26 05 00 Common Work Results for Electrical

1. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway unless written approval is granted by the engineer or noted otherwise on the construction documents. 120 volt and 277 volt receptacle and lighting circuits are exempt from this requirement, but must meet the requirements of the NEC.

2. Coordinate the connection of mechanical systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Provide a single connection for each service except where multiple connections are indicated.

3. Products:
   a. A firestop system shall be used to seal penetrations of electrical conduits and cables through fire-rated partitions per NEC 300.21, NEC 800.52(B) (2002), NEC 800.3(C) (2005) and NEC 800.26 (2008). The firestop system shall be qualified by formal performance testing in accordance with ASTM E-814, or UL 1479.
   b. The firestop system shall consist of a fire-rated caulk type substance and a high temperature fiber insulation. It shall be permanently flexible, waterproof, non-toxic, smoke and gas tight and have a high adhesion to all solids so damming is not required. Only metal conduit shall be used in conjunction with this system to penetrate fire rated partitions. Install in strict compliance with manufacturer's recommendations. 3M or approved equal.
   c. Comply with TIA/EIA-569-A, Annex A, "Firestopping".

26 05 01 Electrical Demolition

1. Field verify measurements and circuiting arrangements as shown on as-built drawings.

2. Remove abandoned wiring to source of supply.

3. Remove exposed abandoned conduit and outlet boxes, including abandoned conduit above accessible ceilings. Cut conduit flush with walls and floors and patch surfaces.

4. Provide blank cover plate for abandoned outlets that are not removed.

5. All demolished lighting ballasts and lamps must be recycled. The removal, transportation and disposal of electrical equipment containing Polychlorinated Biphenyl (PCB) shall be in accordance with the Federal Toxic Substances Control Act (TSCA).
6. Reuse of conduits not remaining in place, conductors and devices is not permitted.

7. A list of all items removed should be reviewed with CCU for determination of items that should be turned over to the University. All other items shall be disposed of properly.

8. Products:
   a. None.

26 05 12 Electrical Coordination

1. Provide layout of all electrical rooms using dimensions of equipment from basis of design. Locate all ducts and piping entering or crossing electrical room spaces.

2. List all equipment that requires electrical connection.

3. List all equipment and systems that require electrical rough-in.

4. Products:
   a. None.

26 05 19 Low Voltage Electrical Power Conductors and Cables (600V and less)

1. Design shall conform to the requirements of the National Electric Code (NFPA 70).

2. Identify and color code wire and cable under the provisions of Section 26 05 53.

3. Motor connections shall be made with compression connectors forming a bolted in-line or stub-type connection.

4. Splicing of feeder conductors shall not be acceptable.

5. Products:
   a. Concealed Dry Interior Locations: Use only THHN-2, THWN-2, or XHHW-2 wire in raceway.
   b. Exposed Dry Interior Locations: Use only THHN-2, THWN-2, or XHHW-2 wire in raceway.
   c. Above Accessible Ceilings: Use only THHN-2, THWN-2, or XHHW-2 wire in raceway.
   d. Wet or Damp Interior Locations: Use only THWN-2, or XHHW-2 wire in raceway.
   e. Exterior Locations (above or below grade): Use only THWN-2, XHHW-2, or USE wire in raceway.
   f. Use conductors not smaller than 12 AWG for power and lighting circuits.
   g. Use conductors not smaller than 14 AWG for control circuits.
h. Metal Clad (MC) cable shall not be used unless prior approval has been granted by CCU.

i. Conductors sized 12 AWG and 10 AWG shall be solid conductors. Conductors sized 8 AWG and larger shall be stranded conductors.

j. All conductors shall be copper with insulation rating of 600 Volts.

26 05 26 Grounding and Bonding for Electrical Systems

1. Design shall conform to the requirements of the National Electric Code (NFPA 70).

2. A grounding ring shall be provided encircling the building with multiple grounding electrodes.

3. Grounding Bus Bars shall be provided at each electrical and IT room and connect to pigtail extensions of the building grounding ring.

4. The lightning protection system shall be bonded to the electrical grounding electrode system.

5. All conductive piping systems shall be bonded to the electrical grounding electrode system.

6. Feeder and branch circuits shall be bonded to the electrical grounding electrode system per the requirements of the NEC.

7. Products:
   a. Electrodes shall be sectionalized steel with copper-welded exterior, ¾” diameter x 10’ long.
   b. Bonding Jumper Braid shall be copper braided type, sized for application.
   c. Electrical Grounding Conductors shall be bare copper or green insulated copper sized in accordance with the NEC. Provide green insulated stranded copper wires for conductors sized 10 AWG and smaller.
   d. Below grade connections shall be by exothermic-weld.
   e. Above grade connections shall be by compression type connectors.

26 05 29 Hangers and Supports for Electrical Systems

1. Anchors and fasteners shall not be supported by pipes, ducts, mechanical equipment, ceiling support wires or conduits.

2. Boxes shall be supported independently of conduit.

3. Support groupings of conduit with conduit racks.

4. Products:
a. Powder-actuated anchors shall not be used.

b. Anchors and Fasteners shall be of the type that is suitable to be used with the structural element present and shall be corrosion-resistant of size and type for the load supported.

### 26 05 33 Raceway and Boxes for Electrical Systems

1. Route exposed and concealed conduit perpendicular and parallel to walls and ceiling.

2. Route conduit under slab from point to point. Conduit in grade shall be buried at depths as required by the NEC.

3. Use LTFMC or FMC only to connect equipment subject to vibration or to suspended light fixtures. Maximum length of LTFMC or FMC shall be 6’.

4. Raceways shall not be installed exposed in finished spaces. Install raceways concealed in walls, ceilings or below slab-on-grade.

5. Provide pull string in all empty or spare conduits.

6. Outlet boxes mounted back to back in same wall cavity are prohibited. Provide minimum 24 inch offset between boxes.

7. Panel/circuit shall be identified on all junction boxes with permanent black marker.

8. Products:
   a. Minimum conduit size: 3/4”
   b. Exterior wet/damp location above ground: RMC, IMC, or LTFMC
   c. Exterior wet/damp location below ground: ENT schedule 40/80
   d. Interior wet/damp location: RMC, IMC, or LTFMC
   e. Interior dry location concealed or exposed: EMT or FMC
   f. Areas subject to physical damage: RMC, IMC, or LTFMC

### 26 05 36 Cable Trays for Electrical Systems

1. Cable tray shall be bonded to the electrical grounding system per the NEC.

2. All Cable tray sections shall be made electrically continuous by short bonding jumpers between sections.

3. Cable trays shall not penetrate fire-rated walls or structures. Use sleeves to penetrate fire-rated walls and fire caulk after installation of all cables.

4. Products:
a. Side supported ladder-type cable tray.

26 05 53 Identification for Electrical Systems

1. Install nameplates and labels parallel to equipment lines.

2. Secure nameplates to equipment front using corrosion resistant screws.

3. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations. Provide nameplate on outside top of door for surface mounted panelboards.

4. Provide nameplates on all disconnects and motor starters.

5. Label each junction box with the branch circuit or feeder number.

6. Products:

   a. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

      i. Locations: Each electrical distribution and control equipment enclosure.

      ii. Letter Size: Use 1/4 inch (6 mm) letters for identifying grouped equipment and loads.

   b. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) white letters on black background. Use only for identification of individual wall switches, receptacles, and control device stations.

   c. Wire Markers:

      i. Color shall be green for grounding conductors and green with yellow stripe for isolated grounding conductors.

      ii. The color of the circuit conductors shall be as follows:

         120/208 volt, 3-phase:
            Phase A - Black
            Phase B - Red
            Phase C - Blue
            Neutral - White

         277/480 volt, 3-phase:
            Phase A - Brown
            Phase B - Orange
            Phase C - Yellow
            Neutral – Gray.
26 23 00 Low Voltage Switchboard

1. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the switchboard.

2. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated: 208 Volt Switchboards: Minimum 33,000 amperes rms symmetrical; 480 Volt Switchboards: Minimum 42,000 amperes rms symmetrical.

3. Switchboards:
   a. Square-D Company products preferred. GE Industrial and Siemens are acceptable.
   b. Provide factory-assembled, front accessible dead-front, metal-enclosed, free-standing switchboards.
   c. Unless shown otherwise, switchboard shall consist of separate sections for termination/metering, main breaker and distribution.
   d. The bus shall be copper with 98 percent conductivity.
   e. Vertical bus shall be the full height of the switchboard.
   f. Horizontal bus shall be fully sized for entire length of switchboard, and shall have provisions for future extension (bus stabs). The complete assembly shall be listed for 100% rating.
   g. Provide full sized copper with 98 percent conductivity neutral bus.
   h. Provide copper with 98 percent conductivity ground bus rated not less than 25% of main bus or as required by the NEC, whichever is greater.
   i. Provide mimic buss labeling on switchboard
   j. Provide draw out circuit breaker lift and track system

4. Breakers:
   a. Low voltage AC power circuit breaker, draw out style, stored energy and solid state trip devices.
   b. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. All breakers shall have LSGI settings.
c. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.

d. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.

e. Padlocking: Include provisions for padlocking the breaker in the open position.

f. Operation: Unless otherwise shown on the drawings, breakers 1600 ampere frame size and less shall be manually operated. Breakers larger than 1600 amperes frame size shall be electrically operated.

5. Trip devices shall have the following features:

a. Trip device in each pole.

b. Metering, voltage, current memory and LCD display

c. Mechanically and electrically trip free.

d. Long time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.

e. Short time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.

f. Ground fault element with adjustable pick-up and selective maximum, intermediate and minimum time delay bands.

g. Circuit breakers serving elevators, shall have adjustable long-time setting and shall be provided with a shunt trip coil rated for 120V operation. Breaker shall also have a set of Form C contacts. Connect shunt trip coil to operate as indicated on the drawings.

26 24 00 Panelboards

1. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the switchboard.

2. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated: 208 Volt panelboards: Minimum 10,000 amperes rms symmetrical; 480 Volt panelboards: Minimum 18,000 amperes rms symmetrical.

3. Panelboards:

a. Square-D Company products preferred. GE Industrial and Siemens are acceptable.
b. Provide factory-assembled, front accessible dead-front, metal-enclosed, free-standing panel boards.

c. Provide 25% spare breaker space in each panelboard.

d. The bus shall be copper with 98 percent conductivity.

e. Vertical bus shall be the full height of the panelboard.

f. Provide full sized copper with 98 percent conductivity neutral bus.

g. Provide a separate neutral wire for all branch circuits feeding computer outlets.

h. Provide bolt-on type breakers.

i. For circuit breakers 1200 amps and over (or capable of being adjusted to 1200 amps and over) – Provide a means of arc energy reduction per NEC 2014 240.87.

4. Breakers:

a. For Circuit breakers 1000 Amps and over – Provide low voltage AC power circuit breaker, with fixed mounting, stored energy and solid state trip devices.

   i. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. All breakers shall have LSGI settings.

   ii. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.

   iii. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.

   iv. Padlocking: Include provisions for padlocking the breaker in the open position where required.

   v. Operation: Unless otherwise shown on the drawings, breakers 1600 ampere frame size and less shall be manually operated. Breakers larger than 1600 amperes frame size shall be electrically operated.

b. For all circuit breakers 200 amps and smaller provide - Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers.

   i. Type SWD for lighting circuits.

   ii. Type HACR for air conditioning equipment circuits.
iii. Class A ground fault interrupter circuit breakers where scheduled.

iv. Do not use tandem circuit breakers.

v. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

vi. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration for all residential applications.

For circuit breakers over 200 amps provide -Adjustable Trip molded case, solid state adjustable trip type circuit breakers.

i. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

ii. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

iii. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

iv. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional] [with field-adjustable 0.1- to 0.6-second time delay.

v. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

vi. Trip units shall have field adjustable tripping characteristics as follows:

1. Ampere setting (continuous).
2. Long time band.
3. Short time trip point.
4. Short time delay.
5. Instantaneous trip point.

2. Circuit breakers serving elevators shall have adjustable long-time setting and shall be provided with a shunt trip coil rated for 120V operation. Breaker shall also have a set of Form C contacts. Connect shunt trip coil to operate as indicated on the drawings.
1. Hubbell wiring device products are preferred.
2. Install receptacles with grounding pole on top.
3. Do not install receptacles within 6’ of sinks or basins.
4. Install switches with OFF position down.
5. Back wiring shall be prohibited on all devices.
6. Provide GFCI receptacles as required by the NEC.
7. Wall switches shall be 48” above finished floor.

8. Products:
   c. Occupancy Sensors: Dual technology, wall mounted or ceiling mounted by Leviton, Lutron or Wattstopper.

26 28 16 Enclosed Switches and Circuit Breakers

1. All switches associated with outdoor equipment shall be located as close to the equipment as possible such that the top of the switch is no more than 3’ above grade.
2. All switches associated with equipment above a lay-in ceiling shall also be located above the lay-in ceiling.
3. Coordinate safety and disconnect switch installation with surrounding equipment to provide unobstructed access to the switch (4’ clearance) and to ensure that the switch is within sight of the controller or driven equipment.
4. Provide nameplates on all switch enclosures wherein new circuits are modified or installed. Indicate the following information:
   a. Equipment Switch Serves.
   b. Branch Circuit.
   c. Voltage, phase, wire, short circuit current rating
d. Date installed

5. Products:

a. Square-D Company products preferred. GE Industrial and Siemens are acceptable.

b. Non-fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   i. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   ii. Handle lockable in OFF position.

c. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   i. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   ii. Handle lockable in OFF position.
   iii. Fuse clips: Designed to accommodate NEMA FU1, Class R or J fuse

d. Molded Case Circuit Breakers: UL listed for the following service conditions: Temperature: 40 degrees C.

 e. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time and short time current

 f. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with changeable trip units.

 g. Solid-State Circuit Breaker: Provide main circuit breakers with frame sizes 600 amperes and larger with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with instantaneous trip.

26 32 00 Emergency Power System

1. The Emergency Power Systems shall be a packaged generator assembly and shall provide an alternate AC power source for designated loads in the event of interruption of normal utility power. When required, the units shall automatically transfer the full rated load from the normal power source to the standby emergency generator. Upon return of normal power, the loads shall be automatically transferred back to the normal power source and the emergency generator shall automatically shut off, after designated cool down period.
2. Manufacturers: The following manufacturers are acceptable provided they meet all requirements of the specifications:

   a. Packaged Generator Set
      i. Basis of Design: Onan/Cummings.
      ii. Alternate Manufacturers: Caterpillar and Kohler.

   b. Automatic Transfer Switch.
      i. Basis of Design: Cummins Power Generation
      ii. Alternate Manufacturers: Russelectric and ASCO

3. All wiring and interconnections shall be in accordance with commercial electrical standards. Installation drawings and complete wiring diagrams shall be furnished to the Owner.

4. Install genset on concrete pad whose dimensions exceed the weatherproof housing by at least six inches, all sides. Pad thickness shall be 12". Concrete shall be 2500 psi, reinforced as indicated on plans. Anchor genset to concrete pad as recommended by the manufacturer.

5. Provide factory representative to conduct startup and testing. Testing shall comply with the requirements of NFPA 110, paragraph 5-13, "Installation Acceptance". Provide resistive load bank to conduct the tests.

6. Upon completion of testing, the factory representative shall provide 2-hours of on-site training of the Owner's designated personnel.

7. Install concrete bases, per the seismic requirements for the site.

8. Products:

   a. Natural Gas engine sized to serve designated loads.
   b. Engine mounting base with integral day tank.
   c. Electrical generator with controller and integral instrument panel.
   d. Automatic Transfer Switch
   e. Accessories: Block heater, Generator strip heater, Over voltage protection, Weather housing, batteries and battery rack, automatic float charger, flexible exhaust connection and remote annunciator/controller.

9. Field Tests for the Engine-Generator Set:

   a. Test the engine generator set for eight hours of continuous operation as follows:
      i. First six hours while the set is delivering 100 percent of its specified KW rating.
ii. If during the 6-hour continuous test a failure occurs, either the engine shuts down or the full KW rating of the load bank is not achieved, the test is null and void. The test(s) shall be repeated until the satisfactory results are attained at no additional cost to the owner.

iii. Provide a portable load bank test for the generator.

b. Record the following test data at 30-minute intervals:
   i. Time of day, also reading of running time indicator.
   ii. KW.
   iii. Voltage of each phase.
   iv. Amperes on each phase.
   v. Engine RPM.
   vi. Frequency.
   vii. Engine water temperature.
   viii. Fuel pressure.
   ix. Oil pressure.
   x. Outdoor temperature.
   xi. Average ambient temperature in the vicinity of the engine.
   xii. Average ambient temperature in the vicinity of the engine.

c. Demonstrate that the generator set will attain proper voltage, frequency and will accept 100 percent block load within 10 seconds from a cold start after the closing of a single contact.

d. Demonstrate a functional performance test with a simulated loss of normal power to the building. The Engineer and commissioning agent shall witness test. (use the building load)

e. Demonstrate a functional performance test to the AHJ. (use the building load)

26 41 00 Facility Lightning Protection

1. Determine if Lightning Protection is recommended per NFPA 780, NFPA 70 and the Lightning Protection Institute requirements.

2. Vertical down conductors shall be installed in 1” PVC conduit within the concealed cavity of exterior walls.

3. All roof conductors shall be concealed or exposed based on the type of roof system on the building.

4. Connections of dissimilar metals shall be made with bimetallic type fittings to prevent electrolytic action.

5. Products:
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a. Lightning protection system materials and components shall be of types, sizes, ratings, for Class 1 service, which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation. Materials and all components shall comply with NFPA 780 and LPI standards.

b. All materials shall be copper or bronze of the size, weight and construction required suffering this application.

c. Copper equipment shall not be connected to aluminum surfaces except by means of on LPI approved bi-metal transition fitting. Lead-coated fittings are not acceptable.

d. Ground rods shall be the type specified in Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. All rods shall be accessible, and shall be provided with a waterproof tag labeled "LIGHTNING PROTECTION SYSTEM".

26 51 00 Interior Lighting

1. LED lighting products are preferred.

2. Incandescent and fluorescent lighting shall only be used upon receiving prior approval from CCU.

3. Lighting supply voltage shall be 277V when possible.

4. 'Automatic off' lighting controls shall comply with ASHRAE 90.1 and International Energy Conservation Code (IECC) requirements.

5. Energy efficient lighting shall be used to meet the requirements of ASHRAE 90.1 and the IECC.

6. Products:

   a. Linear LED lighting shall be provided with 0-10V or low voltage dimming ballasts. CRI shall be 80 minimum and color temperature shall be 4100K unless specified otherwise by CCU. Fluorescent lighting may be used in lieu of LED lighting under direction from CCU. If fluorescent lighting is deemed appropriate, linear fluorescent lighting shall utilize T8 and T8HO lamps with electronic instant start ballasts, programmed start for dimming ballasts. CRI shall be a minimum of 85 and color temperature shall be 4100K unless specified otherwise by CCU.

   b. 2x4 recessed LED/fluorescent ‘volumetric’ type fixtures similar to Lithonia’s Avante LED/Avante series are preferred.

   c. Recessed can lighting shall use LED lighting. CRI shall be 80 minimum and color temperature shall be 4100K unless specified otherwise by CCU. Fluorescent lighting may be used in lieu of LED lighting under direction from CCU.
If fluorescent lighting is deemed appropriate, recessed can lighting shall use compact fluorescent lighting with triple tube vertically mounted lamps with electronic instant start ballasts. CRI shall be a minimum of 85 and color temperature shall be 4100K unless specified otherwise by CCU. Recessed cans installed in hard ceilings without access next to the fixture are not preferred.

d. High/Low bay LED type fixtures are preferred for large areas with high ceilings such as gyms and weight/exercise rooms.

e. Building mounted wall packs shall be LED. Color temperature shall be decided based on architectural features and exterior finishes.

26 56 00 Exterior Lighting

1. LED lighting products are preferred. Color temperature, CRI, and distribution types shall be selected on a case by case basis.

2. Incandescent, fluorescent, and metal halide lighting shall only be used upon receiving prior approval from CCU.

3. Metal Halide source lamps are preferred in standard wattages of 70, 250 and 400 if prior approval is granted.

4. Lighting supply voltage shall be 277V when possible.

5. Automatic off controls shall comply with ASHRAE 90.1 and International Energy Conservation Code (IECC) requirements.

6. Energy efficient lighting shall be used to meet the requirements of ASHRAE 90.1 and the IECC.