

**Division 26 – Electrical**

## 26.1. General

- a. Refer to **CPSM SECTION 6.16 ELECTRICAL DESIGN STANDARDS** which include, but are not limited to, the following topics:
  - i. Lightning Protection
  - ii. Busway Installation
  - iii. Photovoltaic installations
  - iv. Emergency Systems
  - v. Standby Systems
  - vi. MC Cable
  - vii. Clearance Markings
  - viii. 4 Wire Delta systems
  - ix. No incandescent lights without approval
  - x. Aluminum Conductors
- b. Refer to **DESIGN GUIDELINES DIVISION 33 – UTILITIES** for underground electrical requirements.
- c. The campus' primary electrical system is 23 K.V. and owned by Dominion Energy. Secondary services to buildings and facilities shall be 480/277V or 208/120V. Both systems shall be 3-phase, 4-wire WYE connected.
- d. Dominion Energy is responsible for the following, as coordinated through the ODU PM:
  - i. Provide and install transformers
  - ii. Make primary and secondary connections
  - iii. Specifications and inspections for the transformer pad.
  - iv. Relocation of overhead power lines to underground.
- e. Transformer and switch pads to be provided by the general contractor to Dominion Energy specifications.
- f. All damages incurred to new or existing electrical installations shall be immediately reported to the ODU PM and repaired by the general contractor at no additional cost to ODU.
- g. The main electrical room shall be separate from any mechanical room. Electrical rooms may be accessed through the main mechanical room if allowed by code.
- h. No ceiling shall be provided in any electrical room.
- i. All separate variable speed drives and combination starters shall be furnished by mechanical contractor and installed by the electrical contractor. The A/E shall include this in the specifications.
- j. General Contractor job-site construction as built drawings shall show actual conduit runs. They shall be marked and maintained on a daily basis throughout the entire project.

## 26.2. Cables

- a. Wiring
  - i. Minimum conductor size for power wiring to be #12 AWG.
  - ii. All wire shall be insulated for 600V with stranded or solid copper conductors with THWN or THHN insulation as applicable.
  - iii. Spring-type connectors are not allowed.
  - iv. Use solderless connectors and splices in #8 AWG and above.
  - v. Grounding shall use exothermic welds where appropriate.

- vi. Conductor color-coding for 208/120V:
  - 1. A-Black
  - 2. B-Red
  - 3. C-Blue
  - 4. N-White
- vii. Conductor color coding for 480/277V
  - 1. A-Brown
  - 2. B-Orange
  - 3. C-Yellow
  - 4. N-Grey
- viii. All splices in primary cable shall be performed by a Certified Cable Splicer. Splicers shall conform to the recommendations of the ICEA (Insulated Cable Engineers Association) and the cable manufacturer. Cable splicers shall be certified by the Contractor submitting, in writing, the cable splicer's name and qualifications to the Engineer for approval prior to the beginning of any work.
- ix. Phases shall be identified as Phase A, B, C at all splices with tags and attached with wire.
- x. Identify phase arrangement at switches so that when facing the front of the switch, Phase "A" shall be on the left, Phase "B" at the center, and Phase "C" on the right. Where phases are aligned front to rear, Phase "A" shall be front, Phase "B" center, Phase "C" at rear.
- xi. Cable shall be wrapped with flame resistant tape where spliced in manholes and junction boxes. Contractor shall not block a manhole to such an extent as to prevent the full use of all available duct space.
- xii. Testing:
  - 1. All new medium voltage insulated distribution conductors and equipment shall be meggar tested after all final connections, splices, etc., are made, but before the system is energized.

### 26.3. Grounding and Bonding

- a. Provide bonding conductors in all Telecommunications rooms from the TGB (telecommunications ground bar) to the overhead cable trays. Bond bushings that go through walls to cable tray.

### 26.4. Hangers and Supports (Cable Trays)

- a. All cables serving fire alarm and data systems shall be in an approved cable tray or "J" hook system.
- b. No power wiring shall be placed in cable trays.

### 26.5. Raceways and boxes

- a. Conduit
  - i. Refer to **APPENDIX Q – ELECTRONIC ACCESS CONTROL, APPENDIX Q2-EAC CONDUIT DIAGRAMS, and APPENDIX R - TELECOMMUNICATIONS STANDARDS FOR BUILDING PATHWAYS AND SPACES** for additional information.
  - ii. All underground wiring shall be installed in schedule 40 PVC conduit, minimum 1.25" diameter.
  - iii. All above-grade conduit size shall be at least ¾".
  - iv. Pre-wired flexible conduit, other than fixture whips, shall not be used. Fixture whips shall not exceed 10' in length.

- v. Compression-type connectors or couplings shall not be used for interior applications. "Die Cast" connectors of any type are prohibited.
- vi. Home run conduits from distribution panels shall be installed directly to the first device. No more than three (3) 90 degree bends between junction boxes shall be acceptable. Lighting home runs can go to a junction box within the room being served.
- vii. Install pull string in all empty conduits.
- viii. Tubular conduit shall be used for all home runs until the last junction box on the circuit. MC cable will be permitted to extend from junction box to end device.

- b. All panels shall have conductors and MCB (main circuit breaker) sized to full panelboard capacity. Sizing of conductors and MCB's shall *not* be based on load calculation only.

26.6. Underground Ducts and Raceways

26.7. Sleeves and Sleeve Seals for electrical raceways and cabling shall be provided and shown by the A/E on above ground and underground wall/barrier penetrations.

26.8. Identification. The following conduit colors shall be used:

- a. Red – Fire Alarm
- b. Yellow – High Voltage
- c. Blue – Data
- d. Orange – Fiber
- e. Purple Security
- f. Green - Healthcare

26.9. Overcurrent Protective Device shall be provided per code.

26.10. Electrical Power monitoring and Control

- a. Enterprise Wide Power Management and Control System (EPMS)

26.11. Do we need to indicate that for programmable lights ODU has to be provided the means and methods to modify and program the lighting on our own.

26.12. Digital – Network Lighting Controls – is this the right name for this section – its confusing with programmable lights versus lighting controls for occupancy.

- a. Provide occupancy sensors in all occupied spaces except the following where standard toggle switches shall be provided, unless otherwise directed by code:
  - i. Electrical
  - ii. Mechanical
  - iii. Telecom/data/AV
  - iv. Research Laboratories
  - v. Residence Hall Sleeping Rooms
- b. All other occupied spaces shall have occupancy sensors, unless requested by and justified by the end user and not required by code. The A/E shall review spaces to receive occupancy sensors, locations and type, with end users.
- c. When dimming is desired provide modular LED dimmer switches compatible with dimmer drivers.
- d. The lighting control system shall be capable of providing all of the following functions for all lighting, although they may not be required for every project or fixture:
  - i. Continuous dimming and automatic on/off controls.

- ii. Occupancy control.
  - iii. Vacancy control.
  - iv. Daylight harvesting.
  - v. Load management.
- e. The lighting control system includes the following components:
- i. Sensors each contain a passive infrared sensor, digital photocell, digital temperature sensor (optional), microprocessor and/or a wireless radio.
  - ii. For systems using controllers, each one shall contain a utility grade power meter chip and a latching relay which powers the sensors and sends the control signal to the light's ballasts or drivers.
  - iii. For systems without separate controllers, the functionality of the controller shall be integrated into an LED driver or have independent functionality when using 2-wire sensors.
  - iv. Hard-wired (preferred) or battery powered (with ODU approval), wireless room controllers with dimming, on/off and scene selection features for manual override.
  - v. The central control system must be able to communicate with the sensors, aggregate the data collected by the sensors and transmit it to a central node that can reside on the premises or in the cloud.
  - vi. This central node can store data collected by the sensors and host the software for a web-based graphical user interface for light management and energy savings display software.
  - vii. Reports shall include graphical visualization tools for playback of occupancy and heat over time, usage by space types (conference rooms, open office areas, etc.), space utilization, and power usage.
  - viii. The project shall use dimmable LED drivers where requested.
- f. Warranty
- i. Provide manufacturer's Enhanced 5 Year Limited Warranty:
    1. 5-year limited warranty for the replacement of defective system components from the date of system startup completion.
    2. Contractor shall provide limited workmanship warranty for one year from customer acceptance.
    3. A driver module warranty is [5] years. When purchased with a lighting control system this warranty shall also be [5] years by the lighting fixture manufacturer.
- g. Acceptable System Manufacturers:
- i. nLight/ Aquity
  - ii. LumaWatt
  - iii. Lutron
- h. Provide ten-year lighting controls operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 50 degrees C (122 degrees F) and 90 percent non-condensing relative humidity. Equipment designed for outdoors must have an operating temperature range of -35 degrees C (-31 degrees F) to 85 degrees C (185 degrees F).
- i. Sensors and Control Units can be either ceiling mounted or fixture mounted built environment sensors.
- i. Built Environment Sensor.
    1. Passive Infrared Occupancy Sensor.
    2. Digital Ambient Light Sensor.
    3. Processing Mechanisms:

- a. Microcontroller in each sensor.
  - b. Communication Mechanism
  - c. Low power 2.4 GHz Transceiver based on IEEE 802.15.4 with an option for Bluetooth enabling.
- ii. Operations:
- 1. Sensors shall monitor changes in occupancy, changes in ambient light levels and communicate digital control commands to light fixtures according to a control strategy stored locally in the sensor.
  - 2. Sensor shall either wired or wirelessly transmit occupancy; light level, power information to a gateway device which allows the data to be stored in a central location on premises or in the cloud.
  - 3. Sensors shall be fully adaptive with the ability to have the sensitivity and timing to be remotely adjusted to ensure optimal lighting control for any use of the space.
  - 4. Sensors have remotely adjustable settings for dimming levels, active motion windows for occupancy/vacancy sensing, and sensitivity to changes in motion and changes in ambient light levels.
  - 5. If power is interrupted and subsequently returned, lights automatically return to their setting prior to power interruption and settings and learned parameters saved in protected memory shall not be lost.
  - 6. Programming is stored in each sensor in addition to the central node. Sensors operate independently from central node, so there cannot be single point failure. Systems must operate so there is no single point of failure.
  - 7. Responds to digital (load shed command) Demand Response signal.
- iii. Electrical/Connections:
- 1. Sensor shall connect to a controller via a low voltage cable for interior applications or Ruggedized Sensors for exterior applications. Battery free, wireless devices will be acceptable.
  - 2. System shall have user initiated manual demand response.
  - 3. System shall be ADR 2.0a compliant. Systems that simulate ADR shall not be acceptable.
- iv. Control Unit.
- 1. Components:
    - a. Utility Grade Power Meter capable of 1% power measurement accuracy.
    - b. Controller to include latching relay, to decrease power requirements of the power pack.
    - c. Operate Bounce Time: 3 ms. Max.
    - d.—
    - f. Controller shall measure the actual wattage of the fixture(s) that it controls.
    - h. Controller shall meter real-time energy use at each fixture.
    - i. Controller shall communicate real-time energy use to sensor unit.
- j. Lighting Control Device Details
- i. Spaces shall be equipped with an automatic control device to shut off lighting in those areas. This automatic control device shall function on either: 1) a scheduled basis, using time of day, with an independent program schedule that controls the interior lighting, or 2) an occupant sensor that shall turn lighting off within 20 minutes of an occupant leaving a space, or 3) a signal from another control or alarm system that indicates the area is occupied.
  - ii. Offers an interface that allows the system to communicate with the Building Automation System (BAS). A BAS enables occupant data to be further utilized to allow for more efficient usage of a building and space. A BAS

can utilize data from the lighting system for providing increased savings by optimizing the operations of a building's HVAC system.

- iii. Uses industry standard HTTPS security with AES-128 encryption safeguards the integrity of the entire system. Automatic backups prevent data loss and restore fixtures to operational modes. The system will provide reports that include fixture outages, lamp failure notifications, temperature and occupancy data. It constantly monitors areas to ensure that spaces are managed according to the assigned user preferences and tasks being performed.
- k. Operator's Software
  - i. User programming and editing may be conducted online in web-based software. Data shall be entered through a simple menu-driven user interface. The operators' software provides all the information to the user regarding the consumption and saving of the energy utilized in the building environment. The basic operating software shall provide the following:
    - 1. Site wiring documentation for all connected fixtures and system components shall be in O&M manual and project submittals. Reflected ceiling plan shall also be present in the software to show the location of components.
    - 2. English descriptions of each circuit switch and calculated load.
    - 3. Monitor/Control all fixtures.
    - 4. Software shall show actual fixture states, with an optional menu showing how and when the fixture change occurred.
- l. Central Programming, Monitoring and Control Work Station
  - i. The control work station shall provide monitoring, programming and control of the system. The system shall include at a minimum:
    - 1. Scheduling Profile and Groups
      - a. Profile: "A lighting profile", which is typically shortened to just profile, is a named set of configuration values that determine the setting of the light level of the luminaire (lighting fixture). The configuration values are used by the intelligence in the fixture along with the current operational mode, past and present sensor values, time of day, day of the week, and passage of time to control the light level. How the light is turned on and off and the light level set, is called the behavior of the light.
      - b. Groups: The use for groups is for all fixtures in a room (e.g. conference room) to change to the occupied state (typically resulting in a fixture turning on their lights) when any fixture senses occupancy, and for all fixtures in a room to stay in the occupied state as long as any fixture senses occupancy.
    - 2. Daylighting Controls
      - a. The sensor shall have the ability to sense daylight in the surrounding areas. This feature shall allow the automatic reduction of ambient lighting levels when sufficient daylight is present to maintain the programmed foot-candle levels. The daylight sensing feature shall be included in one sensor that also has the ability to sense motion, temperature control and individual energy monitoring.
    - 3. Motion Controls

- a. The sensor shall have the ability to sense motion through passive infrared detection in the surrounding areas. This feature shall allow the automatic activation of lighting to preset levels when motion is detected and provide the automatic reduction of lighting to preset levels when no motion is sensed after the programmed time-out period. The motion sensing feature shall be included in one sensor that also has the ability to sense daylight, temperature control and individual energy monitoring.
4. Energy Dashboard
- i. Shall have the ability to provide real-time graphic information concerning the energy usage of the individual lighting fixtures. This information can include but not be limited to:
    - a. Displaying the building floor plan with the "ON" or "OFF" status of each light and the ability to zoom into to any fixture and get expanded operating information.
    - b. Providing real-time information for any lights that are not functioning and the date when they stopped working.
5. Demand Response Control (Future use)
- ii. For buildings 10,000 square feet or greater and upon notification by the local utility, the system can automatically reduce lighting loads by 15% for the building when directed by the Building Management System (BMS).

#### 26.13. Transformers

- a. Dry-type transformers rated 600 V and less, with capacities up to 500 kVA.
- b. Efficiency ratings will meet NEMA TP-1 standards at a minimum with NEMA Premium CSL-3 standards preferred.
- c. Acceptable Manufacturers:
  - i. Square D: by Schneider Electric
  - ii. Eaton Electrical Sector; Eaton Corporation.
  - iii. Siemens Power Transmission & Distribution, Inc.

#### 26.14. Switchgear

- a. All switchgears shall have bakelite, or equivalent, nameplates identifying each assembly as well as on all breakers, disconnects or switches contained therein.
- b. Provide written documentation of all parameters for digital electrical meters provided in the switchgear.
- c. The A/E shall call out DEB required signage as part of the drawings and specs.

#### 26.15. Switchboards

- a. Service and distribution switchboards rated 600 V and less, subject to compliance with project specifications, provide products by one of the following:
  - i. Square D; by Schneider Electric.
  - ii. Eaton Electrical Sector; Eaton Corporation.
  - iii. Siemens Power Transmission & Distribution, Inc.
- b. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete.
- c. All switchboards shall have bakelite, or equivalent, nameplates identifying each assembly
- d. All means of disconnect within assembly needs to be labeled with specific connected loads.
- e. Buses and Connections: Three phase, four wire unless otherwise indicated.

- i. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
  - ii. Phase- and Neutral-Bus Material shall be hard-drawn copper of 98 percent conductivity.
  - iii. Copper feeder circuit-breaker line connections.
  - iv. Tin-plated aluminum feeder circuit-breaker line connections.
  - v. Load Terminals shall be insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
  - vi. Ground Bus shall be the minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with connectors for feeder and branch-circuit ground conductors.
  - vii. Main-Phase Buses and Equipment-Ground Buses shall have uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - viii. Neutral Buses shall have 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- f. Surge Protection Devices (SPDs)
- i. Acceptable Manufacturers: Subject to compliance with project specifications, provide products by one of the following:
    - 1. Advanced Protection Technologies Inc. (APT).
    - 2. Eaton Electrical Sector; Eaton Corporation.
    - 3. Siemens Power Transmission & Distribution, Inc.
    - 4. Square D; by Schneider Electric.
- g. SPDs with the following features and accessories:
- i. Integral disconnect switch.
  - ii. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - iii. Indicator light display for protection status.
  - iv. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - v. Surge counter & Display
- h. Disconnection and Overcurrent Protective Devices
- i. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - ii. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- i. Instrumentation
- i. Main switchboards shall contain a 10-function electronic digital monitoring system. This monitor shall have capabilities to reset approximate values, KWH in particular.



- ii. Multifunction Digital-Metering Monitor shall be a microprocessor-based unit suitable for three- or four wire systems and with the following features:
  - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Accuracy tolerances for values of accumulated energy, megawatt hours shall be plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - b. Megawatt demand values shall be plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - c. Contact devices to operate remote impulse-totalizing demand meter.

#### 26.16. Panelboards

- a. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete.
- b. All panelboards, switchboards, circuit breakers, dry type transformers and disconnect switches shall be of the same manufacturer.
- c. Entire front trim shall be hinged to box using piano type hinge with standard door within hinged trim cover.
- d. Provide directory card located on the inside panelboard door, mounted in transparent card holder.
- e. Create machine-printed panelboard schedules to replace the handwritten schedules. Loads shall be specific room, piece of equipment, etc. verse using a generic "receptacles" label.
- f. All breakers shall be a minimum of 20A rated.
- g. Every electrical panelboard shall be rated at 225-amp minimum. The MCB and all conductors shall be sized to full panel board capacity. Sizing of conductors and MCB's shall not be based on load calculation only. Each panel board shall have its own 225A circuit from the Main Switchgear or MDP. Main lug or "Pass-Through" lug panels are not allowed.
- h. Electrical panels shall have 15% spare capacity. Supply a minimum of four (4)  $\frac{3}{4}$ " empty conduits from recessed panels to an accessible location for future use.
- i. No panelboards shall be located in housekeeping closets. Provide electrical closets on each floor dedicated to electrical panels only.
- j. Commercial kitchens shall have dedicated electric panelboard(s) serving only kitchen-related outlets. Feeding kitchen-related circuits from other electrical panelboards is not acceptable. Commercial kitchen related panelboards shall have a minimum of (4) spare  $\frac{3}{4}$ " conduits stubbed into acceptable ceiling space for future kitchen-related circuits.
- k. All interior transformers greater than 45 kva shall be floor mounted.
- l. Integrated transformer/panelboards shall not be used.
- m. Switchboards, panelboards and components shall have copper buss bars.
- n. When panelboards are used as main service equipment, the same meter shall be installed adjacent to it and provisions for current transformers and other connections shall be made.
- o. Fusible switches shall be spring-loaded types, with interlock and padlock capabilities.
- p. Provide 5% spare fuses for fusible switches. Fuses shall be stored in the main electrical room.
- q. Panelboards for light and power shall be of the dead-front, automatic C/B type. Circuit breakers shall be bolt-on or I-line type. Panelboards shall have copper grounding bars.

- r. When an electrical panel is surface mounted, all under slab conduit that turns up into the electrical panel, shall transition from sch40 PVC to a rigid 90o elbow before extending through the floor. IMC conduit shall extend from the 90o elbow into the bottom of the panel.
- s. Provided "fed-from..." phenolic bakelite, or equivalent, labels for panel boards and the lighting inverter.
- t. If an existing building is renumbered, the corresponding electrical panels shall be renumbered and new labels produced and shall be documented by the A/E.
- u. Distribution Panelboards acceptable manufacturers:
  - i. Eaton Electrical Sector; Eaton Corporation.
  - ii. Siemens Industry, Inc.
  - iii. Square D.
- v. Lighting and Appliance branch-Circuit Panelboards acceptable manufacturers:
  - i. Eaton Electrical Sector; Eaton Corporation.
  - ii. Siemens Industry, Inc.
  - iii. Square D.

26.17. Motor-Control Centers (reserved)


26.18. Enclosed Bus Assemblies (reserved)

26.19. Power Distribution Units (reserved)

26.20. Electricity Metering

- a. All new construction and major renovations to be metered. It is the intent of the university to meter all buildings over time. The A/E shall discuss the metering scheme with Facilities Management at the earliest possible opportunity.
- b. Equipment for electricity metering by utility company shall be furnished and installed by Dominion Energy. The general contractor shall provide the meter base. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- c. Meter shall be located outside facility or accessible by local utility without the need of an ODU provided escort.
- d. Equipment for Electricity metering shall be provided by one of the following manufacturers:
  - i. E-Mon.
  - ii. National Meter Industries.
  - iii. Square D.
- e. The meter shall have the potential to interface with the DDC system for HVAC. The meter can be integrated into the switchboard or motor control center.

26.21. Wiring Devices

- a. Typical Building Cover Plates: Stainless Steel
- b. Residence Hall Cover Plates: White Plastic
- c. Controlled Receptacle Cover Plates: To meet the requirements for identifying receptacles that will be automatically de-energized as part of an overall plug load control program, the 2017 NEC requires all 15A & 20A, 125V receptacles that are automatically controlled (as required by code) to be marked with the controlled receptacle marking symbol  and the word "CONTROLLED" on the receptacle face. Provide green colored devices that meet this requirement with stainless steel cover plates (White in Residence Halls)

- d. Emergency Power Cover Plates: red receptacle with stainless steel cover plate with “EMERGENCY” engraved on cover plate with red lettering.
- e. All receptacle covers shall be labeled with the circuit and panel designation with an adhesive type label.
- f. Single device boxes shall be a (4"x4"x2.125") minimum size with appropriate plaster ring or adapter. Junction and pull boxes shall be a minimum of (4"x4"x2.125") with appropriate cover.
- g. Provide at least two (2) separate electrical 20A, 120V receptacle circuits in every Residence Hall room.
- h. Provide (1 or 2) GFCI receptacles outside of each building entrance. Each receptacle shall share a dedicated 20A, 120 volt circuit.
- i. Wiring devices shall be hard-use, specification-grade, 125V AC, 20A, back or side wired. Devices to have screw/clamp type terminals. Switches to be rated 277 VAC regardless of system voltage.
- j. Receptacles shall be provided inside at each entrance vestibule and at least every fifty feet 50' in all corridors. These receptacles shall be on a dedicated circuit.
- k. Provide at least one dedicated 20A, 120V receptacle circuit per public bathroom.
- l. Provide at least one 20A, 120 VAC GFCI receptacle in each electrical, elevator, mechanical, maintenance storage and trash room, and at each cooling tower and AHU. Each circuit shall be dedicated to its respective room.
- m. Receptacles serving vending machines shall have their own 20A dedicated circuit to each receptacle. There shall be one (1) communications outlet for each bank of machines.
- n. All conductors in boxes serving receptacles shall be pigtailed so that the device can be removed without interrupting the circuit.

#### 26.22. Utility Service Entrance

- a. The Owner will pay all charges levied by the Power Company for the underground service. The general contractor shall assist the Owner with the application for electrical service.
- b. All work shall be in accordance with the Dominion Energy's standards for means and methods.
- c. The general contractor shall coordinate work with the power company within 30 days of notice to proceed contract date. Notification shall be in writing. The contractor shall schedule a preconstruction meeting with the appropriate subcontractors present and shall be held at Dominion Energy's district offices.
- d. The contractor shall notify Dominion Energy at least seven days in advance the start of duct bank construction.
- e. Dominion Energy Provided Work and Materials
  - i. Pad mounted transformer.
  - ii. Primary conductors and terminations to the transformer.
  - iii. Cable terminations at secondary bushings of transformer.
  - iv. Conduit seal on the transformer end of Contractor -provided conduits to company transformer.
    - i. Metering circuitry from CT Cabinet to meter.
    - ii. Transformer pad.
    - iii. Grounding at service entrance and transformer pad.
- f. Contractor Provided Work and Materials
  - iv. Excavation and backfill for primary and secondary service ductbanks.
  - v. Conduit ductbank for Dominion Energy primary conductors to transformer.
  - vi. Service switchboard with Utility-Approved CT section.

- vii. Ductbank from utility pad mounted transformer to service switchboard CT section, with conductors terminated in switchboard.
- viii. Conduit seals in accordance with Dominion Energy requirements.
- ix. 1-1/4" concealed empty conduit from CT section to utility meter base.

- g. Furnish two (2) PDF copies of as-built drawings showing the actual location and installation of the main feeders, main duct bank and complete system.

26.23. Fuses (reserved)

26.24. Enclosed Switches and Circuit Breakers

- a. All exterior disconnects shall be NEMA 4X Stainless Steel

26.25. Controllers: Variable frequency drives shall be specified by the A/E as provided by the mechanical contractor.

26.26. Photovoltaic Collectors

- a. ODU has existing photovoltaic installations on campus and is open to discussions for additional installations associated with projects when appropriate.

26.27. Generators

- a. All new construction shall have emergency power shall be supplied by generator set and transfer switch.
- b. Automatic transfer switches and related components shall be provided by the selected generator-set manufacturer.
- c. Acceptable generator manufacturers:
  - i. Generac (preferred)
  - ii. Caterpillar; Engine Div.
  - iii. Kohler Power Systems.
  - iv. Onan/Cummins Power Generation; Industrial Business Group.
- d. The Automatic Transfer Switch (ATS) control pad shall provide the following display features:
  - i. Utility voltage by phase
  - ii. Emergency voltage by phase
  - iii. Frequency by phase
- e. The generator set shall be located outside of the building in a discreet location. Consideration will be paid to flood plain height in relation to the emergency generator; no generator shall be placed in locations prone to flooding. Same consideration shall be applied to main distribution panels as it relates to areas prone to flooding. Considerations shall include the anticipated shift in the floor plane height over the life of the building, to the degree possible.
  - i. The bottom of the generator shall be located at the building's first floor elevation or higher.
- f. The A/E shall locate an exterior portable emergency generator hook up when the permanent generator cannot support additional load as identified by the building users for an extended power outage, such as museum climate control or research facilities. The project team will discuss what is considered an extended power outage for the specific building usage.
  - i. A permanent means of connecting temporary generators shall be installed in a location approved by ODU staff. Shall include a manual transfer switch and the connections will be a cam-lock type. All parts shall be rated equivalent to 100% of main disconnect switch(s).

- g. The A/E shall require generators to operate in high salt content in the air due to sea-spray evaporation.
- h. Permanent generators shall be natural gas fueled.
- i. The generator muffler/silencer shall have a sound attenuation of 25 dB at 500 Hz under no load. After installation is complete sound level measured at a distance of 25 feet from exhaust discharge shall be 78 dBA or less.
- j. Generators <100kw shall provide a means of connecting a portable load bank. The method of connecting the portable load bank shall be easily accessible.
- k. Generator shall be able to communicate to the BAS. Locate generator annunciator panel adjacent to the building fire alarm control panel.
- l. Provide at least one empty ¾" conduit and pull string between the generator enclosure and the ATS switch.
- m. Generator shall be provided with at least one (1) double-duplex convenience outlet. This outlet shall be mounted in an accessible location within the generator enclosure. This outlet shall be fed from a minimum 20 amp capacity breaker that is clearly marked and is also on emergency power.
- n. Outdoor Generator enclosure shall be Vandal-resistant, sound-attenuating, weatherproof aluminum or salt resistant housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- o. All main and distribution IT switches, and HVAC DDC panels shall be connected to emergency circuits. Refrigerators and freezers shall be evaluated on a case by case basis for connection to emergency power.
- p. Provide a service light in the vicinity of the generator to illuminate on and around the unit for servicing.

#### 26.28. Lightning Protection

- a. Install lightning protection components and systems according to UL 96A and NFPA 780.
- b. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- c. Conceal the following conductors:
  - i. System conductors.
  - ii. Down conductors.
  - iii. Interior conductors.
  - iv. Conductors within normal view from exterior locations at grade within 200 feet of building.

#### 26.29. Cathodic Protection (reserved)

#### 26.30. Surge Protection for Low-Voltage Electrical Power Circuits (reserved)

#### 26.31. Lighting General

- a. Design consultant shall submit cut sheets of all proposed light fixtures to the ODU PM for approval prior to the completion of Preliminary Drawings. The cut sheets will be clearly labeled and tied to the lighting plans.
- b. The university attracts a varying array of age levels from toddlers to the elderly for the multitude of activities and learning offered. It is our responsibility to design a safe environment for all individuals without sacrificing the natural environment.
- c. The designer shall consider appropriate fixtures that will provide a minimum value to achieve and be able to demonstrate good to excellent facial recognition at a distance of 30 feet.
- d. Lighting uniformity on campus is a priority. When designing a project, light level plans shall include neighboring fixtures and their impact on the current project.

## 26.32. Exit Signs

- a. Provide LED internally lighted signs with 50,000 hours minimum rated lamp life.

## 26.33. Interior Lighting

- a. New construction shall utilize LED fixtures.
- b. Renovations shall convert to LED fixtures when appropriate, otherwise re-use and or match existing fluorescent fixtures.
- c. All LED lighting shall carry at least a 5 year full product replacement warranty.
- d. Color temperature shall be no less than 3500K.
- e. Color temperature shall not vary more than 200oK within a connected space.
- f. Recessed “can” type fixture shall only be used in locations with hard ceilings that allow repair access through lamp opening only. The use of these fixtures shall be kept to a minimum regardless of location.
- g. Lights shall be installed over landings verses stair treads wherever possible and meet the minimum egress lighting required by code. If lights are required to be installed above treads they shall be no higher than 10' above finished floor and shall be accessible from a 6' ladder.
- h. Lighting in all multimedia classrooms shall be reviewed and approved by the Assistant Director Classroom and Learning Space Technology.
- i. Use wire guards on all lighting in gymnasiums or similar types of athletic spaces, including emergency lights, fire alarms, and clocks. Lenses shall be Plexiglas/ Lexan type material for better resistance to shattering.

## 26.34. Emergency and Exit Lighting

- a. All emergency lights shall be connected to 277V circuits. Emergency lights shall be connected to emergency power when available. Battery backed-up ballasts connected to house circuits are not acceptable.
- b. Refer to the **BCOM NEWSLETTER #12 DECEMBER 2015**, excerpted below
  - i. *Occupancy sensors shall:*
    - 1. *Be installed throughout the building to provide full coverage of all areas.*
    - 2. *Incorporate both infra-red and ultrasonic technologies within each sensor device.*
    - 3. *be equipped with a time-delay (off) function and shall be set for minimum 15-minute duration.*
  - ii. *The means of egress must be illuminated for the entire floor whenever an occupant is sensed anywhere on that floor.*
  - iii. *Elements of the means of egress that serve all floors shall be illuminated whenever an occupant is sensed anywhere within the building. This shall include, but not be limited to, stairways and common lobbies such as main building lobbies and elevator lobbies.*
    - iv. *Means of egress illumination located outside of the building or on the exterior of the building shall not be controlled by occupancy sensors. Typically, this lighting is controlled by photocell(s) and this practice continues to be acceptable. (ODU Comment: The preference is to use HVAC DDC system to control exterior lighting using one master photocell installed to input to the DDC system which will trigger outside lighting to activate.)*
  - v. *In buildings where a fire alarm system is provided, the means of egress lighting shall be illuminated upon activation of the fire alarm system.*

- vi. *The design and sequence of operation of the occupancy sensing system shall be included in the electrical plans submitted for permit and sealed by the electrical design engineer. The means of egress shall be clearly defined on the architectural plans.*
- vii. *Emergency means of egress illumination required by VCC Section 1006.3 shall not be controlled by occupancy sensors. Note: if the same luminaires are utilized for both normal means of egress illumination (VCC 1006.1) and emergency means of egress illumination (VCC 1006.3), then occupancy sensor control of these luminaires must be by-passed in the event of normal power supply failure by use of an emergency device listed for the purpose.*

#### 26.35. Theatrical Lighting (reserved)

#### 26.36. Exterior Lighting

- a. Refer to **APPENDIX AI – STANDARD CAMPUS LIGHT POLE** and **APPENDIX AJ -STANDARD CAMPUS PARKING LOT POLE**.
- b. Photometrics
  - i. Photo metrics shall be provided for exterior lighting as required by the CPSM.
  - ii. All exterior steps, roadways and main pathways shall be designed to meet Illumination Engineering Society of North America (IESNA) standards for cut-off optics, unless otherwise directed.
  - iii. Point-by-point foot-candle calculations of the site lighting and voltage drop calculations for site lighting circuits shall be provided with the preliminary document submission; foot-candle calculations shall include the IESNA design level/classification used.
  - iv. Because we are a college campus and there are not site specific boundaries, it is vital that the surrounding existing fixtures be accounted for in the photometric calculations.
  - v. A final photometric drawing indicating the measured light levels at completion shall be submitted with the record drawings, along with the approved photometric drawings originally submitted to DEB. The calculations shall include exterior building mounted fixtures and exterior light spill from interior fixtures.
- c. Foot candle consistency – exterior lighting design shall provide the required fc levels on walkways and stairs with no greater than a 50% change in fc readings between fixtures. Example: if the light reading the pathway of a light fixture is 2 fc, then the light shall drop to no less than 1 fc or increase no greater than 2fcs along that same path. The intent is to avoid shifts in light levels going from dark to light too quickly which the eyes cannot adjust to.
- d. All exterior lighting fixtures shall use LED lamps only. Lens shall be impact-resistant tempered glass, lexan or other approved material.
- e. The A/E shall indicate in the construction documents that the exterior campus light pole heads shall be owner furnished, contractor installed. The poles and bases shall be provided by the general contractor and shown on the A/E documents. The A/E shall provide ODU with a list of the heads required, the lamping etc. so that ODU can provide the right fixtures for the project.
- f. The A/E shall detail the light pole base, including a hand hole, as part of the construction documents.

#### 26.37. Athletic Exterior Lighting (reserved)