terminal: 18" x 18" clear wall space for Utility Company cabinet.

PART 3 – EXECUTION

3.01 INSTALLATION, ELECTRICAL SERVICE

- A. Make arrangements with Utility Company to obtain permanent electrical service to the Project. Coordinate and arrange for scheduling of Utility Work.
- B. Installation: Comply with Utility Company rules, regulations, and installation requirements.
- C. Maintain minimum 7.5 inch on center spacing between underground parallel electrical service conduits. Install conduits for electrical service rate above 600 volts with 36 inches minimum cover.
- D. Where utilities share common trench or routing, maintain minimum 12 inch clear separation between power and other utility systems.
- E. Provide meter bases, metering conduit, current transformer (CT) enclosure, and service entrance conduit and wire. Leave sufficient service conductor length at transformers for terminations by Utility.
- F. Install meter test block and current transformers (CT's) purchased from the Utility.

- G. Provide excavation, trenching, and backfill for utility company transformer vault and primary service duct from property line to transformer location(s). Allow for installation of gas service to share trench with primary service conduit. Provide trench width and depth per Utility requirements. Exact routing of primary service conduits shall be determined by the Utility. Quantity and location of junction and pull vaults shall be determined by the Utility. Obtain written approval from Utility prior to commencing Work.

3.02 INSTALLATION, TELEPHONE SERVICE

- A. Make arrangements with Utility Company to obtain permanent telephone service to the Project. Coordinate and arrange for scheduling of Utility Work.
- B. Install underground service conduit with 30 inches minimum cover. Include 300 lb test pull rope to building telephone terminal board. Conduit bends shall be 36 inch minimum radius sweeps, 3-90 degree equivalent sweeps maximum.
- C. Install telephone terminal board 76 inches above finished floor measured to top of board with 6 inches clear on all sides.

3.03 INSTALLATION, CABLE TELEVISION SERVICE

- A. Make arrangements with Utility Company to obtain permanent cable service to the Project. Coordinate and arrange for scheduling of Utility Work.
- B. Install underground service conduit with 300 lb test pull rope to building terminal space. Conduit bends shall be 36 inch minimum radius sweeps, 3-90 degree equivalent sweeps maximum.
- C. Cable terminal space shall be 72 inches above furnished floor measured to top of space, unless otherwise indicated.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Power system grounding.
- B. Electrical equipment and raceway grounding.
- C. Communication system grounding.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 SUBMITTALS

- A. Submit reports for test required under Part 3 of this Section.

1.04 OPERATIONS AND MAINTENANCE DATA

- A. Include data on testing procedures, obtained test values, and correction of deficiencies in the Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Ground Rods: Copper-clad steel, $\frac{3}{4}$ inch diameter, 10 feet long.
- B. Mechanical Connectors at Accessible Ground Rods: Tin-plated, heavy duty, high strength, corrosion resistant copper alloy, hex head bolt and clamp.
- C. Mechanical Connectors at Ground Connections: Heavy duty, solderless, bolted pressure or compression type connectors or clamps labeled as being suitable for the purpose. Manufacturer's standard grounding lug when furnished as part of panel boards and other equipment.

- D. Exothermically Welded Connections: Copper thermite weld process conforming to manufacturer's instructions; use molds, weld material, tools, and accessories supplied by the manufacturer. ERICO CADWELD or equal.
- E. Ground and Bonding Conductors: Bare, soft drawn copper; stranded for 8 AWG and larger, unless otherwise indicated or specified.
- F. Ground Wells: 8 inch diameter x 12" long concrete pipe with belled end; cast iron or concrete well cover with embossed or imprinted legend "Ground".
- G. Electro-Chemical Ground Rods: UL listed, electrolytic filled copper tube electrode, 8 foot minimum length, 50 year rate life.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Ground electrical service system neutral per Code. Size grounding electrode conductor, main bonding, jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 except when larger size is shown or specified. Minimum of two (2) NEC 250.52 permitted grounding electrodes must be installed and located at least 20 feet apart and shall include a concrete encased or a driven electrode.
- B. Make grounding connections which are buried or otherwise inaccessible using exothermic welds. Where installed outdoors, bury ground conductors with minimum 18 inches of cover.
- C. Driven Electrodes: Drive ground rods full depth unless otherwise indicated or specified. Provide 20 feet minimum separation between driven electrodes.
- D. Inspection Access: Provide a ground well at the first ground rod of a driven electrode system for inspection access. At pad mounted equipment, ground rod may extend up 6 inches inside enclosure for inspection access.
- E. Equipment Grounding Conductor: Provide separate insulated green equipment grounding conductor in feeders and in branch circuits to plug-in outlets. Provide equipment grounding conductor in non-metallic conduits and flexible conduit. Size equipment grounding conductors per NEC 250.122 unless larger size is shown or specified.

- F. Provide grounding locknuts on each end of feeder conduits serving panel boards. Exception: Provide grounding bushing with bonding jumper where conduit is used as equipment ground.
- G. Provide conduit sleeves where ground conductors pass through concrete slabs. Metal conduit sleeves shall have threaded end extending above slab to accommodate a grounding bushing or conduit hub per NEC 250.64(E).
- H. Provide minimum 1/0 AWG conductor for communications service grounding. Leave 10 feet slack conductor at terminal board. Connect conductor to building ground electrode system.
- I. Ground exposed noncurrent carrying metal parts for equipment fastened in place or connected by permanent wiring and likely to become energized per Code. In MDF and in IDF rooms, bond cable trays and equipment racks to terminal board ground bus using #6 minimum AWG conductor.
- J. Concrete Encased Electrode: Provide 20 feet minimum of bare copper conductor encased by at least 2 inches of concrete and located within and near bottom of concrete foundation or footing that is in direct contact with earth. Size electrode to match grounding electrode conductor or No. 4 AWG, whichever is larger. Provide 3/4" non-metallic conduit sleeve where conductor enters concrete foundation.
- K. Electro-Chemical Electrodes: Set in 6 inch diameter bored hole backfilled with bentonite clay. Provide ground well for inspection access. Provide 20 feet minimum separation from other electrodes.
- L. Additional Electrodes: Where maximum resistance to ground is specified, provide additional driven electrodes as needed to meet specified requirements or provide one electro-chemical ground rod.

3.02 ISOLATED GROUNDING SYSTEMS

- A. Provide a separate insulated grounding conductor, green with yellow stripe, and connected to ground only at service or separately derived power source.
- B. Metal conduit may serve as separate equipment grounding means where an isolated ground conductor is provided, unless otherwise indicated. Exception: Provide separate equipment grounding and isolated grounding conductors in conduits which serve both isolated and non-isolated plug-in outlets.

3.03 SEPARATELY DERIVED SYSTEMS

- A. Ground secondary neutral and housing of all transformers and Uninterruptible Power Supply (UPS) per Code. Size grounding electrode conductor, bonding jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 unless larger size is shown or specified. In addition, provide a driven ground electrode when indicated.
- B. Install grounding electrode conductor in 1 inch conduit between transformer and grounding electrode connection. Bond free end of conduit to grounding electrode conductor using grounding type bushing or hub.

3.04 TESTS

- A. Service Entrance Ground Electrode System: ANSI/IEEE 81; measure and record ohmic value by performing fall of potential test using a ground testing Megger. Tests shall be performed with the ground electrode system disconnected/isolated from neutral and with the test current probe located at least 100 feet from the nearest ground system electrode.
- B. Separately Derived Systems: ANSI/IEEE 81; measure and record ohmic value of ground resistance between main grounding system and each separately derived transformer neutral point by performing two point method tests.
- C. Maximum Acceptable Resistance to Ground: 3 ohm's

END OF SECTION

SECTION 16470

ELECTRICAL DISTRIBUTION

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Switchboards
- B. Panel boards and Circuit Breakers
- C. Disconnect switches
- D. Fuses
- E. Motor controllers
- F. Nameplates
- G. Compression Lugs

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Concrete for Equipment Pads: Comply with Division 3 – Concrete.

1.04 SUBMITTALS

- A. Submit product data for switchboards, panel boards, circuit breakers, motor controllers.
- B. Submit shop drawings for switchboards, and panel boards.
- C. Submit reports for test required under Part 3 of this Section.

- D. Submit product data and shop drawings for service switchboard to serving utility for review and approval in addition to Architect/Engineer submittal requirements.

1.05 **OPERATION AND MAINTENANCE DATA**

- A. Include data for switchboards, panel boards, circuit breakers, and motor controllers in Operation and Maintenance Manuals.
- B. Include preventative maintenance data for switchboards in Operation and Maintenance Manuals.

1.06 **SPARE PARTS**

- A. Fuses: Furnish to Owner three (3) spare fuses of each type and rating installed.
- B. Fuse Pullers: Furnish two (2) fuse pullers to Owner.

PART 2 – PRODUCTS

2.01 **ACCEPTABLE MANUFACTURERS**

- A. Switchboards, Panel boards, Circuit Breakers and Disconnects: Square “D” to match existing campus standard.
- B. Motor Controllers and Contactors: Square “D” to match existing campus standard.
- C. Fuses: Bussman and Littlefuse.

2.02 **SWITCHBOARDS**

- A. Switchboards: NEMA PB2; factory assembled, dead front, front accessible, metal-enclosed, free-standing, service entrance label. Distribution section devices shall be group mounted.
- B. Electrical Ratings, Configuration, Special Features: AS shown on drawings. Indicated ampere interrupting capacity (AIC) is full rms symmetrical integrated equipment short circuit rating of bussing and of over current devices without series rating.
- C. Switchboard Dimensions: 90 inch nominal height excluding base channels, lifting members, and pull boxes; length and depth not to exceed dimensions as scaled

on drawings. Align section so that back of complete structure may be placed flush against wall.

- D. Finish: Manufacturer's standard enamel over rust inhibitor on exterior surfaces; minimum one coat corrosion-resisting paint or zinc coating on interior surfaces.
- E. Main Over current Protective Device: NEMA AB1; molded case circuit breaker with thermal magnetic trip fixed mounted.
- F. Circuit Breakers: NEMA AB1; molded case, thermal magnetic trip, AIC rating greater than available symmetrical short circuit amperes at the switchboard. Distribution circuit breakers must be series rated with load side lighting and appliance panel boards, load centers, and enclosed circuit breakers.
- G. Bussing: Copper with full neutral. Provide ground bus.
- H. Future Provisions: Provide spaces fully equipped for future devices with bussing, device supports, and bus connections. Include provisions for extension of bussing when future distribution section is indicated.
- I. Switchboard Instrumentation (Microprocessor Based): UL 1244, ANSI C37.90; digital multi-function monitoring, metering, and control device, ANSI C12.16 revenue accuracy, panel mounted with alpha-numeric LED and/or LCD displays.
 - 1. Metering Functions – displayed value (% accuracy): AC phase current (1%), AC phase voltage (1%) phase-phase and phase to neutral, watts (2%), VAR's (2%), power factor (4%), watt demand (2%) with 5, 10, 15, or 30 minute selected interval, watt hours (2%), and frequency (0.5%). Demand functions shall have zero reset feature.
 - 2. Protective Functions: Phase loss, phase reversal, under voltage, and over voltage. Functions shall have adjustable settings and include adjustable time delay feature for abnormal voltage conditions. Provide separate Form C (SPDT) trip and alarm output contacts.
 - 3. Instrument Transformers: ANSI C57.13; current and potential transformers as required. Provide multi-ratio transformers when indicated. Voltage input shall be fused and include a disconnecting means.
 - 4. Remote Monitoring: Include RS232 data output port.
 - 5. Power Loss: Retain all pre-set parameters, accumulated watt hours, and watt demand without battery back-up.

- J. Utility Metering: Include provisions for utility company transformer metering. Comply with Parkland Light and Water requirements.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

- A. Panel boards: NEMA PB 1; bolt-on circuit breaker type.
- B. Electrical Ratings, Circuit Breaker Arrangement, Special Features: As indicated on drawings. Indicated ampere interrupting capacity (AIC) is the rms symmetrical integrated equipment short circuit rating of the complete assembly.
- C. Cabinet: Concealed trim clamps, concealed hinge door-in-door (one door over interior and one which exposes gutter) with flush locks all keyed alike, 6" deep x 20" wide. Provide two (2) keys for each panel board furnished.
- D. Finish: Manufacturer's standard enamel over rust inhibitor for exposed surfaces; galvanized steel for recessed boxes.
- E. Circuit Directory: Index card under plastic with metal framed holder on inside door.
- F. Circuit Breakers: NEMA AB 1; molded case, thermal magnetic trip. Multi-pole breakers shall have internal common trip. Provide type SWD for lighting circuits. Provide type HACR for air conditioning equipment.
- G. Bussing: Copper with full neutral and ground bus. Provide separate ground bus isolated from cabinet where isolated grounding requirements are indicated.
- H. Where Transient Voltage Surge Protection (TVSS) is indicated, include provisions for integral device. Where separate over current protection or disconnect device is required, provide sub-feed device. Coordinate requirements with Section 16671.
- I. Provide sheet metal skirt with matching panel board finish from bottom of surface mounted panel boards to floor.

2.04 DISCONNECT SWITCHES

- A. Safety Switches: NEMA KS 1; heavy duty, quick make, quick break, handle with lock out/tag out provisions. Provide rating, number of poles, and fusing required for load served.

- B. Toggle Switches for Small Motors and Appliances: NEMA WD 1; horsepower rated 20 ampere general use snap switch with lock-out attachment.
- C. Elevator Switches: Enclosed fused switch and shunt trip assembly complying with NEC 620 and ANSI 17.1 requirements for elevator power supply. Switch assembly shall include Class J power fuses sized for elevator load, locking handle operator, fused control power, fire alarm initiating device interface relay, keyed test switch, pilot light (ON), and mechanical interlock auxiliary contact for emergency automatic recall. Bussman PS series power module switch or equal.
- D. Switch Enclosures: NEMA ICS6; Type 1 for dry locations, Type 3R for damp or outdoor locations.

2.05 **FUSES**

- A. Approved Fuses, 600 Amperes and Less, for Branch Circuits and Power Distribution:
- B. ANSI/UL 198C Class J low peak with time delay unless otherwise indicated except ANSI/UL 198E Class RK5 may be used in safety switches for protection of motor loads, HVAC equipment, and transformers.
- C. For protection of circuit breakers: Fuses must comply with NEC 240.86 series rating requirements for load side circuit breakers that are not rated for the available fault current. Coordinate series rating requirements with published manufacturer's listings for circuit breakers installed.

2.06 **MOTOR CONTROLLERS**

- A. Manual Motor Starters: NEMA ICS2; AC general purpose Class A manually operated full-voltage controller for fractional horsepower induction motors, with thermal overload unit, green neon pilot light, and toggle operator.
- B. Magnetic Motor Starter: NEMA ICS2; full-voltage non-reversing (FVNR) type, hand reset solid state overload relay with phase loss protection, green 20,000 hour "ON" pilot light, one normally open and one normally closed auxiliary contacts, fused 120 volt control transformer, 120 volt operating coil; additional features as indicated. Provide cover mounted "Hand-Off-Auto" selector switch unless operator station is indicated.
- C. Combination Motor Starters: Combine Magnetic Motor Starter and fused and disconnect switch with Class R fuse provisions in common enclosures.

- D. Operator Stations: NEMA ICS2; heavy duty oil tight, operator and legend plate indicated.
- E. Enclosures: NEMA ICS6; Type 1 for dry locations, Type 3R for damp or outdoor locations.
- F. Enclosure Finishes: Manufacturer's standard enamel over rust inhibitor on all interior and exterior surfaces.

2.07 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, white letters on black background, affixed with stainless steel screws, adhesive acceptable in dry locations. Use black letters on yellow background for series combination rating identification. Use white letters on red background for emergency distribution.
- B. Letter Height: ½ inch for series combination rating identification. ¼ inch for switchboards, panel boards, switches, and disconnecting means; 1/8 inch for motor starters and equipment served.
- C. Flash Protection Labels: Self-adhesive vinyl label, minimum 5 inches wide x 3.5 inches high, with ANSI header to read WARNING or DANGER and informational text to include:

Arc Flash Hazard
Appropriate PPE required
Failure to comply can result in death or injury
Refer to NFPA 70E

2.08 COMPRESSION LUGS (ALUMINUM CONDUCTOR)

- A. Aluminum conductor shall not be used.

PART 3 – EXECUTION

3.01 SWITCHBOARDS

- A. Install in accordance with manufacturer's instructions and NEMA PB 2.1.
- B. Seismic Restraint: Comply with requirements of the International Building Code (IBC). Obtain anchoring plans from equipment manufacturer indicating size and location of anchors suitable for Seismic Design Category F. Secure floor mounted equipment to concrete floor or pad with corrosion proof ½ inch – 13 SAE Grade 5

wedge anchors having a minimum embedded depth of 5-1/2 inches unless otherwise approved or recommended by manufacturer.

- C. Provide initial programming and set up for microprocessor based switchboard instrumentation. Coordinate with Owner to verify requirements for User selected programming inputs.

3.01 **PANELBOARDS**

- A. Install in accordance with NEMA PB 1.1.
- B. Height: 78 inches maximum measured from finish floor to top of enclosure; 78 inches maximum measured from finish floor to highest device handle for panel boards over 66 inches high.
- C. Provide typewritten circuit directory for each panel board listing load description for each circuit. Use final room names and numbers as verified with the Owner.
- D. Stub 3 empty $\frac{3}{4}$ inch conduits to accessible location above ceiling from each recessed panel board.

3.02 **FUSES**

- A. Install fuses in fusible switches.
- B. Size fuses for motor loads at 150% of nameplate full load amperes; size fuses for air conditioning and refrigeration equipment and maximum recommended nameplate rating.

3.03 **MOTOR CONTROLLERS**

- A. Adjust solid state overload relay to match installed motor characteristics and ambient conditions.

3.04 **NAMEPLATES AND LABELS**

- A. Switchboards, Panel boards: Provide nameplate to identify equipment designation, voltage, and source of supply for each, e.g. Panel A, 208/120V, Fed from Panel M. Provide arc flash protection label. Provide series combination rating nameplate where such rating is applicable.
- B. Individual Devices Installed in Switchboards, Distribution Panel boards Without Circuit Index: Provide nameplate to identify circuit number and load served.

- C. Motor Starters: Provide nameplate to identify load served. May be deleted when load is immediately adjacent and obvious as determined by Construction Management.
- D. Individual Safety Switches, and Disconnecting Means: Provide nameplate to identify load served and circuit source and circuit number.
- E. Equipment Served: Provide nameplate to identify equipment designation corresponding with nameplate of serving over current device, disconnect switch, or controller when there is more than one of the same type of equipment being served, e.g. Air Handler No. 2. Coordinate with Architect/Engineer to assign numbers when not designated in equipment schedules.
- F. Nameplate and Label Location: Secure to equipment fronts, except recessed panel boards in finished locations secure nameplates and labels to inside face of door.

3.05 **EQUIPMENT PADS**

- A. Switchboards – Indoors: Provide concrete equipment (housekeeping) pads, 3-1/2 inches high and 4 inches larger than the footprint of the equipment.

3.06 **TESTS**

- A. Motors and Compressors: Record all nameplate data. Measure actual voltage and running amperes for each phase. Record manufacturer and catalog number of overload thermal units installed.

END OF SECTION

SECTION 16495

TRANSFER SWITCHES

PART 1 – GENERAL

1.01 SUMMARY OF WORK

- A. Automatic transfer switch is **Owner furnished, Contractor installed.**

1.02 SECTION INCLUDES

- A. Automatic transfer switches.

1.03 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.04 RELATED SECTIONS

- A. Section 16622, Packaged Engine Generator Systems: Emergency power source.
- B. Section 16995, Commissioning Electrical Systems.

1.05 SUBMITTALS

- A. Coordinate with Owner to obtain product data for transfer switch showing overall dimensions, electrical connections, electrical ratings, field wiring requirements and environmental requirements.

1.06 OPERATION AND MAINTENANCE DATA

- A. Include record of final settings for adjustable and factory time delays and sensors from system start-up.

PART 2 – PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

- A. Description: UL 1008, NEMA ICS2; automatic transfer switch, as manufactured by Onan.
- B. Configuration: Electrically-operated, mechanically-held transfer switch.
- C. Ratings: UL 1008, NEMA ICS2; as follows:
 - 1. Voltage: 120/208 volts, three phase, four wire, 60 Hz.
 - 2. Switched Poles: 3
 - 3. Load Inrush Rating: Combination tungsten lamp, electric discharge lamp, resistive load, and motor load.
 - 4. Continuous Rating: Ampere rating indicated on drawings.
 - 5. Withstand Current Rating: 22000 rms symmetrical amperes, when used with molded case circuit breaker.
 - 6. Suitable for use on NEC 700 Systems.
- D. Control: Solid state circuitry; separately adjustable voltage and frequency sensing of normal and alternate sources, all phases.

2.02 **AUTOMATIC SEQUENCE OF OPERATION**

- A. Initiate Time Delay to Start Emergency Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay to Start Emergency Source Engine Generator: 0 to 6 second, adjustable.
- C. Initiate Transfer Load to Emergency Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Emergency Power Source: 0 to 60 seconds, adjustable.
- E. Initiate Retransfer to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

- G. Time Delay Before Engine Shut Down: 0 to 5 minutes, adjustable, of unloaded operation.
- H. Engine Exerciser: Start engine every 30 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period. Provide load/no-load selector switch.

2.03 ENCLOSURE

- A. Enclosure: ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations; 30 inch maximum width. Provide hinged door with locking handle latch and gasketed jambs.

2.04 ACCESSORIES

- A. Indicating Lights: Mount in cover of enclosure to indicate normal source available, alternate source available and switch position.
- B. Key Operated Selector Switch: Mount in cover of enclosure for Test-Auto-Off-Engine Start.
- C. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.
- D. In-Phase Monitoring: To reduce destructive transients during switching of motor loads.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Obtain product submittals and installation requirements from product Vendor.
- B. Coordinate delivery of transfer switch with product Vendor. Provide off loading, moving, uncrating, and setting in place.
- C. Install in accordance with manufacturer's instructions and approved shop drawings.
- D. Nameplates: Comply with Section 16470; Indicate equipment designation, voltage, and description of distribution (emergency or stand-by power).
- E. Provide multiple automatic transfer switches as required to automatically transfer emergency (life safety) loads separate from optional stand-by loads.

3.02 TESTING AND ADJUSTMENTS

- A. Comply with Section 16622 – Packaged Engine Generator Systems as related work.
- B. Comply with NFPA requirements for Emergency and stand-by systems.
- C. Make initial and final settings for adjustable time delays and sensors.
- D. Provide testing to ensure smooth transfer of Life Safety and back-up systems. During test, record and provide written documentation to include the following information:
 - 1. Proper operation of all controls and indication lights.
 - 2. Time Delay to Start Emergency Source Engine Generator.
 - 3. Time Delay Before Transfer to Emergency Power Source.
 - 4. Time Delay Before Transfer to Normal Power.
 - 5. Time Delay Before Engine Shut Down.
 - 6. Additional documentation required by Commissioning Authority.

3.03 COMMISSIONING

- A. The equipment and systems referenced in this Section are to be commissioned per Section 01810 – Commissioning General Requirements and Section 16995 – Commissioning: Electrical Systems. The Contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Comply with Section 16622 – Packaged Engine Generator Systems as related work.

END OF SECTION

SECTION 16500

LIGHTING FIXTURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaries and accessories
- B. Exterior luminaries and accessories
- C. Lamps
- D. Ballasts
- E. Poles and concrete bases

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Concrete for Bases: Comply with Division 3 – Concrete

1.04 COORDINATION

- A. Confirm luminary type, mounting, and recessed depth is compatible with ceiling system prior to ordering. Coordinate with architectural reflected ceiling plans, sections, and details.
- B. Determine final luminary locations according to architectural reflected ceiling plans and elevations.

1.05 SUBMITTALS

- A. Submit product data for light fixtures, fixture accessories, lamps, ballasts, and poles.

PART 2 – PRODUCTS

2.02 ACCEPTABLE MANUFACTURERS

- A. Luminaries & Accessories: Identified in Fixture Schedule.
- B. Fluorescent Lamps: General Electric, Osram Sylvania, North American Phillips.
- C. High Intensity Discharge (HID) Lamps: General Electric, Osram Sylvania, Venture Lighting.
- D. Fluorescent Ballasts, Electronic: Advance, EBT, Motorola, Magnetek, Lithuania.
- E. HID Ballasts: Advance, Valmont, Jefferson, Universal, Widelight.
- F. Incandescent Lamps: General Electric, Osram Sylvania, North American Phillips.

2.03 LAMPS

- A. Fluorescent T8: 3500K, 80 CRI minimum, 2950 initial lumens minimum.
- B. Fluorescent T5HO: 3500K, 82 CRI minimum, 5000 initial lumens minimum.
- C. Compact Fluorescent: 2700K.
- D. General Use Incandescent: Inside frosted, 125 volt rating.

2.04 FLUORESCENT BALLASTS – RAPID AND INSTANT START

- A. General: ANSI C82.1; high power factor, Class P, CBM/ETL certified.
- B. Electronic Ballasts: Solid state high frequency type, 10% maximum total harmonic distortion (THD), 1.5 maximum line current crest factor, rated 120 volts. Ballast factor (BF) shall be .88 minimum unless otherwise indicated.
- C. Sound Rating: Group A
- D. Low Temperature Ballasts: Minimum starting ambient temperature of 0 degrees Fahrenheit.
- E. Ballast Location: Center mount on suspended fixtures.
- F. Split Switching: Where split switching of fluorescent fixtures is indicated, wire ballasts so that inboard lamps are switched separately from outboard lamps.

- G. Emergency ballast – T8 use Lithuania ps300qd, T5 use Lithuania ps600qd or ps1400qd.

2.05 **FLUORESCENT BALLASTS – COMPACT LAMPS**

- A. General: ANSI C82.1; Class P, encapsulated; high power factor unless otherwise scheduled.
- B. Sound Rating: Group A

2.06 **FLUORESCENT DIMMING BALLASTS AND CONTROLS**

- A. Ballasts: UL listed, Class P thermally protected, solid state electronic dimming ballast, Class A sound rating, 100% to 5% or better dimming range, 10% maximum total harmonic distortion (THD), Advance Mark X, Lutron Hi-lume manufacture.
- B. Dimming ballasts shall be compatible with low mercury fluorescent lamps per latest CBM/ETL standards.
- C. Control Units: Architectural linear slide with preset feature, 1000 VA minimum rating, UL listed for use with the dimming ballast provided, single pole or 3-way as indicated.

2.07 **HID BALLASTS**

- A. General: ANSI C82.4; constant wattage autotransformer (CWA) type, $\pm 10\%$ allowable line voltage variation, unless otherwise indicated. Provide inline time delay fusing option for each line phase (not required for multi-tap ballasts).
- B. Multi-Tap Ballasts: Rated 120/208/240/277 volt, unless otherwise noted. In line fusing option not required.

2.08 **FIXTURE WHIPS**

- A. 3/8 inch flexible conduit or approved MC cable assembly with circuit and equipment ground conductors; 72 inch maximum length.
- B. Where fixtures are provided with pre-installed whips, verify wiring arrangement, termination location, and installation clearances prior to ordering.

2.09 **FIXTURE ACCESSORIES**

- A. Provide necessary hangers, brackets, plates, anchors, and other mounting accessories required by construction features and ceiling conditions. Comply with requirements of Section 16050, Basic Materials and Methods.
- B. Pendants: Provide single pipe stem type with self-aligning swivel hangar and canopy and suitable for sloped ceilings, stem length as required.
- C. Allow sufficient length for pendants, cables, chains, conduit, or rods as specified to install hanging fixtures at 8 feet above finished floor or 36 inches below the ceiling, whichever is lower, unless otherwise indicated in the construction documents.

2.10 **LIGHTING POLES**

- A. Wind Load Rating: 100 mph with luminaries and brackets installed.
- B. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.

2.11 **LIGHTING FIXTURE SCHEDULE**

- A. See Drawings.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Provide lamps in lighting fixtures and lamp holders provided under this Section.
- B. Set lighting fixtures plumb, square, and level; measure mounting heights to center of fixture for wall mounted and to bottom of fixture for pendant hung.
- C. Support lighting fixtures from building structural members; provide metal channels or additional framing as required for fixture support between structural members or to avoid interference from mechanical pipes and ducts. Conceal supports within building construction in finished spaces.
- D. Recessed and surface mounted lighting fixtures weighing less than 56 lbs (25.4 kg) may be supported from metal ceiling suspension systems when auxiliary support from structural members using two (2) #12 AWG wire hangers at

diagonal corners are provided (hangers may be slack). Fixtures weighing 56 lbs or more must be supported directly from the structure by approved hangers.

- E. Light fixtures hung below suspended ceilings by pendants, cables, chains, conduit, rods, or other means shall be supported from structure above using #9 AWG wire hanger on alternate support approved by Inspection Authorities.
- F. Securely fasten recessed and surface fixtures in place; provide seismic clips (one each corner) for lay-in fixtures; attach surface fixtures tight to ceilings and walls, and secure fluorescent fixtures within 12 inches of each end.
- G. Mounting height for wall mounted fixtures and for hanging fixtures supported by pendants, cable, chain, conduit, rods, or other means shall be determined by the Architect/Engineer during construction unless otherwise indicated in the construction documents.

3.02 **RELAMPING**

- A. Re-lamp luminaries which have failed lamps at completion of work.

3.03 **ADJUSTING AND CLEANING**

- A. Align and tighten luminaries and clean reflectors, lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaries.
- B. Make final aiming adjustment of directional luminaries as directed by Architect/Engineer at completion of work.

3.04 **EMERGENCY LIGHTING EQUIPMENT**

- A. Self-Contained Emergency Lights: Connect ahead of switch control on local lighting circuit.

3.05 **THERMAL AND SOUND INSULATION**

- A. Coordinate with General Contractor to ensure provisions are made to support insulation materials minimum of 3 inches clear of recessed lighting fixtures that are not IC rated.

3.06 **CONCRETE BASES**

- A. General: Provide concrete bases for anchor base poles and for pathway lights.

- B. Pole Bases: Size and construction as indicated. Install anchors using template obtained from pole manufacturer. Install poles on bases plumb; provide double nuts or shims for adjustment. Grout around pole bases.

END OF SECTION

SECTION 16611

FLYWHEEL UNINTERRUPTIBLE POWER SUPPLY

PART 1 – GENERAL

1.01 SUMMARY OF WORK

- A. Automatic transfer switch is **Owner furnished, Contractor installed.**

1.02 SECTION INCLUDES

- A. Continuous-duty three-phase, solid-state, uninterruptible power system (UPS) complete with external by-pass switch and accessories. The UPS shall provide high-quality AC power for sensitive electronic equipment loads.

1.03 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.04 STANDARDS

- A. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this Specification shall govern.

- ANSI C62.41 (IEEE 587)
- ASME
- CSA 22.2, No. 107.1
- FCC Part 15, Class A
- ISO 9001
- National Electrical Code (NFPA-70)
- NEMA PE-1
- OSHA
- UL Standard 1778

- B. The UPS shall be ETL listed per UL Standard 1778 Uninterruptible Power Supplies, and shall be CSA Certified.

1.05 SYSTEM DESCRIPTION

A. Design Requirements – UPS Module:

1. Voltage: Input/output voltage specifications of the UPS shall be:
2. Rectifier Input: 208 volts, three-phase, 3-wire-plus-ground.
3. Bypass Input: 208 volts, three-phase, 3-wire-plus-ground.
4. Output: 208 volts, three-phase, 4-wire-plus-ground.
5. Output Load Capacity: Specified output load capacity of the UPS shall be 40 kVA at 0.8 lagging power factor.

B. Design Requirements – Matching Flywheel Cabinet:

1. Storage System: Carbon fiber composite flywheel rotating within two containment vessels, assisted by an active magnetic levitation system.
2. Reserve Time: 120KW available for 20 seconds to provide enough time to put generator on line.
3. Recharge Time: to 95% capacity within ten (10) times discharge time.

C. Modes of Operation:

1. The UPS shall be designed to operate as an on-line, double-conversion, reverse-transfer system in the following modes:
 - a. Normal – The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float-charging a power reserve battery.
 - b. Emergency – Upon failure of utility AC power, the critical AC load is supplied by the inverter, which without any switching, obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
 - c. Recharge – Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charger shall automatically restart,

walk-in and gradually assume the inverter and battery recharge loads.

- d. Bypass – If the UPS must be taken out of service for maintenance or repair, or should the inverter overload capacity be exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.

D. Performance Requirements

1. AC Input to UPS

- a. Voltage Configuration for Standard Units: three-phase, 3-wire plus ground.
- b. Voltage Range: + 10%, -20% of nominal.
- c. Frequency: Nominal frequency +/-5%.
- d. Power Factor: Up to 0.96 lagging at nominal input voltage and full rated UPS output load with optional input filter. Minimum 0.80 lagging without optional input filter.
- e. Inrush current: 800% of full load current maximum.
- f. Current Limit: 115% of nominal AC input current maximum. 100% of nominal for optional generator operation.
- g. Input Current Walk-In: 15 seconds to full rated input current maximum. Field selectable 5 through 15 seconds.
- h. Current Distortion: 10% reflected THD maximum at full load when fitted with optional input filter. 30% THD maximum at full load without optional input filter.
- i. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category A and B.

2. AC Output, UPS Inverter

- a. Voltage Configuration: three-phase, 4-wire plus ground
- b. Voltage Regulation:

- 1) $\pm 0.5\%$ three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.
 - 2) $\pm 1.0\%$ three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.
- c. Frequency: Nominal frequency $\pm 0.1\%$.
- d. Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 0.1 to 5.0 Hz per second.
- e. Phase Displacement:
- 1) ± 0.5 degree for balanced load
 - 2) ± 1.0 degrees for 100% unbalanced load
- f. Bypass Line Sync Range:
- 1) ± 0.5 Hertz
 - 2) Field selectable ± 0.5 to 5.0 Hz
- g. Voltage Distortion:
- 1) 1% total harmonic distortion (THD) for linear loads
 - 2) 2.5% THD for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating.
- h. Load Power Factor Range: 1.0 to 0.7 lagging without derating.
- i. Output Power Rating: Rated kVA at 0.8 lagging power factor.
- j. Overload Capability:
- 1) 125% for ten minutes (without bypass source).
 - 2) 150% for one minute (without bypass source).

- 3) 200% for 10 cycles, pulse paralleling with the static switch.
- k. Inverter Output Voltage Adjustment: +/-5% manual adjustment.
- l. Voltage Transient Response:
 - 1) 100% load step \pm 2.5%
 - 2) Loss or return of AC input power \pm 1.0%
 - 3) Manual transfer of 100% load \pm 3.0%

1.06 ENVIRONMENTAL CONDITIONS

- A. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:
- B. Operating Ambient Temperature
 1. UPS Module: 32° F to 104° F (0°C to 40°C).
 2. Battery: 77 +/-9° F (25 +/-5°C).
- C. Storage/Transport Ambient Temperature
 1. UPS Module: -4°F to 158°F (-20°C to 70°C).
 2. Battery: -4°F to 92°F (-20°C to 33°C).
- D. Relative Humidity
 1. 0 to 95%, non-condensing
- E. Altitude
 1. Operating: to 6,600 ft (2,000 meters) above Mean Seal Level, Derated for higher altitude applications.
 2. Storage/Transport: to 40,000 ft. (12,200 meters) above Mean Seal Level.
- F. Audible Noise

1. Noise generated by the UPS under any condition of normal operation shall not exceed 65 dBA measured 1 meter from surface of the UPS.

PART 2 – PRODUCT

2.01 **40 KVA FLYWHEEL UPS**

- A. Liebert NPower 3 – Phase UPS with UPS cabinet, maintenance bypass cabinet, and flywheel cabinet, and Factory start-up.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Obtain product submittals and installation requirements from product Vendor, Contact Campbell Company, Jim Sweet, 206.763.5000.
- B. Coordinate delivery of UPS with product Vendor. Provide off loading, moving, uncrating, and setting in place.
- C. Install UPS per manufacture installation instructions. Include seismic anchoring of cabinets, power cable interconnection between cabinets using manufacturer furnished cable, and control wiring interconnection between cabinets using contractor furnished conductors.

3.02 **FIELD QUALITY CONTROL**

- A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS start-up.
- B. Visual Inspection
 1. Inspect equipment for signs of damage
 2. Verify installation per drawings
 3. Inspect cabinets for foreign objects
 4. Verify neutral and ground conductors are properly sized and configured
 5. Inspect battery cases

6. Inspect battery for proper polarity
 7. Verify all printed circuit boards are configured properly
- A. Mechanical Inspection
1. Check all control wiring connections for tightness
 2. Check all power wiring connections for tightness
 3. Check all terminal screws, nuts, and/or spade lugs for tightness
- B. Electrical Inspection
1. Check all fuses for continuity
 2. Conform input voltage and phase rotation is correct
 3. Verify control transformer connections are correct for voltages being used
 4. Assure connection and voltage of the batter string(s)

END OF SECTION

SECTION 16622

PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY OF WORK

- A. Packaged Engine Generator System.

1.02 SECTION INCLUDES

- A. Packaged engine generator set with circuit breaker and control panel.
- B. Sub-base fuel tank.
- C. Batteries, tray and charger.
- D. Exhaust silencer and fittings.
- E. Weather protective housing.
- F. Remote annunciator panel.
- G. Remote emergency stop station.
- H. Factory start-up.

1.03 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.04 RELATED SECTIONS

- A. Section 16495, Transfer Switches
- B. Concrete for Equipment Pads: Comply with Division 3
- C. Section 16995 Commissioning: Electrical Systems

1.05 REGULATORY REQUIREMENTS

- A. Conform to the requirements of the following publications:
 - 1. NFPA 110 – Standard for Emergency and Standby Power Systems
 - 2. UL 2200 – UL Standard for Safety for Stationary Engine Generator Assemblies

1.06 **SYSTEM DESCRIPTION**

- A. UL 2200 Engine generator system to provide source of emergency power.
- B. System Capacity: Comply with KW/KVA ratings indicated on plans, at elevation of 500 feet above sea level, and ambient temperature 85 degrees F; continuous standby rating using engine-mounted radiator.
- C. Installation: Outdoor packaged assembly with integral fuel tank, batteries, charger, block heater (water jacket), exhaust, and weather protective housing.

1.07 **SUBMITTALS**

- A. Coordinate with Owner to obtain product data for transfer switch showing overall dimensions, electrical connections, electrical ratings, field wiring requirements and environmental requirements.

1.08 **OPERATION AND MAINTENANCE DATA**

- A. Submit data in Operation and Maintenance Manuals.
- B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, and emergency maintenance procedures.
- C. Include documentation from system start-up.

1.09 **WARRANTY**

- A. Provide five (5) year warranty on engine-generator packaged unit.

PART 2 – PRODUCTS

2.01 **ACCEPTABLE MANUFACTURERS**

- A. Cummins/Onan

2.02 ENGINE

- A. Type: Water-cooled inline or V-type, four stroke cycle, compression ignition Diesel internal combustion engine.
- B. Fuel System: No. 2 fuel oil.
- C. Engine Speed: 1800 rpm.
- D. Governor: Electronic isochronous type.
- E. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- F. Engine Starting: Two wire DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- G. Engine Block Heater: Thermostatically controlled water jacket heater, sized to maintain 90 degrees F, ambient, and rated for 120 volt.
- H. Radiator: Unit mounted, with duct flange, using glycol coolant, with engine driven blower type fan, sized to maintain safe engine temperature in 110 degrees F ambient and against static air flow restriction of 0.5 inches of water.
- I. Diesel Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear driven water pump.
- J. Mounting: Mount unit on structural steel base using suitable vibration isolators.

2.03 GENERATOR

- A. Generator: ANSI/NEMA MG 1; four pole, reconnectable brushless synchronous generator with brushless exciter.
- B. Rating: Comply with KW rating and voltage configuration indicated on plans, 60 Hz at 1800 rpm.
- C. Insulation: ANSI/NEMA MG 1; Class F minimum.
- D. Temperature Rise: 105 degrees C continuous, 130 degrees C standby.
- E. Enclosure: ANSI/NEMA MG 1; open drip proof.

- F. Voltage Regulation: Include generator-mounted volts per Hertz exciter-regulator to match engine and generator characteristics, with voltage regulation +/- one percent from no load to full load. Include manual controls to adjust voltage drop +/- five percent voltage level, and voltage gain.

2.04 ACCESSORIES

- A. Fuel Tank: Double wall, UL listed, sub-base tank unit with fuel lines, 336 gallon minimum capacity, with low fuel level alarm switch and tank rupture alarm switch.
- B. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions.
- C. Batteries, Diesel Engine: Heavy duty, diesel starting type lead-acid storage batteries, 170 ampere-hours minimum capacity with thermostatically controlled 120 volt plug-in blanket heaters. Include necessary cables and clamps.
- D. Battery Tray: Plastic coated metal or structural plastic, constructed to contain spillage of electrolyte.
- E. Battery Charger: Dual rate type designed to provide a trickle charger rate of 80 to 500 milliamperes, or steady current output of 2 amperes minimum to maintain a fully-charged condition, at a constant battery voltage without danger of overcharging, and capable of recharging a fully discharged battery within 24 hours. Include overload protection. Provide base-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
- F. Line Circuit Breaker(s): NEMA AB 1 molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole; number and rating as indicated. Mount unit in enclosure to meet ANSI/NEMA 250, Type 1 requirements.
- G. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls, shut downs and indicators meeting requirements of NFPA 110, level 2 installation. In addition, include the following equipment and features:
 - 1. Frequency Meter
 - 2. AC Output Voltmeter
 - 3. AC Output Ammeter

4. Output voltage adjustment
 5. Engine running time meter
 6. Oil pressure gauge
 7. Water temperature gauge
 8. Auxiliary Relay, 3PDT
 9. Remote alarm contacts for NFPA 99 110 Level 1 alarm functions
 10. Audible alarm rated 90 dB at 10 feet
 11. Sub-base tank rupture alarm
- H. Weather Protective Housing (With Enclosed Exhaust Silencer): Reinforced steel construction with rust inhibiting primer and enamel finish inside and out, stainless steel hardware, locking access panels, fixed ventilation louvers for full load operation with access panels closed. Alternate Bid: Housing design for diesel engine units shall provide noise attenuation of 70 dBA maximum measured at 7 meters under full load.
- I. Base Mounted Vibration Isolators: Suitable spring type isolators with seismic restraints recommended by generator set manufacturer to comply with installation requirements.
- J. Remote Engine Annunciator Panel: NFPA 110 Level 2; surface mounted panel with brushed stainless steel or color enamel finish. Include sub-base tank rupture alarm and low fuel alarm. Remote annunciator shall connect to generator control using a digital network communication cable.
- K. Remote Emergency Shut-Down Station: Semi-flush single action downward pull lever, manual reset without break-glass rod. Provide permanent label reading "AUXILIARY GENERATOR EMERGENCY SHUTDOWN".

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Obtain product submittals and installation requirements from product Vendor.

- B. Coordinate deliver of Generator with product Vendor. Provide off loading, moving, uncrating and setting in place.
- C. Install in accordance with manufacturer's instructions and approved shop drawings.
- D. Provide water, glycol antifreeze and lubricants required for start-up, testing and adjustment. Fuel shall be furnished by Owner.
- E. Provide all field wiring and interface cabling for generator remote control per manufacturer's standard installation requirements. Provide emergency shut-down station adjacent to the automatic transfer switch.
- F. Provide vibration isolation between engine generator base and equipment pad. Reduce transmitted vibration to a maximum 0.0015 inches total amplitude through frequency range down to 65 cycles/sec; four isolators minimum.
- G. Secure generator set to floor or foundation. Obtain anchoring plans from equipment manufacturer indicating size and location of anchors suitable for Seismic Design Category F. Secure equipment with corrosion proof ½ inch -13 SAE Grade 5 wedge anchors having a minimum embedded depth of 5 ½ inches unless otherwise approved or recommended by manufacturer.
- H. Provide equipment pad for outdoor packaged systems. Pad shall be concrete slab foundation, 8" thick reinforced with 6" x 6" No. 6 welded steel fabric uniformly centered in slab and placed on a well compacted 9" deep gravel sub-base so that the top is 3" above grade. All edges shall have ½" chamfer. Pad dimensions shall allow at least 6" of free space on all sides of the equipment. Conduit entrance dimensions and location shall comply with equipment manufacturers' recommendations. Secure equipment to pad with corrosion proof anchors.

3.02 TESTING AND ADJUSTMENTS

- A. Field start-up, testing and adjustment shall be performed under the supervision of a factory trained manufacturer's representative.
- B. Provide full load test utilizing portable test bank for one hour minimum. Simulate power failure including operation of transfer switch, and return to normal.
- C. During test, record and provide written documentation of the following at 20 minute intervals:

1. Kilowatts
 2. Amperes
 3. Voltage
 4. Temperature
 5. Frequency
 6. Oil pressure
 7. Additional documentation required by commissioning authority
- D. Test alarm and shut-down circuits.
- E. Adjust generator output and engine speed.

3.03 **COMMISSIONING**

- A. The equipment and systems referenced in this Section are to be commissioned per Section 01810 – Commissioning General Requirements and Section 16995 – Commissioning: Electrical Systems. The Contractor has specific responsibilities for scheduling, coordination, start-up, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

3.04 **DEMONSTRATION AND INSTRUCTIONS**

- A. Demonstrate operation and maintenance of system to Owner’s personnel prior to Contract Closeout. Allow one two hour session scheduled at convenience of Owner.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate operation, control, trouble shooting, maintenance, and testing of system.

END OF SECTION

SECTION 16671

AC SURGE SUPPRESSION BELOW 600 VOLTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Transient Voltage Suppression (TVSS) for electrical distribution equipment.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this Section. Include product installation requirements. Include test data demonstrating compliance with specified performance and peak surge withstand ratings.

1.04 OPERATION AND MAINTENANCE DATA

- A. Include data for each device type in Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Integral TVSS: Distribution equipment manufacturer's standard products that meet or exceed the minimum requirements of this specification.
- B. Remote TVSS: Standard products of the following manufacturers that meet or exceed the minimum requirements of this specification: Innovative Technologies, Leviton.

2.02 TVSS PRODUCT DESIGN

- A. General: UL 1449, 2nd Edition; MOV hybrid circuit design with EMI/RFI noise rejection filter. For wye configured systems provide line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G) suppression. Designs incorporating replaceable modules are not approved.

- B. Diagnostics: LED circuit status indication for each phase.
- C. Enclosure (Remote Devices): NEMA ICS 6; Type 12, unless otherwise indicated. Provide flush trim plate for recess mounting at flush mounted panel boards.
- D. Over current Protection: Provide integral fusing for bus mounted TVSS. Provide circuit breaker or fused disconnect for remote mounted TVSS. Coordinate requirements with distribution equipment supplier.
- E. Disconnecting Means for Integral TVSS: Provide for TVSS mounted in switchboards, and branch circuit panel boards installed as service equipment. Coordinate requirements with distribution equipment supplier.
- F. Product Warranty: 10 year minimum.

2.03 TVSS ELECTRICAL REQUIREMENTS (MINIMUM)

- A. Voltage Rating: Conform to nameplate of distribution equipment.
- B. Ampere Interrupting Capacity (AIC) Rating: Meet or exceed rating of highest rated over current device in the distribution equipment.
- C. UL 1449 2nd Edition Suppressed Voltage Rating (SVR):

System, Volts	L-N	N-G	L-L
	<u>Normal Mode)</u>		<u>Common Mode)</u>
120 to Ground	500 volts	500 volts	700 volts
- D. ANSI/IEEE C62.41 Category C3 voltage let thru: 900 volts L-N (120 volts to ground).
- E. ANSI/IEEE C62.41 Category C1 voltage let thru: 600 volts L-N (120 volts to ground).
- F. Peak Surge Withstand Rating per Phase (8 x 20 microsecond impulse wave form):

Service Entrance	80,000 Amps
Branch Circuit Panel boards	40,000 Amps
- G. Noise Attenuation: 55 dB minimum at 100 kHz using MIL-STD-220A insertion loss test method.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Provide TVSS where indicated.
- B. Provide factory mounted TVSS device integral with distribution equipment except remote mounted TVSS may be used for panel board construction.
- C. Remote Mounted TVSS Installation Requirements
 - 1. Provide TVSS device next (close nipped) to equipment enclosure near panel board over current device provided for the purpose. Wiring leads for remote device shall be as short and straight as possible, but in no case shall exceed 12 inches in length.
 - 2. Comply with manufacturer's recommendations for over current protection.
 - 3. Provide additional equipment grounding terminal in panel for TVSS ground connection where required to comply with maximum lead length specified for remote mounted TVSS.
 - 4. Provide recessed mounting with flush trim plate where TVSS is installed at flush mounted panel boards. Obtain rough-in inspection by the Architect/Engineer prior to cover of recessed installation.

END OF SECTION

SECTION 16710

SIGNAL SYSTEMS PATHWAY

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Conduit, raceway, and outlet rough-in for
 - 1. Voice (Telephone)
 - 2. Data for Business LAN
 - 3. Data for Broadcast LAN
 - 4. Television (TV)
 - 5. Clocks
- B. Telecommunications Terminal Boards
- C. Conduit Sleeves, Risers, and Horizontal Pathway

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 16741, Telecommunications Premises System.
- B. Section 16781, Television Distribution System.
- C. Section 16730, Master Clock.

PART 2 – PRODUCTS

2.01 OUTLETS

- A. General Telecommunications (Voice, Data, and/or TV): 40inch square x 2-1/8 inch deep outlet box with single gang plaster ring. Provide blank device plates on unused outlets.
- B. Clocks: Backbox as specified under related specification section.

2.02 MATERIALS

- A. Boxes, Conduit, Raceway, Device Plates, and Cable Tray: Comply with Section 16050.

2.03 TELECOMMUNICATIONS TERMINAL BOARDS

- A. ¾" plywood mounting board with Class A fireproofing, location and size as indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. General: Comply with Section 16050.
- B. Outlets for TV, Voice, and/or Data:
 - 1. Boxes: Conform to requirements of Section 16050.
 - 2. Raceway: Comply with requirements of Section 16050, except minimum conduit size shall be 1 inch. Terminate conduit with plastic bushing. Install maximum two 90 degree equivalent bends between raceway terminations.
 - 3. Mounting height unless otherwise directed: See Drawings
 - 4. Do not install signal outlets on same side of wall stud common with electrical outlets or vertical power wiring.
 - 5. Open cable not permitted in spaces open to structure (without suspended ceiling).
- C. Clock Outlets: Comply with requirements of Section 16730. Unless otherwise indicated, provide ½ inch conduit concealed from each back box to nearest accessible ceiling space or cable tray of first floor. Terminate conduit with plastic

bushing. Provide conduit nipple with bushing for boxes installed in accessible ceiling tiles.

- D. Risers and Horizontal Pathway: Provide conduit for signal pathway between floors and as otherwise indicated. At MDF, IDF's and equipment head ends, tag or otherwise label with permanent marker each conduit termination to identify its destination.
- E. Install nylon pull cord in each conduit longer than 20 feet. Leave 18 inches of slack minimum each end. Tag end of pull cord at conduit termination to identify outlet location at other end.
- F. Conduit Sleeves: Provide conduit sleeves for installing open signal cables thru fire rated construction, draft stops, and partition walls in accessible ceiling spaces. Locate and size sleeves per approved shop drawings provided under related sections and as otherwise indicated.

END OF SECTION

SECTION 16724

ADDRESSABLE FIRE ALARM SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Building fire detection and alarm system, **bidder design**.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 14245, Hydraulic Passenger Elevators
- B. Section 15500, Fire Protection Sprinkler System
- C. Section 15505, Fire Suppression system (Alternate Bid).
- D. Section 15900, Automatic Temperature Controls

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of Washington State Fire Marshal's office and local Fire Marshal.
- B. Conform to requirements of following publications in addition to requirements of 16010:

IFC	International Fire Code
NFPA 72	National Fire Alarm Code
Local fire alarm code adopted by the jurisdiction	

1.05 SYSTEM DESCRIPTION

- A. Fire Alarm System: Supervised, non-coded, addressable, using Style 4 (Class B) signaling line circuit (SLC) intelligent loop wiring for initiating and monitoring, and Class B (two wire with end-of-line device) for signaling.

- B. Alarm Sequence of Operation: Actuation of any manual or automatic initiating device results in system ALARM which includes the following operations:
 - 1. Display alarm status information at control panel and remote annunciator.
 - 2. Audible and visual alarm signals operate continuously until initiating devices are restored to normal and control panel is reset. If alarm silence switch is activated, alarm LED annunciation continues. New alarm resounds signals.
 - 3. Alarm signal is transmitted to Pacific Lutheran University (PLU) Campus Central Station.
 - 4. Relays activate to initiate HVAC shut down, release door hold open devices, and close smoke dampers.

- C. Trouble Sequence of Operation: Grounded circuit, open circuit, power failure, or system failure results in system TROUBLE which includes the following operations:
 - 1. Display trouble status information by zone at the control panel. Audible trouble signal operates continuously until activation of silence switch.
 - 2. Trouble signal is transmitted to PLU Campus Central Station.

- D. Sprinkler Supervision: Closing: OSY, PIV, or zone valves, or abnormal air pressure for dry systems results in zone supervisory which includes the following operations:
 - 1. Display trouble status information by zone at the control panel. Audible trouble signal operates continuously until activation of silence switch.
 - 2. Sprinkler supervisory signal is transmitted to PLU Campus Central Station.

- E. Zoning: As approved by authority having jurisdiction.

1.06 **SYSTEM PARAMETERS**

- A. Design: Comply with requirements of the International Fire Code, International Building Code, and local fire alarm code as adopted and supplemented by authority having jurisdiction and applicable for the Building Occupancy, by Group and Division, indicated in the Construction Documents. Location of control

panel, remote annunciator, and door hold open devices are indicated on the Electrical Plans.

- B. Pre-bid Coordination: Obtain and review all construction documents prior to bidding as required to verify site conditions, floor plans, building sections, ceiling types, building construction, mechanical systems, building equipment and other conditions that will affect the fire alarm system design. Verify fire alarm design and system requirements with local authority having jurisdiction.
- C. Fire Protection Sprinkler System: Building is sprinklered. Coordinate scope of sprinkler coverage with Section 15500.
- D. Device Compatibility: All alarm, initiating, and accessory devices provided shall be listed in the device compatibility document available from the manufacturer for the fire alarm control panel installed.
- E. Detectors: Unless otherwise indicated, provide detectors as follow:
 - 1. Smoke Detectors: Photo-electric or ionization type
 - 2. Heat Detectors:
 - a. Indoor high ambient temperature areas (e.g. boiler rooms, kitchens, attics, ceiling space, etc.): rate anticipation heat detectors.
 - b. Other locations: combination rate of rise and fixed temperature heat detectors.
- F. Outdoor Installation: Equipment and devices installed outdoors shall be weatherproof and otherwise suitable for the application.
- G. Horns: System design shall provide alarm audibility of not less than 15 dB above ambient noise levels. Horns installed in individual rooms under 900 square feet shall be small area type.
- H. Visual Signaling Devices: The following building areas and spaces are to be considered public areas subject to requirements for ADA visual signal devices: Halls, corridors, toilets, restrooms, conference rooms, open offices, reception areas, break rooms, work rooms, waiting areas, entries.
- I. Radio Broadcast production and Control Rooms: Individual alarm indication required in each room (typical of 5 rooms). Provide visual alarm indication only if approved by Fire Marshal.

- J. Elevators: Smoke detectors for Machine Room, Shaft, and Lobbies shall have auxiliary contacts to initiate elevator recall.
- K. Access: Provide service access to detectors not readily accessible and to sampling tubes of duct smoke detectors.
- L. Duct Smoke Detectors:
 - 1. Provide for HVAC units rated above 2000 CFM.
 - 2. Provide for smoke dampers unless total coverage smoke detection is provide in all areas served by the HVAC system per IMC requirements.
 - 3. Provide each duct smoke detector with a remote LED/Test station located in an accessible location approved by the Fire Marshal.
 - 4. Coordinate quantity, location, and access for duct smoke detectors with Division 15 Contractor.
- M. Provide identification sticker on end of line (EOL) devices.
- N. Wiring Method: Provide conductors installed in conduit. Open cabling not approved.
- O. Device Locations: Subject to review and approval by Architect/Engineer during shop drawing review. Changes in device locations may be directed and shall be accommodated subject to Code compliance.

1.07 **SYSTEM MONITORING**

- A. Provide final connections at University Campus Central Alarm Panel for transmission of supervisory, alarm, and trouble signals from the Fire alarm Control Panel. Campus Central alarm panel is located in the Security Office of Harstad Hall. Wiring between the main-terminal signal board and Campus Central Alarm Panel shall be provided by the University. Coordinate with University for additional information required.

1.08 **SUBMITTALS**

- A. Submit product data for all items specified under Part 2 of this Section.
- B. Submit shop drawings of entire system showing graphic annunciator plaque, wiring diagrams, system layout and battery calculations. Indicate wire color

coding and termination points for control panel, remote annunciator, and each type of device. Show equipment and device locations, size, type quantity, and routing of interconnecting wiring, end of line locations, and zoning.

- C. Submit product data and shop drawings to Fire Marshal for review and approval in addition to Architect/Engineer submittal requirements.
- D. Submit record drawings along with reports specified under Testing.

1.09 **OPERATION AND MAINTENANCE DATA**

- A. Include data for complete system in Operation and Maintenance Manuals.

1.10 **QUALIFICATIONS**

- A. Company: Have minimum five (5) years experience in the installation of fire alarm systems and capable of providing 24 hour repair service with two (2) hour response time.
- B. Installers: Trained technicians possessing a current specialty electrician certificate of competency issued by the State of Washington and National Institute for Certification in Engineering Technologies (NICET) Level II certification shall perform the work.
- C. Authorized factory representative of the system being installed shall supervise installation, testing, and adjustment of the system.

PART 2 – PRODUCTS

2.01 **ACCEPTABLE MANUFACTURERS**

- A. Fire Control Instruments (FCI) to match University Campus Standard.

2.02 **CONTROL PANEL**

- A. Panel: Microprocessor based addressable fire alarm control panel, E-3 series.
- B. Power Supply: 120 volt AC power input, 24 volt DC system operation. Include transient surge protection, automatic battery charger and 24 volt rechargeable, maintenance free, sealed lead-acid batteries capable of operating system under alarm condition for five minutes after a 60 hour interruption of 120 volt AC power. Batteries provided shall not be older than 60 days from date of manufacture.

- C. Initiating Circuits: Supervised programmable input/output circuits with 80 character minimum LCD status display and keypad.
- D. Smoke Alarm Verification Circuit: Delays alarm and resets smoke detectors allowing second (verified) alarm initiation. Adjustable alarm delay 1-60 seconds; adjustable verification period 1-120 seconds.
- E. Signal Circuits: Supervised signal modules with march time feature and trouble LED indication. Provide signal controller(s) for synchronizing strobes to flash together. Provide sufficient size and quantity so that no signal circuit is loaded more than 75% of listed capacity.
- F. Panel Status Indicators: LED annunciation of normal power, batter power, battery trouble, ground detection, system trouble, alarm silence, and trouble silence. Audible signal annunciation of any alarm or trouble condition or system.
- G. Operating Controls: Lamp test, panel reset, alarm silence, trouble silence, and Drill. Operating controls shall be enabled by key switch or shall be located behind locking cabinet door.
- H. History File: Minimum 500 event capacity in non-volatile memory. Include provisions to allow RS232 interfaces with remote personal computer and printer (2 ports minimum).
- I. Signal Transmission: Provide output connections for system alarm, trouble, and supervisory signal transmission via digital communicator.
- J. Auxiliary Relays: As required, with 120 VAC rated contacts; include for HVAC fan shutdown, electro-magnetic door holders, elevator pressurization fan operation, smoke dampers, and elevator recall sequencing.

2.03 **REMOTE ANNUNCIATOR**

- A. Annunciator: Recessed enclosure containing supervised back-illuminated LCD display and keyboard with key enabled acknowledge, system reset, and signal silence.

2.04 **INITIATING DEVICES**

- A. Manual Stations: Addressable, single or dual action, downward pull lever, key reset without break-glass feature.

- B. Heat Detectors: Combination rate-of-rise and fixed temperature 135 °F rated, self-restoring rate-of-rise element, low profile addressable twist lock base, LED status indicator, listed for 2500 square feet. In high ambient areas provide 190 °F fixed temperature rated detectors listed for 625 square feet.
- C. Smoke Detectors, Photo-Electric Type: Light scattering photodiode principle of operation, LED status indicator, test feature, integral 135 °F fixed temperature sensor, addressable twist-lock base, supervised 2-wire operation.
- D. Smoke Detectors, Ionization Type: Dual chamber, LED status indicator, test feature, adjustable sensitivity, addressable twist-lock base, supervised 2-wire operation.
- E. Duct Detector, Smoke: Photoelectric or ionization type smoke detector, duct mounted detector housing with sampling tubes extending width of duct, visual indication of detector actuation. Provide auxiliary SPDT contacts for HVAC shutdown.

2.05 **SIGNALING DEVICES**

- A. Alarm Horns: Basic electronic horn rated 96 dB at 10 feet. Provide integral alarm light where indicated. Provide exterior mounted horns with weather resistant back box.
- B. Alarm Horns, Small Areas: Compact electronic horn rated 60 dB minimum at 10 feet, designed for flush mounting. Provide integral alarm light where indicated, mounted on front of device plate.
- C. Alarm Strobes: UL 1971; lamp and flasher with clear lens and visible FIRE markings on device housing. Housing color shall be white or red as selected by Architect. Strobes shall be synchronized to flash together. Strobe candela rating shall be 75 cd minimum or meet "Equivalent Facilitation" allowed under ADA accessibility guidelines.

2.06 **AUXILIARY DEVICES AND ACCESSORIES**

- A. SLC Interface devices: Remote addressable module for monitoring status of alarm initiating circuit devices or to provide remote control (pilot duty) from the SLC loop.
- B. Door Holders: Semi-flush magnetic door holder, 24 volt DC coil, for wall-to-door installation.

- C. Access Doors: Milcor Style M locking access panel, keyed to match electrical panel boards. Provided where required to maintain service access to detectors.
- D. Signal Expander: Independent 4-circuit power supply with battery back-up, 120 VAC input, 24 VDC output. 1.5 amp minimum output each circuit. Batteries shall comply with requirements specified for Control Panel.

2.07 MATERIALS

- A. Conductors for 120 Volt Circuits: Building wire as specified in Section 16050.
- B. Conductors for 24 Volt DC Circuits: Comply with NFPA 70, Article 760 for insulation requirements. Stranded copper conductor, minimum #14 AWG for signal and control circuits. Shielded twisted pair, copper conductor, as recommended by alarm system manufacturer for SLC intelligent loop wiring. Outside plant cable shall be UL listed for the purpose.
- C. Conduit: As specified in Section 16050, metallic only.
- D. Device and Junction-Boxes: As specified in Section 16050, except surface boxes shall be furnished by alarm system manufacturer to match devices. Boxes shall be red in color, both inside and out. Device and junction boxes located outside of buildings shall be tamper proof. Outdoor boxes shall be weatherproof.

PART 3 – EXECUTION

3.01 PREPARATION

- A. After building structure is in place and prior to completion of rough-in, meet with the inspecting authority on site to review system requirements and location of devices and equipment using the approved shop drawings. The purpose of this meeting is to avoid additional devices and other required changes that are often identified during final inspection.

3.02 INSTALLATION

- A. Install system in accordance with manufacturer's instructions. Provide all necessary programming and adjustment of system equipment to make operational.
- B. Comply with requirements of Section 16050. Exposed wiring is not permitted.

- C. Coordinate quantity, location, and access for duct smoke detectors and sampling tubes with Division 15 Contractor. Do not locate less than six (6) duct widths from return air inlet, bend in duct, or other obstruction in duct.
- D. Do not locate detectors within four (4) feet of HVAC supply and return registers and not in a direct airflow. Do not located detectors within one (1) foot of light fixtures.
- E. Provide recessed backboxes for semi-flush installation of devices where construction permits, otherwise provide surface boxes.
- F. Mounting Heights: Install wall mounted equipment and devices, measured above finished floor as noted, unless otherwise indicated on shop drawings approved by the Authority Having Jurisdiction (AHJ).

Manual stations	48 inches to top
Alarm signaling devices and remote alarm lights	80 inches to bottom
Remote annunciator and graphic plaques	60 inches to bottom

- G. Wiring: Install conductors in conduit dedicated for fire alarm, consistently color coded per shop drawings. Wiring shall not share conduits with other systems. Proper ground for fire alarm shall be wired to manufacturer's specifications for lighting protection.
- H. Detectors shall not be installed until finish work and construction clean up of all trades is complete, and area is ready for occupancy.
- I. Provide conduit, wire, interface relay, and connection to door release contacts of two ADA power operated door locations (doors 110A and 110B). Include addressable interface modules where required.
- J. Fire Protection and Monitoring: Provide addressable interface modules, conduit, wire and connections to fire sprinkler flow switches, sprinkler valve tamper switches, pressure switches, to the TOC room fire suppression control panel (Alternate Bid) and electric sprinkler alarm bell. Coordinate number and location of alarm and supervisory connections with fire protection shop drawings.
- K. Elevator Recall: Provide conduit and wire from control panel to each elevator controller for elevator recall. Program relay operation for primary and alternate floor recall sequence of each elevator based on alarm inputs from associated smoke detectors located in machine room, top of elevator shaft, and each elevator lobby. Leave sufficient conductor length at controller for connections by elevator installer.

- L. Smoke Control: Provide conduit, wire, interface relay, and connection to smoke dampers. Include addressable interface modules where required.
- M. Fan Shut-Down: Provide conduit, wire, relays and connection for shutdown of air moving equipment rated over 2000 cfm per IMC Section 606. Final connection to HVAC equipment with integral motor controls shall be provided under Division 15.
- N. Adjust sensitivity for each smoke detector based on the application and type of space being protected as recommended by the product installation instructions.
- O. SLC Interface: Provide addressable interface modules for all non-addressable initiating devices and equipment furnished under other sections.
- P. Primary Power Supply: Provided dedicated branch circuit(s) for fire alarm control, transmitter, and NAC auxiliary power supplies. The location of the circuit disconnecting means shall be permanently identified at each cabinet. Where the circuit disconnecting means is located at the panel board branch circuit breaker, provide a red pad locking attachment.

3.03 TESTING

- A. Test system in accordance with NFPA 72 and Fire Marshal requirements.
- B. During testing verify device address descriptions match device type, location description, and zoning assignments shown on record drawings. Submit address log and correction report and confidence test report with record drawings.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation, maintenance and programming of system to Owner's personnel prior to Contract Closeout. Allow one four hour session scheduled at convenience of Owner.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate operation, control, trouble shooting, maintenance, and testing of system.

END OF SECTION

SECTION 16725

ACCESS CONTROL SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Provide a complete and fully operational access control system with point-of-entry identification. Work includes control panel, power supplies, request to exit sensors, door contacts card readers with cards, accessories, and programming.
- B. System shall be designed and installed by an Owner selected system vendor.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Division 8 – Door Hardware.

1.04 SYSTEM VENDOR

- A. System Design and Installation Vendor: Stanley Security Solutions, Best Access Systems Division, Tamera Woessner, 877-433-4370 or 206-963-8933. Contact vendor to coordinate Work responsibilities and to obtain costs for inclusion in contract price. No substitute.

1.05 SYSTEM DESCRIPTION

- A. Provide all labor, equipment, materials, hardware, and software for a complete building access control system. System shall provide card access of designated doors as indicated in drawings. Include open/close monitoring of four exterior building entrance doors. System shall interface with the building fire alarm system for automatically release of two ADA operated/access control doors upon fire alarm activation. System shall be connected to existing main campus server and software. System shall consist of but not be limited to:

1. Power Supplies

2. Bi-directional card swipe access readers
 3. Intelligent system controllers
 4. Door contacts
 5. Interface Boards
 6. Request to exit passive infrared detectors
 7. Access cards per campus standard
 8. Network interface between local system controller and main campus server
- B. Provide wiring and electrical connection to 24vdc electromechanical door strike provided under Division 8. Connect 120 VAC primary power supply and 24 VDC secondary power supply to entry control system.
- C. Provide conduit pathways and junction boxes at locations indicated in drawings for future access control under Alternate Bid. Refer to Section 01230.

1.06 **SUBMITTALS**

- A. Furnished by system Vendor. Submit product data for all system components and low voltage cabling to be furnished under this Section.
- B. Furnished by system Vendor. Submit shop drawings of complete system design. Show building plan with equipment and device locations and interconnecting wiring. Indicate wire and cable type, size, and quantities. Provide wiring diagrams to indicate wire color coding and termination points for system equipment.

1.07 **OPERATION AND MAINTENANCE DATA**

- A. Include data for complete system in Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 **ACCESS CONTROL SYSTEM COMPONENTS**

- A. Provided by system Vendor. Components shall include system controller, card reader interface boards, by-direction card swipe readers, power supplies, power

supplies for access control of ADA automatic doors, request to exit sensors, door contacts, and component cabinets.

- B. Access Cards: Include 100 encoded access cards to be furnished by system Vendor.

2.02 MATERIALS

A. CONDUCTOR

1. 120 Volt Circuits: As specified in Section 16050 for 600 volt.
2. Low Voltage Circuits: Provided by system Vendor.

- B. BOXES, CONDUIT, RACEWAY, DEVICE PLATES: Comply with Section 16050.

PART 3 – EXECUTION

3.01 COORDINATION

- A. Coordinate with door hardware supplier regarding voltage, type, and placement of electromechanical door strikes.

3.02 INSTALLATION

A. EQUIPMENT AND DEVICES

1. Install and test per manufacturer's instructions.
2. Provide demonstration and training.
3. Provide all required programming and system start-up. Variable and optional access control software features shall be programmed as directed by the Owner.

B. WIRING

1. Provide 120 VAC power to system controller and all power supplies.
2. Comply with requirements of Section 16050. Exposed wiring is permitted only in ceiling spaces open to structure.

3. Install conductors in metallic conduit except wiring may be open cabling where installed in concealed accessible ceiling spaces and in cable trays.
4. Consistently color code wiring throughout per Shop Drawings. Do not splice conductors. Terminate conductors at screw terminals of equipment and devices.

C. REQUIREMENTS FOR OPEN CABLE

1. Install cable parallel and perpendicular to building lines.
2. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
3. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
4. Protect cables with plastic bushing through device plates and outlet boxes.
5. Provide conduit sleeves for installing open signal cables thru fire rated construction and thru partition walls above accessible ceilings.

3.03 TESTING

- A. Test conductors for continuity prior to cover.
- B. Test complete system including each request to exit detector, door contact, and card reader, and demonstrate satisfactory operation in presence of Owner and his representatives. Furnish all equipment, two way radios, etc., required for testing.

END OF SECTION

SECTION 16730

MASTER CLOCK SYSTEM

PART 1 – GENERAL

1.01 SUMMARY OF WORK

Conduit rough-in, pre-wire, and 120 VAC power for master clock system.

Master Clock System is **Owner furnished, Contractor installed.**

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 SUBMITTALS

Product Data: Submit for conduit, wire and cable.

PART 2 – PRODUCTS

2.01 MASTER CLOCK SYSTEM (PROVIDED BY OWNER)

GPS referenced master clock system. Includes rack mounted master clock, wall mounted slave clocks, and GPS antenna, as manufacture red by ESE.

2.02 BASIC MATERIALS

A. Conductors:

1. 120 Volt Circuits: As specified in Section 16050 for 600 volt.
2. Circuits Below 100 Volts:
 - a. Clock Signal:
 - 1) RG-59/U coaxial copper conductor cable, 75 ohm impedance, polyethylene insulation, dual shield (bi-foil with aluminum braid).

- A. Boxed, Conduit, Raceway, Wiring Devices: Comply with Section 16050.
- B. Clock Outlet – 120 Volt Power: Specialty receptacle outlet with recessed 5-15R receptacle and integral device plate with hook; white color. Leviton #688-W or equal.
- C. Clock Outlet – Signal:
 - 1. General: 4-inch square x 2-1/8 inch deep outlet box with single gang plaster ring.
 - 2. Option for outlets in hollow frame walls without insulation and below concealed accessible ceiling space. Single gang low voltage metal mounting ring suitable for use without a back box.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Coordinate exact location of clock system components with Owner prior to rough-in.

3.02 INSTALLATION

- A. Clock System Components
 - 1. Installed and connected by Owner.
- B. Wiring (Below 100 Volts)
 - 1. Comply with requirements of Section 16050. Exposed wiring is not permitted.
 - 2. Install conductors in conduit except wiring may be open cabling where installed as follows:
 - a. In attic and concealed ceiling spaces that are accessible.
 - b. In hollow frame walls without insulation below concealed accessible ceiling space.
 - 3. Install cable without splices.

4. Leave 6.5 feet minimum cable slack at head end for termination by Owner. Leave 12 inches minimum of cable slack at outlets for termination by Vendor.

C. Requirements for Open Cable

1. Install cable parallel and perpendicular to building lines.
2. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
3. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
4. Protect cables with plastic bushing through device plates and outlet boxes.
5. Provide conduit sleeves for installing cables thru fire rated construction, draft stops, and partition walls, in attics, crawl spaces, and accessible ceiling spaces.

D. 120 VAC Power

1. Comply with requirements of Section 16050.
2. Provide 120 VAC clock receptacle outlet at each wall clock.

END OF SECTION

SECTION 16741

TELECOMMUNICATIONS PERMISES WIRING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Cable and Accessories
- B. Station Outlets
- C. Cross-Connect Components
- D. Equipment Mounting
- E. System Design

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 16710, Signal Systems Pathway.
- B. Section 07270, Fire Stopping and Smoke Seals.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of the latest revisions of the following standards:

EIA/TIA-569A	Commercial Building Standard for Telecommunications Pathways and Spaces.
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EIA/TIA-568-B.1,2,3	Commercial Building Telecommunication Standards
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EIA/TIA-455-61	FOTP-61, Measurement of Fiber or Cable Attenuation Using An OTDR
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EIA/TIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA/TIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications

1.05 **SYSTEM DESCRIPTION**

- A. Provide design and installation of a Leviton Certified Cable System (CCS) Premises Distribution System (PDS) consisting of unshielded twisted pair (UTP) horizontal station wiring with fiber optic backbone for data PDS and copper backbone for voice PDS.
- B. Horizontal station PDS for Voice/Data Business LAN: Conform to EIA/TIA Category 6 requirements. Terminate each station jack via a dedicated cable to a patch panel at the indicated Distribution Frame or wiring closet. PDS shall provide cross connect to telephone system jacks using voice grade patch panels.
- C. Horizontal station PDS for Voice/Data Broadcast LAN: Conform to EIA/TIA Category 6 requirements for data and Category 3 requirement for voice. Terminate each station data jack via a dedicated cable to patch panel in assigned racks located in the TOC room as directed. Terminate each studio console data cable to a patch panel in assigned racks located in the TOC room as directed. Terminate each studio voice cable on assigned wiring terminal blocks in the TOC room as directed. Termination of data and voice cables within the studio consoles is provided by others.
- D. Voice PDS backbone: Conform to EIA/TIA Category 3 requirements or better. Provide two (2) 25 pair cables between each 48 port telephone patch panel and main cross connect. Terminate trunk cables at patch panels using one (1) pair per port, and at the main cross connect end using wiring terminal blocks.
- E. Data PDS backbone: Provide one (1) multi-strand fiber optic cable from TOC MDF to 3rd Floor IDF. Fiber cable shall be terminated at a fiber patch panel each end.

1.06 **SUBMITTALS**

- A. Submit product data for all items specified under Part 2 of this Section.
- B. Submit shop drawings showing floor plans with room numbers, station outlet locations, horizontal station cable routing, backbone cable routing, and alpha numeric identification of terminals and jacks. Include elevation plans showing

layout of cross-connect and wire management hardware. Show location and size of conduit sleeves for open cable routing.

- C. Submit terminal and face plate labeling plan, for approval prior to submitting shop drawings.
- D. Submit documentation for tests required under Part 3 of this Section.

1.07 **OPERATION AND MAINTENANCE DATA**

- A. Include data and extended warranty information for complete PDS in Operation and Maintenance Manual.
- B. Coordinate with Owner to obtain current telecommunication symbols and provide As-Built Drawings utilizing these symbols. Provide one (1) complete hard copy set of As-Built Drawings and two (2) CD ROMs with complete set of As-Built Drawings on each CD in AutoCAD 2000 dwg format.

1.08 **QUALIFICATIONS**

- A. Company: Contractor specializing in the design, installation, and testing of high speed data and voice network systems for a minimum of five (5) years.
- B. Installers: Trained and experienced technicians of the company, certified by the product manufacturer and by Building Industry Consulting Service International (BICSI) for the PDS cabling, hardware, and accessories being installed, shall perform the Work.

1.09 **WARRANTY**

- A. Provide Leviton Net Sync lifetime CCS performance warranty for the PDS.

PART 2 – PRODUCTS

2.01 **ACCEPTABLE MANUFACTURER**

- A. UTP Cable: Leviton Mohawk Net Sync CCS approved to match campus standard.
- B. UTP Station Outlets and Cross-Connect Components: Leviton eXtreme 6+ to match campus standard, except telephone cross connect patch panels may be Leviton voice grade.

- C. Fiber Optic Cable, Equipment, and Accessories: Leviton CCS approved to match campus standard.
- D. Equipment Racks, Floor Mounted, and Associated Wire Management: Ortronics “Mighty Mo 6”, to match campus standard.
- E. Equipment Cabinets, Floor Mounted, and Associated Wire Management in TOC: **Owner furnished, Owner installed.**

2.02 CABLE

- A. Station Cable: UL type CMR, EIA/TIA Category 6, 24 AWG solid copper, 4-pair unshielded twisted pair, color coded, color coded jacket overall (Yellow – Voice, Blue and Gray/White – Data Business LAN, Green and Orange – Data Broadcast LAN, as shown on drawings).
- B. Telephone Cable (Studio Broadcast LAN): UL Type CMR, EIA/TIA Category 3 or better, 24 AWG solid copper, 25 unshielded twisted pairs, color coded, jacket overall with amphenol connector.
- C. Trunk Cable (Telephone Backbone): UL Type CMR, EIA/TIA Category 3 or better, 24 AWG solid copper, multiple unshielded twisted pairs, color coded, jacket overall.
- D. Multi-Mode Riser Rated Fiber Optic Cable (Data Backbone): UL listed OFNR six (6) strand multi-mode 50/125 micron high performance, indoor/outdoor rated, loose buffer.

2.03 CABLE ACCESSORIES

- A. Cable Support: Extra wide base J hooks, with tie wraps. Caddy cable cat system or equal. Staples, straps, bridle rings, and similar supports are prohibited.
- B. Fiber Protection, Inside Plant: Non-metallic corrugated flexible raceway, ¾ inch minimum diameter, orange color, UL listed for use with OFNR fiber cable. Carlon Riser-Gard or equal.
- C. Fiber Protection, Outside Plant: Maxcell fibermesh innerduct, UL listed for use as an innerduct within conduit systems.
- D. Wire Management, Backboards: Provide slotted channel duct with cover as indicated. Provide open “D” style wire rings for horizontal and vertical cable management, including strain relief, bend radius, and cable routing, as required.

- E. UTP Voice Cable Circuit Protection, Outside Plant: UL 497, solid-state, fused, press to fit cross-connect block protectors with automatic reset and ground bar attachment. Provide for each circuit pair. Portu Systems: Blocks 24100 – 110 – M110C, fuses 115 SCSN – 3 - .

2.04 STATION OUTLETS

- A. Outlet Jacks: EIA/TIA – T568B Category 6 RJ45, 8-position/8-conductor, “QuickPort” modular jack, with color coded replaceable icons to identify use (Yellow – Voice, Black – Data Business LAN, Green – Data Broadcast LAN). For wall phones provide integral stainless steel wall plate with mounting lugs compatible with telephone handset.
- B. Faceplates: Multimedia Outlet System (MOS) style with identification strip top and bottom; 2 module/4 port arrangement with 45 degree “QuickPort” adaptors; color to match wiring devices. Provide blank modules for unused plate openings.
- C. Floor Box Outlets: Standard duplex mounting strap with modular snap-in outlet jacks. Provide blank insert where ever jack is not installed.

2.05 CROSS-CONNECT COMPONENTS

- A. Terminating Blocks: AT&T 110 series connecting blocks with stand-off brackets, bridging clips, cable troughs, and distribution rings as required for cable management. Provide labeling strips for conductor assignment identification.
- B. Telephone Cross Connect: EIA/TIA Category 3, 48 port printed circuit board patch panels, 6 port modular construction with RJ45 8-position jacks, AT&T 110 connector system, identification strips, 19 inch rack mounting, unless otherwise indicated. Provide one (1) panel in 3rd Floor IDF, located as directed. Provide two (2) panels in 1st Floor TOC cabinet, located as directed.
- C. Station Outlet Cross Connect: EIA/TIA Category 6, 48 port printed circuit board patch panels, 6-port modular construction with RJ45 keyed 8-position jacks, AT&T 110 connector system, identification strips, 19 inch rack mounting, unless otherwise indicated. Provide three (3) panels in 3rd Floor IDF, located as directed. Provide six (6) panels for voice/data business LAN and two (2) panels for data broadcast LAN in 1st Floor TOC cabinets, located as directed.
- D. Multi-mode Fiber Cross Connect: Multi-port ST style panel installed in locking protective cabinet with provisions for fiber storage, fiber routing, and connector identification; 19 inch rack mounting, unless otherwise indicated. Provide one

(1) 6-port panel in 3rd Floor IDF, located as directed. Provide one (1) 6-port panel in 1st Floor TOC located as directed.

- E. Singlemode Fiber Cross Connect: Multi-port SC style panel installed in locking protective cabinet with provisions for fiber storage, fiber routing, and connector identification; 19 inch rack mounting, unless otherwise indicated. Provide one (1) 12-port panel in 1st Floor TOC cabinet, located as directed.
- F. Voice Patch Cords: UL type CM, EIA/TIA Category 6, 4-pair cable with RJ45 plug each end, length not to exceed 4 meter, quantity equal to 40% of total installed station jacks. Provide 25% 3-feet, 50% 5-feet, and 25% 7-feet long, color yellow. Carlyle or Leviton.
- G. Data Patch Cords: UL type CM, EIA/Tia Category 6, 4-pair cable with RJ45 plug each end, length not to exceed 4 meters, quantity equal to 75% of total installed station jacks. Provide 25% 3-feet, 50% 5-feet, and 25% 7-feet long, color blue for Business LAN and green Broadcast LAN. Carlyle or Leviton. Verify color and quantity prior to ordering.
- H. Fiber Optic Connectors: Multi-mode ST style, and singlemode SC style. Quick cure epoxy adhesive. Bayonet style coupling with multi-mode ceramic or glass-in-ceramic ferrule, keyed for repeatable performance.
- I. Multi-Mode Fiber Patch Cords: Preassembled single fiber, multi-mode 50/125 micron/ULTRA grade jumper cord with connectors each end, length 3 meters. Provide one patch cord for each terminated/assigned fiber patch panel port plus 10%, with ST to ST or ST to SC connectors as required (verify).

2.06 EQUIPMENT MOUNTING

- A. Equipment Racks, Floor: Aluminum self-supporting frame designed for open rack mounting of telecommunications equipment, base anchor design, pre-drilled EIA mounting holes, 19 inches wide by 84 inches high unless otherwise indicated. Provide four (4) equipment shelves with mounting hardware. Finish: black.
- B. Wire Management, Equipment Racks: Provide vertical wire management channels each side of equipment racks for strain relief, bend radius, and cable routing. At each patch panel provide rear mounted strain relief bar for station cable routing and front mounted wire management rings or cable trough for patch cords.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Pre-Construction Conference: Early in the construction time line, and before any shop drawings are produced, a representative of the telecommunications premises wiring installer, who shall serve as supervisor to the installation crew throughout construction, shall attend a pre-construction meeting with the customer and representatives of the General Contractor where installation details and requirements, including labeling, wire management, testing parameters and procedures, and other pertinent issues will be discussed and clarified.
- B. Provide location and size of conduit sleeves for routing open cables thru fire rated construction, draft stops, and partition walls in attics, crawl spaces, and accessible ceiling spaces. Size sleeves with 25% minimum space capacity. Indicate on shop drawings for coordination with Section 16710.

3.02 INSTALLATION

- A. Comply with product manufacturer installation instructions. Conform to requirements of EIA/TIA – 568B.1, 2, 3 and EIA/TIA-569A for the specified Category.
- B. Provide one (1) dedicated cable drop per jack.
- C. Label station outlets sequentially using the following alpha/numeric identification plan unless otherwise directed: IDF# - Floor # - Sequential outlet # on floor – Jack (A, B, ...). In each room start with first outlet by main entrance door and continue clockwise around room. Label station cable at each end with a permanent cable marker to match the corresponding terminal number. Label each station jack using polyester film adhesive pre-labeled markers to indicate corresponding terminal number. Coordinate label scheme with Owner.
- D. Label voice cross-connect terminals sequentially using an approved numeric or alpha-numeric plan submitted for approval.
- E. Conceal wiring in suspended ceiling spaces, and in wall construction. Utilize conduit rough-in specified in Section 16710 and shown on drawings. Install cable in neat parallel runs within cable trays and down to cross-connect hardware without rolls, twists, or loops.
- F. Install cables continuous without splicing. Install open cable above accessible ceilings, parallel and perpendicular to building lines. Bundle cables with Velcro wraps ½ inch minimum width and support cable in tray, conduit sleeves, or from

structure using specified J hooks at intervals not to exceed 4 ½ feet. Maximum number of cable per bundle shall be 48.

- G. Provide cable slack not less than required under referenced EIA/TIA standards. Provide 12 inch slack at stations and 10 foot slack in Telecommunications Rooms.
- H. Seal conduit sleeves thru fire rated construction per Section 07270. Seal conduit that penetrates floors with specific technologies putty type SSB.
- I. Maintain a minimum 6 inch separation from parallel power wiring. Do not share bore or knock out holes thru wall studs and other structural members with power wiring.
- J. Secure floor mounted equipment racks with four (4) 5/8 inch diameter anchor bolts, one near each corner of floor base. Use lead expansion anchors in concrete floors.
- K. Bond together all equipment racks to room cable tray and communications service ground using #1/0 AWG conductor minimum. Comply with Section 16450 for grounding materials.
- L. Provide fiber optic cable within protective non-metallic raceway system. Install raceway to within 18 inches of fiber termination.
- M. Provide required telecommunication wiring between fire alarm transmitter and telephone service demarcation point. Verify requirements with fire alarm system provider. Allow for three (3) RJ11 jacks with dedicated Category 6 or better station cable terminated at a shared headend cross connect block reserved for analog telephone service interface.
- N. Provide required telecommunication wiring between each elevator machine room and telephone service demarcation point. Verify requirements with elevator system provider. Allow for three (3) RJ11 jacks with dedicated Category 6 or better station cable terminated at a shared headend cross connect block reserved for analog telephone service interface.
- O. Provide UL497 primary circuit protection at building entrance and building exit for all outside plant copper telecommunication cabling.

3.03 TESTING

- A. Owner Notification of Testing

1. The Owner/Engineer shall be notified one week prior to any testing so that the initial testing may be witnessed. Contractor shall not replace or correct any cable deficiencies found through testing prior to the notified date. (The initial test results are an effective indication of the overall quality of an installation. "Rehearsal" test by the Contractor deprive the test observer of the opportunity to detect general quality conditions that may be detected at the time of the first test performed).
2. Before requesting a final inspection, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit, for approval, a proposal describing the test procedures, test result forms, and timetable for fiber optic and all copper plant wiring.

B. UTP Cabling

1. Test station drops for specifications compliance at completion of work. Correct deficiencies by replacing terminations, components, or cable as required.
2. Perform continuity test on each wire/pair prior to cover. Verify no open circuits, short circuits, or accidental grounds exist.
3. PDS shall be certified to meet or exceed the specifications as set forth in EIA/TIA – 568-B2-1 for specified Category compliance. Certifications shall include the following parameters for each pair of each cable installed:
 - a. Wire map (pin to pin connectivity)
 - b. Length (in feet)
 - c. Attenuation
 - d. Resistance
 - e. Ambient noise
 - f. Crosstalk (NEXT)
 - g. PSNEXT
 - h. ELFNEXT
 - i. PSELFEXT

- j. RL 9Retrun Loss
- k. ACR
- l. PSACR
- m. Propagation Delay
- n. Delay Skew

1. Use test equipment such as the Fluke DTX Series, or approved equal, to measure all essential cable parameters specified by EIA/TIA and UL thru Category 6. Provide certificate showing test equipment was calibrated within three months of testing. Provide a written record of these tests.
2. Correct malfunctions when detected and proceed with testing. Record test results on a "UTP Cable Test Results" form. No "x" test results will be allowed.

C. Fiber Optic Cabling

1. OTDR Acceptance Tests: Test fiber optic cable for continuity, normalized fiber loss, and overall length verification, using an Optical Time Domain Reflectometer (OTDR). Attenuation measurements in Db/km shall be performed for each fiber at 850 nm and 1300 nm wavelength. Perform tests of cable both on reel when delivery of cable is taken, and after cable is installed and before connectorizing. Attenuation of multi-mode fibers shall be no greater than 3.0 Db/km at 850 nm and no greater than 1.0 Db/km at 1300 nm. Installed cables with any damaged fibers shall be removed and replace at Contractor expense.
2. Visual Inspection Reports: Visual inspection of each field installed fiber optic connector shall be documented to include report on end face quality, polish, and informational comments.
3. Optical Loss Tests: Fibers shall be loss tested in both directions at 850 nm and 1300 nm wavelengths after connectorization. Acceptable attenuation shall be any value less than the fiber attenuation plus 1 dB (0.5 dB per connector).

3.04 **DOCUMENTATION**

- A. Documentation includes the following and shall be delivered to the Architect/Engineer within twenty work days after the wiring is completed.

1. Certification documents and test results
2. Record drawings.
3. Permanent ID record at each MDF and IDF location

END OF SECTION

SECTION 16781

TELEVISION DISTRIBUTION SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Broadband television distribution system, bidder design.
- B. Amplifiers, power supplies, combiners, couplers, cable, outlets, and all other parts and accessories necessary for the reception and distribution of selected cable company TV channels.
- C. Installation of cable television service.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED WORK

- A. Section 16710, Signal Systems Pathway.

1.04 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this Section.
- B. Submit shop drawings showing system block diagram, signal loss calculations, and required tap isolation values. Provide floor plan showing device and equipment locations and routing of interconnecting cabling. Show location and size of conduit sleeves for open cable routing.
- C. Submit test reports required under Part 3 of this Section.

1.05 OPERATION AND MAINTENANCE DATA

- A. Include data for complete system in Operation and Maintenance Manuals. Identify actual system configuration, products, equipment, modules, cards, and options furnished.

1.06 **QUALIFICATIONS**

- A. Installers: Trained, experienced, and licensed technicians of company having minimum three (3) years experience in the installation of telecommunications systems shall perform the work.
- B. Authorized factory representative of the system being installed shall supervise installation, programming, testing, and adjustment of the system.

1.07 **SYSTEM DESCRIPTION**

- A. The system shall provide for TV reception, amplification, and distribution of all available VHF and UHF channels.
- B. The system shall receive the television signals from commercial cable service, amplify these signals, and distribute them to all TV outlets.
- C. The system shall deliver at all outlets all monochrome and NTSC color television signals without introducing noticeable degradation or other effect on intelligence and color fidelity. Picture quality and signal strength at each wall tap shall meet or exceed FCC requirements under Part 76 for CATV systems.
- D. The system and all equipment shall meet the FCC requirements regarding low radiation of RF signal.
- E. Location of system head end and TV outlets are shown on the drawings.

PART 2 – PRODUCTS

2.01 **ACCEPTABLE MANUFACTURERS**

- A. Equipment: Blonder Tongue, unless noted otherwise.
- B. Cable: Alpha, Belden, West Penn.

2.02 **BROADBAND AMPLIFIERS**

- A. Rack mounted distribution amplifiers: Frequency range 50 to 550 MHz minimum, variable gain and slope controls, line transient protection, dB gain as selected to meet system design requirements. Blonder Tongue RMDA series.

2.03 **COMBINERS**

- A. Rack mounted unit to combine outputs of multiple modulators and designed to accept up to 12 inputs. The active combiner shall be provided for amplification of up to twelve modulated inputs. It shall be solid-state design, contain its own power supply, and a manual gain control.
- B. Passive Combiners: Blonder Tongue OC series.
- C. Active Combiners: Shall include amplified output with integral variable gain control. Blonder Tongue OCA series.

2.04 **LINE SPLITTERS**

- A. Line splitters shall be a low radiation type, 5 to 750 MHz, hybrid design with a 75-ohm match on input and outputs and a VSWR of not more than 1.45. Blonder Tongue CRS series or better.
- B. All unused outputs on the splitter and end of runs shall be terminated with 75-ohm terminators. Blonder Tongue PBT.

2.05 **CABLE**

- A. Indoor Cable: UL listed, NEC type CATV coaxial copper conductor cable, 75 ohm impedance, polyethylene insulation, dual shield (bi-fold with aluminum braid), PVC jacket overall.
- B. Type: RG-6/U and RG-11/U, as required.

2.07 **CONNECTORS**

- A. Standard male F-type with attached crimp ring, for RG cable specified. Provide DC blocking termination on last tap of each branch line.

2.08 **OUTLETS (TAPOFFS)**

- A. Back matched low radiation wall taps, 10 to 900 MHz, 24dB isolation minimum, duplex strap with one F connector front, two F trunk connectors back. Blonder Tongue V-3889. Provide matching device plate as specified under 16050.

PART 3 – EXECUTION

3.01 **PREPARATION**

- A. Provide location and size of conduit sleeves for routing open cables thru fire rated construction, draft stops, and accessible ceiling spaces. Sizes sleeves with 25% minimum capacity. Indicate on shop drawings for coordination with Section 16710.
- B. Arrange installation of cable TV service as provided for under Section 16420.

3.02 **INSTALLATION**

- A. Install products in accordance with manufacturers' recommendations. Use RG-6/U cable specified except type RG-11/U cable shall be used for trunk cable and long feeders as required to achieve minimum signal requirements.
- B. All cables terminating at amplifiers or splitters shall be tagged as to function and destination.
- C. Wiring
 - 1. Comply with requirements of Section 16050. Utilize conduit rough-in specified in Section 16710 and shown on drawings. Exposed wiring is not permitted.
 - 2. Install conductors in conduit except wiring may be open cabling where installed as follows:
 - 3. Ceiling spaces that are accessible.
 - 4. In cable trays.
 - 5. Install cable without splices.
 - 6. Install cable without sharp bends or physical distortions.
- D. Requirements for Open Cable
 - 1. Install cable parallel and perpendicular to building lines.
 - 2. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
 - 3. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.

4. Protect cables with plastic bushing through device plates and outlet boxes.
5. Provide conduit sleeves for installing open signal cables thru fire rated construction and thru partition walls above accessible ceilings.

3.03 **PERFORMANCE AND TESTING**

- A. On completion of the installation of the system, the installing contractor shall provide a qualified technician to perform the following tests:
 1. The overall system shall be swept tested with a spectrum analyzer from the head-end location to the last outlet in each distribution leg of the system.
 2. Test for signal strength at each outlet (wall tap) and correct deficiencies. Measured signal strength shall be 0 dBmV (minimum) to 12 dBmV (maximum) at 50 – 550 MHZ.

END OF SECTION

SECTION 16783

CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Cameras
- B. Control equipment
- C. Cable and accessories
- D. System design and installation by an Owner selected system Vendor.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 16050 – Basic Materials and Methods
- B. Section 16710 – Signal Systems Pathway
- C. Section 16781 – Television Signal Distribution System

1.04 SYSTEM VENDOR

- A. System Design and Installation Vendor: Evergreen Fire & Security, John Banks, 253.277.3202. Contact vendor to coordinate work responsibilities and to obtain costs for inclusion in contract price. No substitute.

1.05 SYSTEM DESCRIPTION

- A. Provide video communications between two outdoor points of surveillance indicated on drawings and the Pacific Lutheran University central campus monitoring station using fiber optic signal transmission. Provide additional video monitoring at reception 108 to include dedicated flat screen monitor and required PC software. PC furnished by Owner.

- B. Outdoor cameras shall have pan/tilt/zoom (PTZ) feature. Receivers and transmitters shall be mounted in designated rack space of a cabinet in the TOC Room.

1.06 **SUBMITTALS**

- A. Product Data: Furnished by system Vendor. Submit for all items specified under Part 2 of this specification.
- B. Shop Drawings: Furnished by system Vendor. Show plan of equipment and device locations, type, quantities, and routing of wiring. Show direction and field of view for each camera.

1.07 **PROJECT RECORD DOCUMENTS**

- A. Include data for complete system in Operation and Maintenance Manuals.
- B. Record actual locations of cameras and routing of television cable.
- C. Include instructions for starting and operating procedures.
- D. Include instructions for using software provided.

PART 2 – PRODUCTS

2.01 **CCTV SYSTEM COMPONENTS**

- A. Provided by system Vendor. Includes outdoor pan/tilt/zoom (PTZ) cameras, receivers, transmitters, monitors, power supplies, mounting accessories, and operating software.

2.02 **BASIC MATERIALS AND ACCESSORIES**

- A. 120 Volt Circuits: As specified in Section 16050 for 600 volt.
- B. Low Voltage Cable and Connectors: Provided by system Vendor.
- C. Boxes, Conduit, Raceway, Device Plates: Comply with Section 16050.

PART 3 – EXECUTION

3.01 **INSTALLATION**

- A. Install products in accordance with manufacturers' recommendations. Verify exact camera location prior to rough-in.
- B. Wiring
 - 1. Comply with requirements of Section 16050, except minimum conduit size shall be $\frac{3}{4}$ inch. Exposed wiring is permitted only in ceiling spaces open to structure.
 - 2. Install conductors in conduit except wiring may be open cabling where installed in concealed accessible ceilings spaces and in cable trays.
 - 3. Install cable without splices. Run CCTV and low voltage power cable together.
 - 4. Leave 12 inches minimum cable slack at each camera and monitor termination. Leave 36 inches minimum cable slack for each head end termination.
- C. Requirements for Open Cable
 - 1. Install cable parallel and perpendicular to building lines.
 - 2. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
 - 3. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
 - 4. Protect cables with plastic bushing through device plates and outlet boxes.
 - 5. Provide conduit sleeves for installing open signal cables thru fire rated construction and thru partition walls above accessible ceilings.
- D. Mounting Brackets: Coordinate with General Contractor to provide suitable backing for wall mounted cameras.

3.02 **DEMONSTRATION**

- A. Demonstrate system operation and provide two hours of instruction to Owner Personnel prior to Contract Closeout.

- B. Conduct walking tour of Project and briefly describe function and operation of each component.

END OF SECTION

SECTION 16785

AUDIO-VIDEO CABLING SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Audio/Video wall and ceiling outlets and associated cabling for interconnecting audio-video (AV) equipment.

1.02 SUSTAINABLE BUILDING REQUIREMENTS

See Section 01011 for sustainable building requirements affecting the Work of this Section.

1.03 RELATED SECTIONS

- A. Section 16710 – Signal Systems Pathway
- B. Section 16781 – Television Distribution System

1.04 SUBMITTALS

- A. Submit product data for all items specified under Part 2.
- B. Submit shop drawings showing outlet details and cable lengths.

1.05 OPERATION AND MAINTENANCE DATA

- A. Include data for all products in Operation and Maintenance Manual.

1.06 QUALIFICATIONS

- A. Installers: Trained, experienced, and licensed technicians of company having minimum three (3) years experience in the installation of audio/visual (AV) system shall perform the work.
- B. Authorized factory representative of the system being installed shall supervise installation, testing and adjustment of the system.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Outlets: Ortronic Hubbell, Leviton approved equal.
- B. Cable: CommScope, Belden, Berk-tek, West Penn, Black Box, TecNec

2.02 RCA TYPE COMPONENT VIDEO CABLING SYSTEM

- A. Outlets: Modular RCA with three (3) jacks (red/green/blue), feed-thru female/female or 110 terminal.
- B. Cabling: Premium video cables complete with three (3) color coded RCA connectors male/male each end. Hubbell IMCRF10W series or approved equal.

2.03 RCA TYP COMPOSITE AUDIO VIDEO CABLING SYSTEM

- A. Outlets: Modular RCA with three (3) jacks (white/red/yellow), feet-thru female/female or 110 terminal.
- B. Cabling: Premium video cables complete with three (3) color coded RCA connectors male/male each end. Hubbell SFRCYFFW series or equal.

2.04 S-VIDEO TYPE CABLING SYSTEM

- A. Outlets: Modular S-Video (4-pin DIN) feed-thru connectors; female/female or 110 terminal.
- B. Cabling: Premium S-Video cables with male connectors each end. Hubbell SFSVBK series or approved equal.

2.05 VGA TYPE VIDEO CABLING SYSTEM

- A. Outlets: Modular HD 15 pin VGA feed-thru connectors; female/female or 110 terminal.
- B. Cabling: Premium VGA video cables with straight hoods in plenum areas and 90 degree hoods in non-plenum areas male/male. Hubbell IM15DIN10W series or approved equal.

2.06 MATERIALS

- A. Boxes and Device Plates: Low voltage recessed wall boxes, 3.5 inches deep, with modular face plates and matching flange trim ring. Hubbell Multi-Connect series or approved.
- B. Conduit: As specified in Section 16050.
- C. Cable Supports: Molded nylon clamps, heavy duty nylon ties, or galvanized steel bridle rings; size to match cables supported.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Provide custom cable lengths for pre-assembled cables and indicate lengths on shop drawings.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's recommendations.
- B. Wiring:
 - 1. Utilize conduit rough-in specified in Section 16710 and shown on drawings. Exposed wiring is not permitted.
 - 2. Install cabling without splices, sharp bends, or physical distortions.
 - 3. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
 - 4. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
 - 5. Protect cables with plastic bushing through device plates and outlet boxes.

END OF SECTION

SECTION 16995

COMMISSIONING: ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning procedures
- B. Related Sections:
 - 1. The following sections specify commissioning activities for this project:
 - a. 01810 Commissioning General Requirements
 - 2. Selected systems in the following sections are included in the commissioning scope and these sections contain start-up, testing and/or commissioning related activities:
 - a. 16010 Electrical General Requirements
 - b. 16050 Basic Materials and Methods
 - c. 16149 Low Voltage Switching
 - d. 16470 Electrical Distribution
 - e. 16495 Transfer Switches
 - f. 16622 Packaged Engine Generator Systems

1.02 DESCRIPTION OF WORK

- A. Work includes the completion and documentation of formal commissioning procedures by the Contractor on selected equipment and systems as outlined in the sections listed under 1.1 B. Commissioning is defined as the process of verifying and documenting that the installation and performance of selected building systems meet the specified design criteria and therefore satisfies the design intent and the Owner's operational needs. The Contractor shall be

responsible for participation in the commissioning process as outlined herein, and in subsequent sectional references and attachments throughout the project documents. Commissioning procedures shall be designed and conducted under the direction of the Commissioning Authority (CA) and coordinated by the Commissioning Coordinator (CC).

- B. This section contains that system specific commissioning requirements for the systems referenced herein.

PART 2 – PRODUCTS

2.01 DOCUMENTATION REQUIREMENTS

- A. Documentation requirements for the systems to be commissioned are specified in Section 01810, Part 2 – Products.

PART 3 – EXECUTION

3.01 EXECUTION

- A. Execution of the commissioning process for the systems to be commissioned is specified in Section 01810, Part 3 – Execution.

END OF SECTION

SECTION 16995

COMMISSIONING: ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning procedures
- B. Related Sections:
 - 1. The following sections specify commissioning activities for this project:
 - 2. 01810 Commissioning General Requirements
 - 3. Selected systems in the following sections are included in the commissioning scope and these sections contain start-up, testing and/or commissioning related activities:
 - a. 16010 Electrical General Requirements
 - b. 16050 Basic Materials and Methods
 - c. 16149 Low Voltage Switching
 - d. 16470 Electrical Distribution
 - e. 16495 Transfer Switches
 - f. 16622 Packaged Engine Generator Systems

1.02 DESCRIPTION OF WORK

- A. Work includes the completion and documentation of formal commissioning procedures by the Contractor on selected equipment and systems as outlined in the sections listed under 1.1 B. Commissioning is defined as the process of verifying and documenting that the installation and performance of selected building systems meet the specified design criteria and therefore satisfies the design intent and the Owner's operational needs. The Contractor shall be

responsible for participation in the commissioning process as outlined herein, and in subsequent sectional references and attachments throughout the project documents. Commissioning procedures shall be designed and conducted under the direction of the Commissioning Authority (CA) and coordinated by the Commissioning Coordinator (CC).

- B. This section contains that system specific commissioning requirements for the systems referenced herein.

PART 2 – PRODUCTS

2.01 DOCUMENTATION REQUIREMENTS

- A. Documentation requirements for the systems to be commissioned are specified in Section 01810, Part 2 – Products.

PART 3 – EXECUTION

3.01 EXECUTION

- A. Execution of the commissioning process for the systems to be commissioned is specified in Section 01810, Part 3 – Execution.

END OF SECTION

SECTION 16995

COMMISSIONING: ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning procedures
- B. Related Sections:
 - 1. The following sections specify commissioning activities for this project:
 - a. 01810 Commissioning General Requirements
 - 2. Selected systems in the following sections are included in the commissioning scope and these sections contain start-up, testing and/or commissioning related activities:
 - a. 16010 Electrical General Requirements
 - b. 16050 Basic Materials and Methods
 - c. 16149 Low Voltage Switching
 - d. 16470 Electrical Distribution
 - e. 16495 Transfer Switches
 - f. 16622 Packaged Engine Generator Systems

1.02 DESCRIPTION OF WORK

- A. Work includes the completion and documentation of formal commissioning procedures by the Contractor on selected equipment and systems as outlined in the sections listed under 1.1 B. Commissioning is defined as the process of verifying and documenting that the installation and performance of selected building systems meet the specified design criteria and therefore satisfies the design intent and the Owner's operational needs. The Contractor shall be

responsible for participation in the commissioning process as outlined herein, and in subsequent sectional references and attachments throughout the project documents. Commissioning procedures shall be designed and conducted under the direction of the Commissioning Authority (CA) and coordinated by the Commissioning Coordinator (CC).

- B. This section contains that system specific commissioning requirements for the systems referenced herein.

PART 2 – PRODUCTS

2.01 DOCUMENTATION REQUIREMENTS

- A. Documentation requirements for the systems to be commissioned are specified in Section 01810, Part 2 – Products.

PART 3 – EXECUTION

3.01 EXECUTION

- A. Execution of the commissioning process for the systems to be commissioned is specified in Section 01810, Part 3 – Execution.

END OF SECTION