

D50 Electrical - UniFormat to MasterFormat Conversion Chart

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D.50 GENERAL PROVISION

26 05 00 GENERAL REQUIREMENTS

A. General Definitions and Codes

1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. National Electrical Contractors Association (NECA)
4. National Electrical Manufacturers Association (NEMA)
5. National Fire Protection Association (NFPA 72)
6. American National Standards Institute (ANSI)
7. Insulated Cable Engineers Association (ICEA)
8. Institute of Electrical and Electronic Engineers (IEEE)
9. American Society for Testing and Material (ASTM)
10. Environmental Protection Agency (EPA)
11. Joint Industrial Council (JIC)
12. Illumination Engineering Society (IES)
13. Applicable Local Codes

14. Americans with Disabilities Act (ADA)
15. OFCI: Owner furnish, contractor install
16. OFCI: Owner furnish, owner install
17. NIC: Not in contract

B. Approved materials

1. Provide only new, standard, first-grade materials throughout, conforming to standards established by a nationally recognized testing laboratory., and so marked or labeled, together with manufacturer's brand or trademark. All like items and associated equipment shall be of one manufacturer.

C. Approved Manufacturers for Power Distribution Equipment

1. Square D
2. General Electric
3. Siemens
4. Eaton

D. Power System Study

1. Provide Short Circuit Study, Protective Devices Evaluation Study, Protective Device Coordination Study and Arc Flash Hazard Study from a Professional Engineer (registered in the state of Alabama) for all portions (new and existing) of the electrical power distribution system. Studies shall be performed with aid of a computer program (SKM, ETAP, EasyPower or equal) in accordance with all applicable studies, including latest editions of IEEE 1584 and NFPA 70E. Fault current values used in the study shall be actual fault current available, not based on infinite bus calculations. Breaker settings recommended by the final study shall be set in the field by the contractor prior to energization of equipment, and arc fault incident energy labels shall be applied to all electrical distribution equipment prior to final acceptance.

E. Modifications to Existing Buildings

1. When UAB Departments or engineering consultants specify electrical systems or equipment for a UAB Building, the Facilities Division should be consulted regarding the building's capacity and available electrical characteristics.
2. Where new circuit breakers are added to existing panelboards or switchboards, new breakers shall be by the same manufacturer and type as the existing equipment. New breakers shall have AIC rating equal to or greater than the existing equipment.
3. Modify existing panelboard bussing as required for new breakers. Ampacity of bussing shall not be less than existing.
4. Panelboard fronts shall be modified as required to accommodate the new breakers.
5. Where existing panelboard to be modified do not contain an equipment grounding bus, a new equipment grounding bus shall be installed.
6. All directory cards shall be retyped to indicate load served by each circuit.

7. The actual historic load of the building shall be reviewed in coordination with any renovations.

F. Electrical Demolition

1. Coordinate all utility shut downs with UAB Facilities prior to start of work.
2. All electrical conduit, wiring, devices, fixtures, etc. required to be removed to allow for new construction, abandoned as a result of new construction, or currently not in service shall be removed as part of renovation. Exposed conduits and conduits in accessible areas shall be removed completely; conduits concealed in floors, walls and above non-accessible ceilings may be capped and abandoned after removal of all conductors.
3. Existing floor outlets found to not be located to coordinate with new furniture and/or partition layouts shall be removed completely. All floor penetrations shall be sealed to maintain fire rating of the floor and to ensure structural integrity.
4. All active devices, wiring, and feeders shall remain in service.
5. All materials removed, unless otherwise specified, shall be removed from the site and disposed of by the contractor. Lighting fixtures, panelboards, and circuit breakers shall, at the Owner's option, be disposed of by the contractor or retained for spare parts by the Owner.
6. Materials to be retained by UAB shall be delivered to a designated facility.
7. All materials removed, unless otherwise specified, shall be removed from the site and disposed of in compliance with UAB's Construction Waste Management Standard.

G. Utility Coordination Above Ceiling

1. The Engineer shall coordinate with other design disciplines to ensure that electrical conduit, junction boxes, cable trays, cabling, etc. shall fit existing and new spaces with the following minimum clearances:
 - a. Horizontal distance between corridor wall and any above ceiling equipment or services: 18"
 - b. Vertical distance from top of ceiling to bottom of above ceiling equipment or services: 6"
2. The Engineer shall prepare Standard Above Ceiling Details to guide electrical contractor in the installation of electrical equipment for the different areas of the project, such as over corridors, over office areas, or over operating and procedure rooms in a hospital.
3. Contract Documents shall require shop drawings, including coordinating plans and sections, to allow verification that systems will be installed allowing clearances as defined above.
4. Recommended maintenance access shall be provided to all installed equipment or services such as air terminal boxes, controls, shut-off valves, pull boxes, junction boxes, air vents, and other such equipment.
5. Access shall be through the ceiling where possible, allowing service work from a standard ladder. If such access is in question, the engineer shall require access from some other

area. The Engineer shall require the Contractor to be able to demonstrate at time of 'above ceiling' and again at final inspection that acceptable and reasonable access has been provided. Such means of access shall be addressed on the design drawings.

6. Access panels shall be required at all equipment installed above hard ceilings, located for easy service access to the equipment. Panels shall be a minimum of 2' x 2' or larger if required for removal of the above ceiling equipment.
7. The Engineer shall perform a thorough above ceiling observation, verifying that service access is provided for all equipment and that required clearances are maintained. Any problems shall be corrected before the above ceiling work is accepted and ceiling installed.

H. Electrical Identification

1. All new and existing equipment modified shall include arc-flash warning labels in accordance with NEC article 110.16 and NFPA 70E.
2. All Panels, Motor Control Centers, Switchboards, Switchgear, Transformers, Etc.:
 - a. Engraved nameplates identifying name of equipment, nominal voltage and phase of the equipment and where the equipment is fed from shall be installed on front surface of all panels, motor control centers, switchboards, switchgear, transformers, etc.:
 - 1) Ex: First Line: "NAME: RP-A", Second Line: "120/208V-3Ø-4W", Third Line: "FED FROM: PP-A CIR. 4 (IN MAIN ELEC ROOM)"
3. Normal power nameplates shall be white with black lettering, and emergency power nameplates shall be red with white lettering.
4. All receptacles in laboratory spaces shall have engraved nameplates installed on the coverplate indicating panel and circuit number serving the device. All other receptacles shall have mechanically printed labels attached to the coverplate indicating the panel and circuit number serving the device.
5. All receptacles and switches on emergency power shall have engraved nameplates installed on the coverplate indicating panel and circuit number serving the device.
6. All junction boxes shall be labeled with panel and circuit numbers.

D.5010 FACILITY POWER GENERATION

26 32 13 EMERGENCY GENERATORS

- A. Generators shall be diesel or diesel/natural gas (dual-fueled) if approved.
- B. Approved Manufacturers for Emergency Generators
 1. Cummins/Onan
 2. Caterpillar
 3. Kohler

- C. For diesel generators, provide a sub-base or separate fuel tank for the generator set, sized to allow for full load operation of the generator set for 72 hours. Smaller sub-base tanks may be allowed for dual-fueled generators.
- D. Generator shall be 12-lead reconnectable type to provide the following voltage output configurations:
 - 1. 277/480V-3 Phase-4 Wire
 - 2. 120/208V-3 Phase-4 Wire
 - 3. 120/240V-3 Phase-4 Wire
 - 4. 120/240V-1 Phase-3 Wire
- E. Provide and install a 20-light LED type remote alarm annunciator with horn, located adjacent to fire alarm control panel/annunciator.
- F. Each generator set shall be furnished with a remote manual stop station of a type to prevent inadvertent or unintentional operation per NFPA 110 requirements. Where generator is located inside the building, the remote manual stop station shall be located outside of the generator room.
- G. Where installed outdoors, the generator set shall be provided with a weatherproof enclosure. Sound attenuated enclosures may be required for certain applications.
- H. Installation acceptance tests to be conducted on-site shall include the following (performed in accordance with NFPA 110):
 - 1. "Cold start" test.
 - 2. Four (4) hour full load test. Provide resistive load banks and make temporary connections as required.
 - 3. One step rated load pickup test.
 - 4. Power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

D.5020 ELECTRICAL SERVICE AND DISTRIBUTION

26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. General: Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation, #12 minimum except for controls and fixture wire. Conductors shall be copper.
- B. General Application (see below for exceptions):
 - 1. At or Below Grade (including within slab-on-grade):
 - a. #8 or larger conductors: XHHW or RHH/RHW/USE stranded.

- b. #10 or smaller conductors for circuits terminating at motors: THHN/THWN or XHHW stranded.
 - c. #10 or smaller conductors (excluding circuits terminating at motors): THHN/THWN or XHHW solid.
- 2. Above Grade:
 - a. #8 or larger conductors: THHN/THWN stranded.
 - b. #10 or smaller conductors for circuits terminating at motors: THHN/THWN stranded.
 - c. #10 or smaller conductors (excluding circuits terminating at motors): THHN/THWN solid.
- C. A color-coding system shall be followed throughout the network of branch power circuits, identifying unique colors for per the following convention:
 - 1. 120/208V-3P-4W Black, Red, Blue
 - 2. 277/480V-3P-4W Yellow, Orange, Brown
 - 3. 120/240V-3P-4W Black, Orange, Blue
- D. Except for certain renovations projects, type MC cabling is not permitted except for light fixture “whips” less than 6 feet in length.

26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- A. All equipment, building steel, and main service shall be effectively and permanently grounded with a conductor cross section as required by the National Electrical Code and of capacity sufficient to insure continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.
- B. All grounding and bonding connections below grade shall be made with a CADWELD type connection.
- C. All grounding connections shall be installed in accordance with the National Electrical Code (NEC) and all local codes and requirements. Such codes shall be considered minimum requirements, and the installation of the grounding system shall insure freedom from dangerous shock voltage exposure and provide a low impedance ground fault path to permit proper operation of overcurrent and ground fault protective devices.

26 05 29 HANGERS AND SUPPORTS

- A. General: This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate drilling into existing structure with existing structural conditions. Where required (ex. Post-tension construction), existing structure shall be x-rayed prior to drilling.
- D. Products: All hangers and supports shall be rated for the load they are intended to support and for the environment into which they are installed.
- E. Execution:
 - 1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems.
 - 2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70.
 - 3. Multiple Raceways or Cables supports shall be sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
- F. Concrete bases shall be sized not less than 4" larger in bother directions than the supported unit. All anchors shall be a minimum of 10 bolt diameters from edge of the base. All anchor bolts shall be installed in accordance with manufacturer's written instructions. Concrete shall be a minimum of 3000-psi (20.7-MPa), 28-day compressive-strength concrete.

26 05 33 RACEWAYS

- A. Raceway Type: Raceway types shall be as specified below, unless indicated otherwise on drawings:
 - 1. Exterior, Exposed: Rigid Galvanized Steel or I.M.C. (coated with two coats of asphaltum paint where below grade or within concrete). unless otherwise noted.
 - 2. Other Exterior (Concrete-Encased or Direct Earth Buried): Schedule 40 PVC. PVC conduit shall convert to metallic conduit (exact type as specified elsewhere within this section) prior to exiting concrete-encasement or direct earth burial.
 - 3. Interior, Exposed:
 - a. Hazardous Locations: Rigid Galvanized Steel.
 - b. Wet Locations (including, but not limited to, Pump Rooms, Wet Wells, Underground Vaults, and other similar locations): Rigid Galvanized Steel
 - c. Dry Locations Where Subject to Mechanical Damage (including, but not limited to, below 8'-0" A.F.F. in process, shop, storage, warehouse and other similar areas): Rigid Galvanized Steel or I.M.C..
 - d. Other Dry Locations: E.M.T.
 - 4. Interior, Concealed: E.M.T.
 - 4. Liquid tight flexible metal conduit shall be used for final connections to motors or other vibrating loads
- B. Installation

1. A standard nylon pull cord or wire shall be installed in all empty conduits.
2. Conduits shall be ¾" minimum.
3. Provide nylon bushings on the end of all conduits that terminate above ceiling.
4. All conduits shall be supported from the structure.

26 05 36 CABLE TRAYS

- A. Cable trays for low-voltage systems shall be wire-mesh construction.
- B. Cable trays for power systems shall be aluminum-ladder construction.
- C. Where barriers are provided, they shall be of the same material as the cable tray.
- D. All cable trays shall be supported per manufacturer's recommendations.
- E. All cable trays shall be installed in accessible locations.
- F. All cable trays shall be grounded and bonded in accordance with NEC.
- G. Include warning sign with Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel." Labeling shall be installed at 10 foot intervals.
- H. Seal all penetrations through fire barriers in accordance with a U.L. listed assembly. See Section 26 05 44.

26 05 44 SLEEVES AND SLEEVE SEALS

- A. All fire barrier penetrations shall be sealed in accordance with a U.L. listed assembly.
- B. All sleeve penetrations through non-rated walls shall comply with NECA 1.
- C. All cable tray penetrations through non-rated walls shall comply with NEMA VE 2.
- D. Sleeves through non-rated concrete or masonry walls shall be sealed around sleeve with mortar or grout.
- E. All sleeves shall be "de-burred" after installation. Nylon bushings shall be installed on all sleeves to protect cables.
- F. All empty conduits entering buildings from outside shall be sealed to prevent insect or rodent entry into building.

26 11 00 PRIMARY SUBSTATION CLASS TRANSFORMERS

- A. Transformers shall be designed to accommodate necessary load requirements of the project. Consult with UAB Facilities for additional spare capacity that may be required.

- B. The transformers shall be furnished with full capacity high-voltage taps (two - 2-1/2% taps above and below rated voltage). Primary voltage shall be coordinated with utility.
- C. The transformers shall have a 55°/65°C average winding temperature rise rating.
- D. Where unit substation secondary distribution is provided transformer secondary shall be close coupled to a Switchboard (UL 891) insulated fixed mounted breaker that is housed in a NEMA 3R enclosure. Breaker compartment shall include control power transformer (CPT) that is used to feed a strip heater in the enclosure and the transformer's temperature indicator. Both shall be pre-wired to the CPT.
- E. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Code Section 450-23, including a minimum fire point of 300°C. The fluid shall be biodegradable, non-toxic, and non-bio-accumulating. It shall be Factory Mutual approved and UL classified FR3 fluid or approved substitute.
- F. All transformer oil must be bulk tested for polychlorinated biphenyl's (PCB's) per ASTM 04059 and certified, upon request, as having no detectable level of PCB.
- G. The tank shall be complete with a stainless-steel laser engraved nameplate. This nameplate shall meet ANSI C57.12.00 for Nameplate B.
- H. The following accessories shall be provided:
 - 1. De-energized tap changer.
 - 2. 1.0" upper fill plug with filter press connection.
 - 3. 1.0" drain/sampling valve.
 - 4. Automatic pressure relief valve.
 - 5. Welded cover with bolted manhole.
 - 6. Lifting lugs (4).
 - 7. Liquid level gauge.
 - 8. Dial type thermometer.
 - 9. Pressure/vacuum gauge.
 - 10. SS ground pads (3).
 - 11. Bleeder valve.
 - 12. Nitrogen blanket with bleeder and purge valve.
 - 13. Touch-up paint.
- I. The transformer shall receive at the factory those tests identified in ANSI Standard C57.12.00-1980, Section 8, as "Routine Tests". The transformer shall be fully assembled, including all permanent radiators and bushings during test.
- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

- K. A factory- authorized service representative shall supervise the field assembly and connection of components, and the retesting and adjustment of transformer components and accessories. Service representative shall demonstrate transformers and accessories and train Owner's staff.
- L. After completing installation and cleaning, touch up scratches and mars on finish to match original finish.

26 12 00 MEDIUM-VOLTAGE SWITCHGEAR

- A. Surge arresters shall be provided for all feeders into or out of buildings or structures.
- B. All medium-voltage switchgear shall have bus arrangement adhesively applied to the enclosure of the switchgear. Animated mimic bus shall be provided to give visual indication of the position of each switch.
- C. Means shall be provided to prevent single-phase conditions.
- D. Switchgear shall be compartmentalized into the following minimum compartments:
 - 1. Main bus compartment
 - 2. Switch compartment
 - 3. Cable connection/fuse compartment
 - 4. Mechanism compartment
- E. Pad-lock provisions shall be provided on covers for the following:
 - 1. Load interrupter switches
 - 2. Grounding switch mechanisms
 - 3. Other operable devices
- F. Live phase indicators and IR viewports with covers for inspection shall be provided.

26 22 00 LOW-VOLTAGE & DRY TYPE TRANSFORMERS

- A. Transformers shall be ventilated with insulation to withstand a minimum of 150 degree Celsius temperature rise.
- B. Transformers shall be copper windings only.
- C. Transformers shall comply with the latest edition of NEMA standard TP-1 and shall be labeled for the EPA Energy Star Program.
- D. Enclosures:
 - 1. Transformers mounted in dry, interior locations shall be furnished with NEMA 1 enclosures unless shown otherwise.
 - 2. Transformers mounted outdoors or in wet locations shall be furnished with NEMA 3R enclosures with drip shields unless shown otherwise.

- E. A minimum clearance of six inches shall be provided around all transformer ventilation openings.
- F. Transformers shall be isolated from structure with neoprene vibration isolation pads
- G. Transformers shall be installed on four-inch-thick concrete pads with beveled edges.

26 24 13 SWITCHBOARDS

- A. Switchboards shall be located indoors.
- B. Provide surge suppression on all switchboards with a disconnecting means to allow replacement of surge suppression without shutting down switchboard.
- C. Switchboard bussing shall be silver-plated copper.
- D. Breakers shall be LSI or LSIG electronic trip.
- E. Provide metering at each switchboard main to monitor and display current, voltage, power, and energy.
- F. Switchboards shall be installed on four-inch-thick concrete housekeeping pads with beveled edges.
- G. Switchboards shall be fully-rated for the available fault current.
- H. Switchboard sections shall be fully-bussed to accommodate future breakers for the full height available.

26 24 16 PANELBOARDS – LIGHTING AND RECEPTACLE

- A. Panelboards shall be dead front type.
- B. All panelboards shall have copper bussing.
- C. A metal framed circuit directory card holder with clear plastic covering shall be factory-mounted on the inside of door.
- D. Provide hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim.
- E. Each section of multi-section panelboards shall be of matching heights and depths.
- F. Panelboards installed in exterior or wet locations shall have NEMA 3R enclosures.
- G. For all flush-mounted panelboards, a minimum of three (3) one-inch empty conduits shall be stubbed out above the nearest accessible ceiling space for future use.
- H. All panels shall have surge suppression devices with disconnecting means.

- I. All panels shall be fully-rated for the available fault current.
- J. All panels shall have bolt-on breakers with fully-bussed space.
- K. Provide a minimum of 10% spare breakers and 10% available spaces when project is complete.

26 24 18 PANELBOARDS – DISTRIBUTION

- A. Panelboards shall be dead front type
- B. All panelboards shall have copper bussing.
- C. All neutral busses shall be full size. All panelboards shall contain ground buss.
- D. Front of enclosure shall be attached to cabinets with hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim.
- E. Panelboards installed in exterior or wet locations shall have NEMA 3R enclosures.
- F. Each section of multi-section panelboards shall be of matching heights and depths.
- G. All panels shall have surge suppression devices with disconnecting means.
- H. All panels shall be fully-rated for the available fault current.
- I. All panels shall have bolt-on breakers with fully-bussed space.
- J. Provide a minimum of 10% spare breakers and 10% available spaces when project is complete.

26 24 19 MOTOR CONTROL CENTERS

- A. Additions to existing MCCs shall be the same as the original manufacturer.
- B. All bussing and connectors shall be tin-plated copper.
- C. Combination Starters
 - 1. Nema motor starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay. Solid state overload relay shall have switch-selectable trip class and shall provide protection from:
 - a. Overload.
 - b. Phase Unbalance.
 - c. Phase Loss.
 - d. Ground Fault (Class II detection).
 - 5. All starters shall be NEMA-rated starters.
- D. Terminal Blocks

1. Wiring within all units shall be type B, with unit-mounted control terminal blocks for each field wire.
 2. Terminal blocks shall be the pull-apart type 600 volt and rated at 25 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
- E. Control Devices
1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
 2. All pilot lights to be cluster LED type & push to test.
 3. All control wiring shall be labeled at each termination.
- F. Motor control centers shall be installed on four-inch-thick painted concrete housekeeping pads with beveled edges.

26 25 13 BUSWAYS

- A. Bus housing shall be steel or aluminum.
- B. The busway shall be non-ventilated outdoors and indoors. Housing and accessory flanges, terminal enclosures, etc., shall be primed and painted construction. All outdoor hardware exposed to the weather shall be stainless steel. Indoor hardware (unless in corrosive environment) shall be manufacturer's standard.
- C. All indoor busway shall be rated IP-54 (minimum).
- D. Outdoor, totally enclosed, non-ventilated housings shall be fitted with screened-breathers and space heaters in sufficient quantity and rating to minimize condensation. Space heaters shall be completely factory wired except shipping split connection.
- E. All housing and flange gasketing shall be EPDM or other noncorrosive material, and shall be completely concealed for protection against deterioration.
- F. The temperature rise at any point on the housing shall not exceed 30° C above an ambient temperature of 40° C.
- G. A fire-resistant divider or barrier shall be provided at all points where the bus duct extends through building walls.
- H. Bus duct should be at least splash proof. IP rating, minimum IP65.
- I. Where bus duct penetrates floors, bus duct shall be protected from spills by use of floor dams.

- J. An internal ground bus shall be furnished which will electrically connect together all equipment connected to the bus duct.
- K. All busway shall be supported in accordance with manufacturer recommendations.
- L. Busway connections shall be accessible for maintenance.
- M. Bus plugs shall be fusible-switch type and installed in readily-accessible locations.

26 27 13 ELECTRICITY METERING

- A. Electrical components, devices, and accessories for metering shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Coordinate with utility companies and components they furnish as required for installation of utility services and electricity-metering components.
- C. Installation shall comply with NECA 1.
- D. Metering shall be provided to comply with ASHRAE 90.1 where required by Alabama Building Commission.

26 29 23 VARIABLE FREQUENCY DRIVES

- A. Approved Manufacturers
 - 1. Variable Frequency Drives – approved manufacturers with acceptable Pulse Width Modulation (PWM) type drives are:
 - a. Danfoss-Graham
 - b. Square-D
 - c. Yaskawa-Manetec
 - d. ABB
 - e. Approved alternate
- B. General
 - 1. Variable frequency drives (VFD's) shall be CSA certified and comply with the latest applicable standards of IEEE, and NEMA. As a minimum the full load output of the drive shall be one size up from the design motor HP as listed in NEC. The drive and all accessories or options shall be listed by either Underwriters Laboratory (UL) or Electrical Testing Laboratory (ETL), and equipment and installation shall comply with the National Electric Code.
 - 2. Variable frequency drives shall be heavy duty type.
 - 3. Variable frequency drives shall be provided with a 3-year warranty from the date of start-up. The 3-year warranty period will be a total of the standard warranty plus

- extended warranty. Contractor shall coordinate with the drive supplier as necessary to allow drive to be installed, started and in service within 60 days of the date the order for the drive is placed. The required in service date shall be as dictated by the UAB Project Manager. The warranty shall include all costs of on-site labor, parts, materials, and travel.
4. Variable frequency drives shall be provided for all centrifugal fans five horsepower and above, except for those systems that are constant volume by design, such as toilet exhausts that do not vary in volume or static pressure. Systems that vary in air quality by design, such as variable air volume distribution, or systems that have medium or high efficiency filters that change static pressure as they load, shall be provided with drives.
 5. In all cases, application of drives should be discussed with the UAB Resident Mechanical Engineer prior to use.
 6. The drive shall consist of a diode bridge rectifier, filter network, a fixed Direct Current (DC) voltage link and a transistorized inverter output section. Input power factor shall be no less than 0.95 under all conditions. The output shall be sine-weighted pulse-width modulated waveform. The rectifier section shall consist of 12 diodes (i.e. a 12-pulse drive) in order to reduce the undesired effects of the 5th and 7th harmonics. The VFD and motor shall be, in general, purchased as a package unit.
 7. Input line reactors shall be 3% minimum.
 8. The following features shall be provided with the drive: NEMA rated contactors, motor overload relay, emergency shutdown of the drive which will immediately disconnect the motor, automatic restart upon return of power following outage. Drive shall be programmable for automatic reset for under voltage, over voltage, current limit, inverter overload, and motor overload.
 9. The drive shall withstand without failure or need for fuse replacement any of the following: output short circuit; ground fault or open circuit; input under voltage; loss of phase; transients caused by switching; DC over voltage; over-temperature; instantaneous overload or sustained overload up to 150% for up to sixty seconds or 110% continuous.
 10. An incoming line reactor shall be installed in order to filter the resulting waveform and attenuate electrical noise and transients associated with the system, thereby extending the service life of the VFD as well as the motor.
 11. It is preferable for drive parameters to be field adjustable without the need for proprietary programming tools, cables, or external interfaces. If such proprietary items are required, the contractor shall provide them with the drive and provide training in their use.
 12. The drive shall provide a three-phase voltage with varying frequency output. The voltage/hertz pattern shall be selectable to that best suited to the motor. The drive shall automatically adjust this relationship during operation for the maximum operating efficiency according to speed and load.
 13. Input and/or output control circuits shall be electrically isolated by use of optical isolators to prevent unwanted ground loops or feedback from other electronic control equipment. A built-in RS-485 port fully equipped for serial communication shall be specified. Input and/or output control signals will be the type described in UAB Facilities Standard No. 15951, Type I Controls.

14. The following features shall be provided: Acceleration and deceleration time adjustment from 1-3600 seconds; front of panel hand/off/auto switch with manual frequency control for hand; dry contact closure output signal for paralleling of other equipment; ramp to start and ramp to stop by external dry contact closure; frequency indication (Hertz preferably) on front of panel; operating pilot light and drive fault light on front of panel; emergency stop provided by external contact closure. Provide elementary or schematic wiring diagram showing only the interface wiring terminations.
15. The drive shall include a bypass circuit so that when activated, it will bypass the Variable Frequency Drive (VFD) and electrically isolate the VFD for removal and/or repair while allowing the system to operate in bypass mode, and vice versa, without being exposed to line voltage. The bypass circuit will include overload protection. Indicator lights, which show if the unit is in bypass mode, are required on the front of the drive panel. Bypass arrangement for 50 HP and larger shall be provided with soft-starter in series with the bypass contactor, and with electronic overload protection in bypass and VFD modes. Bypass arrangement for motors smaller than 50 HP shall be provided with across the line contactor.
16. Soft-starters shall be heavy-duty type and shall be one size up from the design motor HP as listed in NEC.
17. In order to reduce repair part stock, the control and operational circuits for the drive will be interchangeable between different size drives from five to one hundred horsepower.
18. Motors used in variable speed installation shall be rated for inverter duty, and so marked on the nameplate.
19. The Contractor shall provide UAB Maintenance and UAB Energy Management a copy of all available operation and maintenance manuals and wiring diagrams published for the VFD. A permanent laminated document shall be attached to the drive with all user configurable settings that are required to be input at initial start-up.

C. Execution

1. Careful attention shall be given to the placement of the fan static pressure sensor and pump differential sensor, which controls the variable frequency drive output. The Engineer shall closely coordinate with the Test and Balance Contractor and specify the location of the sensors to allow the best possible energy savings.
2. Checks shall be made to assure that the VFD installation does not cause voltage reflection, harmful harmonics, or electrical interference. Filters shall be installed if recommended by the manufacturer to prevent such electrical interference.
3. Carefully evaluate situations where distance from VFD to motor is greater than 100 feet.

26 36 23 AUTOMATIC TRANSFER SWITCHES

A. Approved Manufacturers for Automatic Transfer Switches

1. Caterpillar
2. Kohler
3. ASCO
4. Eaton

- B. The transfer switch and its upstream protection shall be coordinated per NEC requirements.
- C. Transfer switches shall be double-throw, electrically and mechanically interlocked.
- D. In some cases, bypass isolation or closed-transition transfer switches may be required.
- E. All contactors in packaged units shall be NEMA-rated.
- F. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be permanently labeled for switch and control functions.
- G. Digital display metering panel shall be provided to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor.
- H. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
- I. Transfer switch enclosures shall be NEMA 1 for dry locations and NEMA 3R for outdoor or wet locations.
- J. Research Buildings should employ closed-transition transfer switches with bypass isolation.
- K. Transfer switches shall include at least three (3) configurable dry contacts to interface with BAS.
- L. Transfer switches shall include pre-transfer dry contacts with adjustable time delay up to 60 seconds to interface with elevator controls on transfer both normal-to-emergency and emergency-to-normal.

D.5040 LIGHTING AND LIGHTING CONTROLS

26 51 00 LIGHTING AND LIGHTING CONTROLS

- A. All lighting shall be LED with manufacturer provided 5-year warranty and adhere to LM-79 and LM-80 lighting standards.
- B. All drivers shall be located in an accessible location.
- C. All fixtures shall be individually fused.
- D. All fixtures shall have a pull-apart power-disconnecting device.
- E. All lighting levels shall meet IES standards.

- F. Provide lighting calculations for all areas for review by University.
- G. All luminaires shall be provided with 5-year warranty from the manufacturer. Warranty period shall start at date of Substantial Completion.
- H. All light fixtures shall be purchased from a local manufacturer representative and local distributor located within fifty (50) miles of the project site.
- I. Interior Lighting
1. All light fixtures shall be supported independently from the structure.
 2. All interior light fixture color temperatures shall be 4000k unless specific project requirements require otherwise.
 3. LED fixture shall comply with UL 1598, IES LM-79 and IES LM-80.
 4. Provide the following attic stock complete with packaging for storage and labels describing package contents:
 - a. Plastic diffusers and lenses: One for every 100 of each type and rating installed (minimum 1).
 - b. Emergency Battery Pack: One for every 20 of each type and rating installed (minimum 1).
 - c. Globes and Guards: One for every 20 of each type and rating installed (minimum 1).
 - d. Drivers: One for every 30 of each type and rating installed (minimum 1).
- J. Exterior Lighting
1. All projects shall comply with UAB Public Realm Guidelines. Questions should be routed (via Project Manager) to the appropriate UAB Facilities Planning, Design and Construction Team U Member.
 2. All exterior light poles shall be grounded with a grounding electrode at each pole.
 3. All exterior light poles shall have an in-line water resistant fuse holder/fuses in hand hole at each pole.
 4. All exterior light fixture color temperatures shall be 4000k unless specific project requirements require otherwise.
 5. Poles shall be rated for pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M. Basic wind speed for calculating wind load for poles is 100 mph (45 m/s) with 1.3 gust factor.
 6. Poles shall be rated for a minimum design life of 50 years.
 7. Poles shall be provided with a 3-year warranty from the manufacturer. Warranty period shall start at date of Substantial Completion.
 8. LED fixtures shall be rated for wet locations and tested according to NEMA LE 5B.
 9. All bollard-type light fixtures must be reviewed and receive the expressed approval (via Project Manager) from the appropriate UAB Facilities Planning, Design and Construction Team U Member.
 10. Provide the following attic stock complete with packaging for storage and labels describing package contents:

- a. Glass and Plastic Lenses: one for every 100 of each type and rating installed (minimum 1).
- b. Globes and Guards: One for every 20 installed of each type and rating (minimum 1).
- c. Drivers: One for every 30 of each type and rating installed (minimum 1).
- d. Banner Arms: One set for every 10 poles (minimum 1)

K. Lighting Controls

- 1. All lighting controls shall comply with the current State of Alabama Energy Code requirements.
- 2. All lighting controls shall be commissioned by a Manufacturer’s Representative prior to Substantial Completion.
- 3. Occupancy sensor types shall be as follows:
 - a. Classrooms, Conference Rooms, Offices, etc. – dual technology
 - b. Restrooms – ultrasonic
 - c. Janitor’s closets and small storage rooms – passive infrared
- 4. Approved manufacturers for lighting controls are as follows:
 - a. Acuity
 - b. Lutron
 - c. Leviton

D.5030 GENERAL PURPOSE ELECTRICAL POWER

26 05 34 OUTLET BOXES, JUNCTION BOXES & WIREWAYS

- A. All boxes and wireways shall be of sufficient size to provide free space for all enclosed conductors per NEC requirements. Fill calculations shall be performed by contractor per NEC requirements.
- B. Outlet Boxes & Junction Boxes (through 4-11/16”)
 - 1. Sheet metal boxes shall be used on concealed work in ceiling or walls and exposed work in dry, interior locations. Cast boxes shall be used on exterior or any work exposed to moisture, fumes or gases.
- C. Junction & Pull Boxes (larger than 4-11/16”)
 - 1. For all below grade exterior use and elsewhere as shown:
 - a. In areas subject to future vehicular traffic: shall be galvanized cast iron (rated AASHTO H-20 Loading unless noted otherwise).
 - b. In areas not subject to vehicular traffic: shall be galvanized cast iron or pre-cast polymer concrete (rated for Tier 15 Loading unless noted otherwise).

2. All boxes installed exposed in exterior or wet areas shall be powder-coated galvanized steel (NEMA 3R).
3. All boxes installed exposed in corrosive areas shall be stainless steel (NEMA 4X).

D. Wiring Devices

1. Switches and general receptacles shall be commercial specification-grade and rated for 20A (minimum). Receptacles in hospital areas (except business areas) shall be hospital-grade.
2. Coverplates shall be stainless steel.

**See Also: D5020: 26 05 29 HANGERS AND SUPPORTS
26 05 44 CABLE TRAYS
26 05 44 SLEEVES & SLEEVE SEALS**

26 28 16 ENCLOSED SAFETY SWITCHES AND CIRCUIT BREAKERS

- A. Safety switches shall be quick-make, quick-break, NEMA heavy duty type HD.
- B. Switch blades shall be fully visible in the off position.
- C. Switch and circuit breaker enclosures shall be rated NEMA I indoors in dry locations and NEMA 3R outdoors and in wet areas.
- D. Provide not less than one spare set of fuses for each size used. Provide an additional spare set for each five sets of same size fuses used.
- E. All switches and circuit breakers shall be fully-rated for the available fault current.

D.5080 MISCELLANEOUS ELECTRICAL SYSTEMS

26 05 13 MEDIUM VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Conductors shall have current carrying capacities per N.E.C. with ratings for 6,000 Volt to 15,000 insulation.
- A. Conductors shall be Class B stranded annealed copper.
- B. 15KV cable shall be single conductor ethylene propylene rubber insulation (EPR) insulated, shielded power cable for use in ungrounded neutral circuits (133% insulation level) at conductor temperatures of 90 degrees C for continuous normal operation.
- C. Splicing connectors and splice kits shall comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

- D. All conduits shall be cleaned of foreign matter prior to installation of cable and close attention shall be paid to ensure that the cable is not damaged during installation. Pulling eyes shall be used on all cable installations to avoid insulation damage by pulling tensions.
- E. After the cable installation is complete and all splices and terminations are made, cable shall be DC proof tested at a test voltage of 55 KV for a period of 15 minutes. Leakage currents shall be recorded after 15, 20, 45, 60 second and at one-minute intervals thereafter.

26 41 13 LIGHTNING PROTECTION SYSTEM

- A. Lightning Protection Systems shall comply with the latest edition of the following codes and standards:
 - 4. U.L. Standard 96A.
 - 5. Lightning Protection Institute - Installation Code LPI-175.
 - 6. N.F.P.A. 780.
- B. System design shall be concealed wherever practical, with roof perimeter cables concealed in parapet walls, and mid-roof cables installed under roof slabs. Exposed cable on parapet walls will only be accepted if structural details preclude cable concealment
- C. Surge protection devices shall be provided on the power, telecommunications and other conductive electrical services at the points of entrance into the building(s) as required by UL96A in order to obtain the UL Master Label Certificate of Inspection.
- D. The manufacturer's local representative shall be a Certified Master Installer/Designer under the LPI program, and shall provide direct jobsite technical supervision to Contractor's personnel during installation to insure compliance with all Code requirements. Upon job completion, Contractors shall furnish Owners with written certification on UL Master Label "C", that system is installed in compliance with above Standards.
- E. Revisions to an existing lightning protection system shall be re-certified and an new UL Master Label "C" supplied.

28 05 28 PATHWAYS FOR ELECTRONIC SAFETY & SECURITY

- A. Pathways shall be sized as follows:
 - 1. 1/2-inch (16-mm) trade size (minimum) for copper cables
 - 2. 1-inch (27-mm) trade size (minimum) for optical-fiber cables.
- B. All pathways shall be installed concealed except where specifically approved otherwise.
- C. All pathways shall be at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Horizontal pathways shall be installed above water and steam piping.

- D. Pathways shall have no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Conduits shall be supported within 12 inches (300 mm) of changes in direction.
- E. All empty pathways shall have pull wires installed. Pull wires shall be polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength.
- F. Expansion fittings shall be installed at all locations where conduits cross building or structure expansion joints.
- G. Where boxes are required on opposite sides of walls, these boxes shall be separated so that they are not in the same vertical channel.

**See Also: D5020: 26 05 29 HANGERS AND SUPPORTS
26 05 44 CABLE TRAYS
26 05 44 SLEEVES & SLEEVE SEALS**

28 31 11 DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

A. Qualifications

1. Fire alarm system installer shall have the following minimum qualifications:
 - a. Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
 - b. Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
 - c. Installer shall be licensed as a certified fire alarm contractor by the State Fire Marshal's Office in accordance with Alabama Act 2009-657.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.
3. The fire alarm system shall be furnished by one of the following manufacturers:
 - a. Notifier.
 - b. Siemens Industry, Inc.; Fire Safety Division.
 - c. SimplexGrinnell LP/Johnson Controls.
 - d. Edwards.

B. Fire Alarm Control Panel

1. Fire alarm control panel shall have field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

2. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
3. Include a real-time clock for time annotation of events on the event recorder and printer.
4. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
5. The FACP shall be listed for connection to a central-station signaling system service.
6. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
7. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
8. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70. Provide integration gateway using UAB Network Protocol for connection to building automation system.
9. Primary power shall originate from an emergency power source where emergency power is available.
10. Fire alarm control panels shall be marked with a red engraved nameplate with white letters indicating panel and circuit number serving the control panel.
11. Batteries shall be vented, wet-cell pocket, plate nickel cadmium.
12. Fire alarm sequence-of-operation shall be approved by UAB Facilities.

C. Devices

1. Smoke detectors shall be photoelectric.
2. Heat detectors shall be 190 deg F (88 deg C) unless specific project requirements require otherwise.
3. Notification devices shall be placed in accordance with NFPA 72 requirements.
4. Where speakers are provided for voice notification, speakers shall be located to provide the intelligibility per the requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
5. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
6. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72. F.
7. Where devices are required to be surface-mounted, a surface mount box furnished by the fire alarm vendor matching the device type shall be utilized. Fire alarm devices mounted to standard electrical boxes are not acceptable.

D. Installation

1. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
2. Devices placed in service before all other trades have completed cleanup shall be replaced.
3. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
4. All fire alarm cabling shall be installed in conduit.
5. Pathways shall be concealed wherever possible.
6. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
7. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.
8. Exposed EMT shall be painted red enamel.

E. Field Quality Control

1. Field tests shall be witnessed by authorities having jurisdiction.
2. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections for all test listed in this section.
3. Conduct visual inspection prior to testing.
4. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
5. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
6. "Initial/Reacceptance" column and list only the installed components.
7. Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
8. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
9. Test visible appliances for the public operating mode according to manufacturer's written instructions.
10. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
11. Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
12. Fire-alarm system will be considered defective if it does not pass tests and inspections.
13. Prepare test and inspection reports.

14. Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
15. One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.
16. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

F. Maintenance Service

1. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
2. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
4. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

G. Warranty

1. Five years from date of Substantial Completion.

H. Closeout Submittals

1. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
2. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
4. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
5. Riser diagram.
6. Device addresses.
7. Record copy of site-specific software.
8. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
9. Equipment tested.
10. Frequency of testing of installed components.
11. Frequency of inspection of installed components.

12. Requirements and recommendations related to results of maintenance.
13. Manufacturer's user training manuals.
14. Manufacturer's required maintenance related to system warranty requirements.
15. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

Revision Request Form - Electrical Construction Standards

Date: _____

Requestor: _____

Department/Consultant: _____

Project Number & Name: _____

EXISTING ELECTRICAL STANDARD

Section Number & Name: _____

Section Revision Number: _____ Section Paragraph: _____

(ENTER CURENT SECTION LANGUAGE BELOW)

REQUESTED REVISION REQUEST

(ENTER REVISION SECTION LANGUAGE BELOW)- **Identify if request will be permanent to standards or for the referenced project.**

JUSTIFICATION FOR REVISION

FOR UNIVERSITY OF ALABAMA AT BIRMINGHAM USE ONLY

UAB Staff Requestor: _____

Authorized UAB Approval Personnel : _____ Date: _____

Status: ____ Rejected ____ Accepted

____ Revise and Resubmit (see attachment)