26 00 00. ELECTRICAL

26 00 03. GENERAL PROVISIONS

.1 QUALIFICATIONS OF CABLE SPLICERS: Specifications shall contain a statement that lead cable splicers must be certified by the Electric Utilities Division, Facilities Operations and Development upon request of the University before cable splicing operations are begun. A sample splice, either part of the project or simply a sample must be made to determine eligibility for approval. The contractor shall provide the material for the sample splice.

.2 INFORMATION FOR DESIGN OF SYSTEM: During the initial planning conference, consult the University and Facilities Design and Construction, regarding the choice of primary service voltage to be used, its location, and the capacity available. Refer to Division 33 00 03.3.1 for requirements that the Associate's Electrical Consultant shall follow.

.2.1 EQUIPMENT AND INSTALLATION GUIDELINES:

.2.1.1 An important aspect of Power System Design and Installation involves consideration of service reliability of the proposed system and loads that are to be supplied. System Installation inspection and Service reliability will be performed by the Contractor in the presence of the University Representative(s), Facilities Operations and Development, Electrical Utilities Shop when and if the Systems are to be connected to University Electrical Power Systems. The System shall not be energized if these requirements are not met or it fails Final Inspection.

.2.1.2 Contractor(s) and Associate Engineer(s) are responsible for addressing all the Design review comments to the satisfaction of the university in order to assure the continued reliability of the University Power Distribution System.

.2.2 SAFETY

.2.2.1 The incorrect application of Electricity and unsafe installation can cause both minor and serious accidents. The Designer must remain vigilant to Electrical hazards and take appropriate steps in meeting all safety rules and regulations in Electrical Power and Installation Distribution Design. It is important that the Design meet requirements of the following codes and regulations; NEC, NFPA, OSHA, and National Electrical Safety Code. It is also important that all the Equipment, Devices and Installations supplied and installed in all University's Facilities meet high level of Safety Requirements, and the OSU Building Design Standards. It shall also be known that the equipment, devices, and installation that fail to meet these requirements will not be accepted.

.3 OVER CURRENT PROTECTION COORDINATION: For any building with an electrical service larger than 1,200 amperes, an analysis of the coordination of over current protection shall be shown on the drawings.

.3.1 The coordination study shall show the system by elementary diagram and indicate Arc Flash Coordination Study, Load Flow the available fault current at critical points in the distribution system and the selection of over current devices

26 00 03. GENERAL PROVISIONS (Cont'd)

for time and interrupting capacity coordination. This study shall be part of design services.

.4 COORDINATION OF HARDWARE: All electric panel doors shall be equipped with Best Access Systems cylinders with removable 7-pin cores. Refer to Division 08 for further details.

.5 Equipment belonging to other University Departments shall not be installed in or stored in Facilities Operations and Development mechanical or electrical rooms, unless permission is given by Facilities Operations and Development in writing.

.6 Building electrical power shall be from the OSU power system, if available.

.7 PROHIBITED MATERIALS AND CONSTRUCTION PRACTICES:

.7.1 Door Closers: Refer to paragraph 08 70 20.5 regarding the prohibition against door closers with integral smoke detectors.

.7.2 Extra-flexible non-labeled conduit:

.7.3 Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors and for ground wires in any location. The transition from PVC to steel shall be made below the floor.

.7.4 Steel conduit shall not be used outside unless in concrete. Use aluminum conduit outside and wet locations above grade.

.7.5 Aluminum wiring shall not be used.

.7.5.1 Use of aluminum plated bus and aluminum wound transformers is prohibited in all OSU projects.

.7.6 Use of Incompatible Materials: Aluminum fittings and boxes shall not be used with steel conduit. All materials in a raceway system shall be compatible.

.7.7 Power actuated anchors or plug anchorage using wood, lead, or plastic.

.7.8 Multi-use Suspension Systems: Piggyback suspension systems for conduits, fixtures, etc. are prohibited. All suspensions must be hung independently from structure, or, in limited cases, from trapeze suspension systems.

.7.9 Use of wire ties to support conduit.

.7.10 Use of wood strips and wood screws to support lighting fixtures.

.7.11 Use of Class J fuses.

.7.12 Direct burial electrical cable.

.7.13 Electrical ducts crossing above gas piping.

.7.14 Ducts within 10 feet of a buried steam line in any direction. If it becomes necessary to cross a steam line, acceptable insulation of the crossing must be approved by the Electric Utilities Division, Facilities Operations and Development.

26 00 03. GENERAL PROVISIONS (Cont'd)

.7.15 Hard insulated wire connectors, which have Bakelite or Ceramic insulation, are prohibited.

.7.16 Dimmable lighting unless permission is obtained in writing from the University Architect. See 26 58 00.3.

.7.17 Armored or Metallic cable (BX, MC, AC, etc.)

.7.18 Nonmetallic sheathed cable.

.7.19 Flat conductor cable type FCC, under carpet, etc.

.7.20 Fluorescent fixtures using other than 4-foot tubes are discouraged. Where 2' x 2' fixtures are needed, use 2' long fluorescent tubes. Fluorescent U tubes are prohibited.

.7.21 Setscrew type connectors and couplings.

.7.22 Locating the following equipment less than three feet from a wall: electrical equipment that permits or requires rear cooling, rear access for maintenance or cleaning, or rear connection.

.7.23 Bottom fed switches, breakers or fuses.

.7.24 Switches in which the blades pivot on the top.

.7.25 Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.

.7.26 Do not use compact fluorescent lamps or T5 fluorescent lamps and fixtures as the main source of illumination in any area. The use of compact fluorescent lamps or T5 fluorescent lamps shall be limited to highlighting. Note: Highlighting is a wall or artwork not task or a walkway. T5 Fluorescent lamps have no standard socket, hence can not be purchased from the open market. It is not cost effective for maintenance.

.7.27 Use of cable tray with primary conductors.

.7.28 Time clock controls used on exterior or security lighting.

.7.29 Use of busway other than as permitted in Section 26 05 35.11.

.7.30 Use of busway for panel risers.

.7.31 Drilling, tapping of existing bussing in panelboards, switchboards, and motor control center.

.7.32 Troffers: Use of radiant ceiling panels.

.7.33 Lamps not Manufacturered by GE, Phillips, and Sylvannia.

.7.34 Lamps provided by only one Manufacturer.

.7.35 Fixtures that require proprietory lamps.

26 00 00. ELECTRICAL (Cont'd)

26 00 03. GENERAL PROVISIONS (Cont'd)

.8 SPECIAL REQUIREMENTS FOR MANHOLES OR VAULTS

.8.1 Manholes shall not be installed inside buildings.

.8.2 If there are existing manholes (MH) or vaults inside buildings undergoing major renovation that can not be moved or relocated, then provision must be made for access by *a live truck, known as the High Voltage Truck*, for emergency pair, maintenance, and cable termination or replacement.

.8.3 Tapping existing switchgear, switchboards, panelboards, and motor control centers to provide power for new feeders or equipment is prohibited in all University facilities.

26 05 05. ELECTRICAL MATERIALS AND METHODS:

.1 UL LISTED EQUIPMENT AND MATERIALS: Specify only Underwriter's Laboratories listed equipment, assemblies, and materials when such items are available. The equipment and materials shall be installed in accordance with its listing.

26 05 15. WIRE AND CABLE

.1 MATERIAL: Copper conductors of 98 percent conductivity shall be used unless use is restricted by Government Agencies.

.1.1 4,160-volt cables shall be UL listed. 1/c, copper, mil Ethylene propylene rubber insulated, 5Kv, 133% rated, shielded, MV 105 degrees C. Extension or modification of existing 4160 volt cables can only be done with prior written approval of the Facilities Operations and Development Electric Utilities Shop.

.2 SECONDARY CONDUCTORS:

.2.1 COLOR CODING

Color-coding for 480/277V and 208Y/120V shall be as follows:

Phase	Voltage - 208Y/120	Voltage - 480Y/277
Neutral	White/Gray	White or Gray (each with identifiable colored stripe)
A	Black	Yellow
B	Red	Orange
C	Blue	Brown
Equipment Ground	Green	Green w/ Yellow stripe

.2.2 Solid and Stranded Wire: No. 12 AWG and smaller may be solid. No. 10 and larger shall be stranded.

.2.3 Minimum size for lighting and power branch circuits: No. 12 AWG.

.2.3.1 Use No. 14 AWG stranded for control wiring and auxiliary system circuits.

.2.4 Field wired incandescent fixtures shall be wired with Type SF 150-degrees C 300-volt wire.

26 05 05. ELECTRICAL MATERIALS AND METHODS: (Cont'd)

26 05 15. WIRE AND CABLE (Cont'd)

.2.5 Field installed cords to portable equipment shall be type ST or G and Field installed cords for normal Equipment shall be type SRDT containing an identified equipment.

.2.6 Circuit wiring through ballast channels of fluorescent fixtures shall be 600-volt 90-degrees C insulation. Fixture must be approved for through wiring, if thus used.

.2.7 General use insulation: NEC, 600-volt type THHN/THWN or XHHW.

.2.8 Connections in No. 10 and smaller wire shall be made with threaded-on plastic or nylon insulated wire nuts. Crimp connectors, except butt connectors, are prohibited. Joints in No. 8 and larger conductors shall be made with pressure type mechanical connectors insulated with plastic electrical tape.

26 05 17. WIRING DEVICES

.1 DESIGN: All wiring devices provided shall be specification grade. New building devices will be ivory with stainless steel plates for standard and ground fault interrupter use. Isolated ground devices shall be orange with stainless steel coverplates. Existing building designers shall match existing color scheme that is prevalent throughout building.

.1.1 Placement of Receptacles:

.1.1.1 In standard size classrooms (49 students or less) provide a double duplex receptacle at the front of the classroom centered under the chalkboard. Provide two additional receptacles at the front of the room spaced half way between corners and double duplex receptacles. Back of rooms to be provided with single duplex receptacle at center of wall. Remaining walls to be provided with two duplex receptacles on each wall equally spaced.

.1.1.2 Classrooms (50 students +) Provide two duplex receptacles for the front wall, centered between the corners and double duplex receptacle at the center of the wall. Provide two duplex receptacles equally spaced on all remaining walls.

.1.1.3 Corridors shall be provided with duplex receptacles 35’ on center and a maximum of 15’ from end of corridor. These receptacles shall have separate circuits from the room circuits.

.1.1.4 Lecture halls shall be provided with a double duplex receptacle centered on front wall and two additional double duplex receptacles equally spaced between center double duplex and corners. Provide duplex receptacle in floor for podium. Provide additional receptacles throughout for cleaning. These receptacles shall be a maximum of 25’ on center. If lecture hall is provided with a lab bench, than provide bench with double duplex for every eight-foot of bench.

.1.1.5 Computer Labs shall be provided with at least two general-purpose receptacles equally spaced per wall in addition to all receptacles for computers.

26 05 05. ELECTRICAL MATERIALS AND METHODS: (Cont'd)

26 05 17. WIRING DEVICES (Cont'd)

.1.1.6 Mechanical room shall be provided with at least four duplex receptacles (one per wall) and additional duplex receptacle where walls are 25' or longer.

.1.2 Switches

.1.2.1 Switches provided for all uses shall be specification grade. Color scheme shall match receptacles.

.1.2.2 Switches provided at roof hatches or where provided outside of rooms they are serving shall be provided with pilot lights.

.1.3 Coverplates

.1.3.1 Generally coverplates for flush-mounted standard devices shall be stainless steel for interior use in new buildings. Where work is being performed in existing buildings coverplates shall match the majority of the existing devices.

.1.3.2 Coverplates for exterior use shall be type, which allow NEMA 3R rating to remain while in use. Where exterior device could be exposed to vandalism, provide locking type coverplates.

26 05 29. HANGERS AND SUPPORTS

.1 MATERIALS FOR STRAPS AND HANGERS: Heavy-duty malleable iron or steel. For installation in locations above grade that are subject to moisture penetration, specify corrosion-resisting steel. Perforated straps are not acceptable.

.2 INDEPENDENT SUPPORT SYSTEMS: Required for all installations, except that light weight incandescent fixtures on, or recessed into, suspended ceilings may have adjustable bar strap supports carried on the ceiling suspension system.

.2.1 Surface outlet boxes, to which fixtures are attached, and pull boxes, shall be fastened to the structure independent of the conduit system supports.

.2.2 Conduits above suspended ceiling shall be attached to the structure and shall not be supported by a ceiling suspension system.

.3 COORDINATION WITH GENERAL CONSTRUCTION: The Associate shall include the following (or similar) statements in specifications for suspended lay-in ceilings:

.3.1 Surface mounted fluorescent lighting fixtures shall be supported from the structure above independent of any ceiling system by use of 3/8 inch all thread rods.

.3.2 Flush or recessed fixtures in ceilings of the suspended lay-in type shall be installed so that the long dimension of the fixture is supported on the main support member of the ceiling system. Provide at least two galvanized steel safety hangar wires or safety chains, attached from the fixture housing to the structure independent of the ceiling system. Wire or chain shall withstand a 3-foot, 50-pound drop test. In addition the Luminaire Support Requirements of NEC shall be strictly followed.

26 05 05. ELECTRICAL MATERIALS AND METHODS: (Cont'd)

26 05 33. RACEWAYS:

26 05 33.10 INTERIOR CONDUIT AND FITTINGS: Minimum conduit size for power circuits shall be 3/4-inch. Minimum conduit sized for control wiring shall be 1/2 inch.

.1 RIGID GALVANIZED THREADED UL LABELED CONDUIT shall be specified for use in exterior walls, outdoors, for indoors exposed (surface) applications from floor level to 8-feet above floor, seal penetrations, and all the areas having potential to corrode or eat away by chemical-action (corrosive atmosphere) and hazardous locations.

.1.1 Threaded couplings shall be used with rigid conduit and I.M.C.

.1.2 I.M.C. may be used in place of rigid galvanized where permitted by code.

.2 UL LABELED, GALVANIZED STEEL EMT (up to the 2 inch size) may be used in interior partitions, above ceilings, and for surface application higher than 8-feet above floor, except in corrosive and hazardous locations, where fiberglass conduit is required to be used.

.2.1 Insulating bushings and insulated throat fittings shall be used throughout EMT installations.

.2.2 Compression fittings shall be used. Setscrew type fittings shall not be used outdoors or indoors.

.3 PLASTIC JACKETED RIGID STEEL CONDUIT shall be used in corrosive atmosphere.

.4 FLEXIBLE CONDUIT used for motor make up and lighting fixture connections. Minimum size: 1/2-inch for lighting fixture whips and ¾" for motor connections; maximum length: 6 feet 0 inches. Flexible conduit of any type shall not be used in interior partitions or in walls as a substitute for EMT, IMC or rigid steel conduit. A ground wire shall be pulled in all flexible conduit.

.4.1 Plastic jacket shall be used on flexible conduit exposed to outdoor or moist locations.

.4.2 Liquid-tight flexible metal conduit shall be used in raised floor computer room applications.

.5 RIGID ALUMINUM CONDUIT shall be used outdoors**,** above grade, in damp locations and may be used in other locations in place of rigid steel conduit where corrosion is not a problem.

.6 Conduit installed through a building wall shall have internal and external seals. Specify link seal or equivalent.

.7 Elbows used for medium voltage cable shall be long radius rigid steel or if above grade, outside, rigid aluminum.

.8 GROUNDING: Conduit crossing building expansion joints shall have expansion provision with grounding continuity.

26 05 05. ELECTRICAL MATERIALS AND METHODS: (Cont'd)

26 05 33.11 BUSWAYS:

.1 The Associate shall not use Feeder Busways in lieu of conduit and wire except for short distances inside substation room. Maximum length shall be 10 feet.

.2 PLUG-IN BUS shall be used in shops where the load density provides an economic advantage over panels and shall not extend into more than one space. Plug-in bus shall be copper. Busway shall be used to serve one room or usable space. It is prohibited for busway to penetrate a fire rated wall**.**

.3 INDOOR BUSWAY (if used) shall be water resistant per ANSI/IEEE Standard 141-1986.

.4 If use of busway is approved by special permission for a project, Contractor shall provide 50 feet of spare busway and 10% of total switches used. It includes when busway is installed in shop areas or specially approved conditions.

26 05 33.12 SURFACE RACEWAYS

.1 The Associate shall specify Surface Raceway / Metallic Raceway with associated coupling, boxes and fitting to be mounted to the surface of structure for the installation of Electrical Conductors. It shall be used in the following locations:

.1.1 In dry locations.
.1.2 In Class I, Division 2 Hazardous (Classified) locations and as permitted by National Electric Code (NEC).

.2 FITTINGS AND BOXES

.2.1 Raceway shall have manufacturer's finish standard prime coating suitable for field painting.

.2.2 Surface Non-Metallic Raceway. Non-metallic surface raceway shall be of two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.

.2.3 Surface Non-Metallic Raceway shall be used in dry locations, extensions through walls, and shall be permitted to pass through drywall partitions and dry walls only if the length going or passing through is not broken. It is required that access to the conductors shall be maintained on both sides of the walls, partition and floor.

.2.3.1 The surface non-metallic raceway shall not be used where concealed, except as permitted by NEC. The use shall be limited to Class 2 power limited applications and communication.

.2.4 The acceptable manufacturers for surface raceways shall include:
A. Mono-Systems, Inc.
B. The Wire Mold Co.
C. Square D Co.

26 05 33.13 UTILITY TUNNEL CONDUIT AND FITTINGS

.1 INSTALLATION REQUIREMENT for corrosive and external heat generating environment.

26 05 33.13 UTILITY TUNNEL CONDUIT AND FITTINGS (Cont'd)

The conduit must be suitable for the best protection from corrosion in the most demanding environments such as utility tunnels, under bridges, chemical, utility plants, underground pipeline, laboratories, electrical substations, and parking lots.

The conduits and the fittings must meet the requirements of UL 1684 that covers conduit type AG for use above ground and/or below ground, and type BG for use below ground applications. The University requires that the Manufacturer supply a letter from UL, not a "Certificate of Compliance," for the product to be approved for use in University facilities.

.1.1 The preferred conduit and fittings shall be fiberglass reinforced epoxy manufactured using the filament process. The optional conduit shall be PVC coated rigid conduit that provides maximum protection against corrosion where fiberglass conduit usage is extremely difficult.

.1.2 FIBERGLASS CONDUIT AND FITTINGS

The fiberglass conduit shall be available in diameters ¾" to 6" and shall be UL listed for use above ground and underground.

The resin system shall be epoxy based using a hydride curing agent. The permitted fiberglass shall possess continuous E-glass roving. All additives for increasing flame spread and lowering smoke density must be halogen free (i.e. must not contain chloride or bromine).

The permitted type shall use carbon black as ultra violet inhibitor to protect the conduit and fittings during storage and if or when it is exposed outside.

.1.3 FITTINGS AND ACCESSORIES

All fittings, elbows, and accessories shall be manufactured from the same process, using the same methods and chemicals as the pipe. The exceptions are plastic duct plugs and access fittings (often referred to as nondalet fittings). Access fittings shall be made from fire retardant vinylester materials, halogen free, must be hot compression molded and shall have couplings attached to the body of the access fittings.

.1.4 OPTIONAL PVC COATED RIGID METAL CONDUIT

The PVC coated conduit must be UL listed. The permitted PVC coating must have been tested and approved by UL as providing the primary corrosion protection for the rigid metal conduit.

Applicable UL Standards may include: UL 6 Standard for safety, Rigid Metal Conduit, UL 514B Standard for Safety; Fittings for conduit and outlet boxes.

26 05 45. UNDERGROUND RACEWAYS:

.1 GENERAL REQUIREMENTS: All underground cables of any classification shall be installed in raceway systems. All the raceways for Medium/High voltage shall be 5" in size and all others for street lighting, and other applications shall be sized in accordance with the projected electrical load growth in the vicinity. The conduit requirements for utility tunnels and under bridges are detailed in Section 26 05 35.13 of this standard.

26 10 00. SECONDARY/LOW VOLTAGE ELECTRICAL DISTRIBUTION

.1 MAGNETIC INTERFERENCE AND MITIGATION

Magnetic Interference can pose major problems in the Design and Operation of Electrical and Electronic Equipment, Instruments, Control Systems, Data processing equipment and communication networks. This equipment frequently indicates aberrations whose sources may not be readily recognized, but which are due to magnetic interference. In general, such interference is classified as internal and external.

A. Internal Interference, created by Operation of Components within the system itself, can usually be eliminated or nullified by shielding the individual components and confirming the magnetic force they create.

B. External Interference is frequently caused by nearby or adjacent equipment such as transformers, medium voltage busway, or switching equipment, which generate magnetic “spikes” affecting apparatus which is not physically attached to the source of interference.

.1.1 Special Protective and Preventive materials: In addition to developing a basic protection design in preventing the penetration of magnetic interference, when it is required by this Standard to Design and specify EMF Mitigation Plans or Strategies that will prevent and solve the Magnetic Interference problems as described in Section 26 10 00.1. The expectation of this Standard is to reduce EMF to below one (1) milligauss, even in the most complex Field Environment.

.1.2 SPECIAL EMF SHIELDING MATERIAL: There are two means of EMF Shielding that may be used to achieve effective prevention of Magnetic Interference or Eliminate the existing problems (See Section 26 10 00.1.1 and 26 10 00.1.3).

In fields of low intensity, use CO-NETIC AA perfection sheet because of its high initial permeability and corresponding high attenuation characteristics. In fields with high intensity, use NETIC S3-6 sheet because of its high magnetic saturation characteristics. CO-NETIC AA Perfection Annealed Sheet are available in standard gauge .014” through .062” thick, in flat sheet sizes up to 30”x59” or Full Sheet of .015” thick and 36” by 120”.

Installation: For wall or floor coverings designer shall specify that sheets shall be butted at seams, all seams flush and tight.

Fasteners: NETIC/CO-NETIC AA Sheets shall be mounted to walls by non-magnetic fasteners to penetrate the shielding sheets. Hole in the NETIC/CO-NETIC AA alloy sheets for fasteners shall be drilled with standard metal drills (Cobalt Steel Drill Bits). Special fastening application (masonry, concrete, etc.) shall be consistent with EMF shield manufacturer’s recommended attachment procedures and OSU Building Design Standards requirements.

Seams: All seams between sheets to be covered by CO-NETIC AA foil, 0.01 inches thick, by 4 inches wide, with factory supplied PST backing. Apply foil centered over the sheet seams and press down tightly.

Finishing: The CO-NETIC AA metal has a natural shiny, silver colored finish and will not rust. Gypsum Wallboard (drywall) or approved other materials shall be applied over the CO-NETIC AA sheets after seams are covered. No magnetic fasteners are to penetrate the CO-NETIC AA sheets.

.1.3 OPTIONAL SHIELD MATERIAL: The use of ferrous metal sheet for EMF shielding has been one method the University utilized for correcting EMF problems. But it has unavoidable installation difficulties for inexperienced installers. The sheet metal sheet is too heavy, requires accurate overlapping to achieve minimum EMF reduction, but it is very effective, if correctly installed.

Installation: All Medium voltage transformers and switch gear including motor control centers that are adjacent to or under offices, computer centers/rooms or locations that will have the use of Sensitive Electronic Equipment (SEE) shall be shielded with ferro-magnetic material.

Use of minimum 10 gauge ferrous steel sheet metal on the side(s) of walls where said offices or rooms are situated, to prevent moving charges that produce Electric Magnetic Field (EMF) penetration that in turn destroys or distorts sensitive electronic equipment.

In order to have an effective shielding, the 10 gauge sheet metal shielding shall be overlapped at a minimum of 4 inches at every joint.

.1.4 Associate Engineer(s) shall contact the University Engineer's Office for details, if there should be any questions.

.2 TRANSFORMERS - UNDER 600 VOLTS

.2.1 General-purpose distributing transformers shall be single-phase and three-phase dry-type which are generally used with primaries connected to secondary distribution circuits. They shall be designed for the voltages of 120, 208, 240, 480, and 600 with ratings ranging from 500VA to 500KVA and frequency of 60Hz.

.2.2 The transformers shall be designed for continuous operation at the rated KVA for 24 hours a day, 365 days a year operation with a nominal life expectancy and greater overload capabilities in accordance with the latest ANSI-C57. The temperature rise of these transformers shall be 80 degrees C temperature rise and shall be insulated with a UL recognized 220 degree C insulation system. Transformers shall have k factor rating as recommended by ANSI/IEEE C57.110-1986, where required (i.e. computer center, lab, etc.). It shall have a 30 percent overload capability.

.2.3 The transformers shall be designed for a low coil watt loss.

.2.4 Coil and Core Assemblies

.2.4.1 Transformer cores shall be constructed with high grade, non-aging, grain-oriented silicon steel with high magnetic permeability, low hysteresis and eddy current losses.

.2.4.2 Transformer coils shall be wound of electrical grade copper and continuous wound construction. The neutral conductor shall be rated to carry 200% normal phase current, when required.

.2.4.3 Enclosure shall be ventilated, heavy gauge sheet steel, primed and finished in gray baked enamel. The core and coil assembly of the transformers shall be impregnated with non-hygroscopic, thermosetting

varnish and cure to minimize hot spots and seal out moisture. The core of the transformer shall be grounded to the enclosure.

.2.4.4 The sound levels of the transformer shall be designed in accordance with ANSI/NEMA recommended levels.

.2.4.5 Provide minimum clear working space of 3 ½ feet (3 ½') about transformers operating at 600 volts, nominal, or less to permit ready and safe operation adjustment, repair and maintenance.

.2.5 Transformers greater than 25 KVA shall not be mounted on or near the wall adjacent to an office, computer room or laboratory unless the wall is magnetically shielded.

26 20 00. LOW-VOLTAGE ELECTRICAL TRANSMISSION

.1 EMERGENCY SERVICE: Refer to Section 26 30 10.

26 20 03. LOW-VOLTAGE SWITCHGEAR – SERVICE ENTRANCE

.1 PROTECTIVE DEVICES: Main breakers and feeder breakers or switches shall be equipped with ground fault protection as required by applicable codes. In critical applications provide coordinated ground fault protection on feeder breakers. Provide settings and coordination information with the service manuals.

.1.1 All circuit breakers with solid state trip units shall comply with the following standards:

.1.1.1 ANSI/IEEE C37.90.1 – Surge Withstand Capability (SWC)

.1.1.2 ANSI/IEEE C37.90.2 – Withstand Capability of relay systems to Radiated Electromagnetic Interference from transceivers.

.2 The maximum operating force required to open or close a switch or breaker shall not be greater than 75 pounds on the operating handle.

.3 Vacuum breakers or vacuum switches may be used with the approval of the University Engineer's Office.

.3.1 All switches shall be top or horizontal fed to the breakers.

.4 Indicator lamps shall be LED or transformer type utilizing low voltage lamps.

26 20 04. METERING

.1 METERING SYSTEM: A meter with system display is required for each building, transformer, or service. Approved and acceptable meters and Manufacturers for OSU facilities are:

Cutler-Hammer shall be **IQ-200** with base and display modules.
Power Measurement Ltd. shall be **6200 ION** or **6200 ION-RMD** with enhanced package #1, RS-485, and 480 volt power supply, if required.
Square D shall be **PM-620** with **PMD 32** display.
Each individual KWA meter specified must have communications and impulse capability.

26 20 04. METERING (Cont'd)

If complete meter setup cannot be done from the front panel, any required software, cables, and keys shall be provided to the Facilities Operations and Development Electric Utilities Shop.

The height shall be five feet (5.0") from the finished floor or 4 ½ feet from the switch pad to the center of the meter.

Provide four current transformers and circuit monitor that indicate true RMS current for phase and neutral.

The monitor shall provide the following information:

Voltage - phase to neutral and phase-to-phase ABC
Amps - present reading and 15 minute maximum demand ABCN
Kilowatt-hours
Kilowatt maximum demand based on 15 minute intervals
Power Factor, Kilo VAR, Kilo VAR Hour KVA

.2 A 6-pole GE PK-2 panel-mounted test plug installed flush on switchgear for portable test metering by University Maintenance Personnel. Specify that three left poles be factory-wired to the phase-current transformer secondaries; wire the right hand pole No. 6 to the phase to neutral potential source. Current transformer poles shall have shorting auxiliary contacts.

.2.1 If the meter used for KWHR reading does not have a meter serial number on the front of the display, then an engraved name plate shall be installed below the meter with the meter serial number engraved on it.

.2.2 Avoid metering schemes that are only capable of measuring partial loads connected to the distribution system or electrical apparatus being monitored. Specify that a meter shall be installed to measure electrical load from the distribution system including fire pumps.

26 20 05. SERVICE DISCONNECT:

.1 Secondary main disconnects shall be equipped with electronic trip devices.

.1.1 The analysis diagram fault currents shall be shown on a symmetrical basis; and for calculation purposes, the transformer primary available fault supply shall be considered as unlimited.

.2 FUSES may be used in primary-voltage services, secondary-voltage main switchgear, distribution panelboards, and motor controls.

.2.1 UL classification fuses shall be used as required for time delay and current limitation requirements of the application.

.2.2 Class J fuse is prohibited. Use class RK1 or RK5, 200,000 AIC rated fuses for up to 600 amp applications and RK1 for maximum short circuit protection.

.2.3 Fuses for secondary service mains and feeders over 600-ampere shall be UL Class L.

26 20 05. SERVICE DISCONNECT: (Cont'd)

.2.4 Spare Fuses: Specify that a spare fuse complement be stored on existing metal shelves, metal mounting boards, or in a cabinet in the electrical switchgear room and that a typewritten and framed bill of material be mounted nearby. (There shall be no combustibles stored or kept near transformers.) If there is no existing storage or additional storage space is required, specify that Contractor provide a cabinet equal to Bussman SFC and provide a lock to accept BEST interchangeable cores.

.2.4.1 Spare fuse complement shall include a minimum of three or 10% of the total each (whichever number is greater) spare fuses of each class, ampere, and voltage rating installed, including primary fuses and control circuit fuses in switchgear and any equipment.

26 20 06. GROUNDING SYSTEM:

.1 DRAWINGS AND SPECIFICATIONS: Drawings shall show ground systems, protective conduit sizes, and relative locations. Specifications and drawings shall include detailed requirements of the grounding system. **A reference only to the National Electrical Code, without elaboration, has proven to be insufficient. Specifying requirements only by referencing the code is prohibited. It is required that the Associate shall specify all requirements applicable, instead of referring only to National Electrical Code.** All sensitive electronic equipment (computer rooms, etc.) shall have single point grounding system.

All connections to the grounding system shall be clamped, exothermic welded, cad weld or equivalent. It is required that the grounding system be tested and have a resistance reading of less than 3 ohms at the ground level. Only copper to copper may be clamped. The Associate shall calculate the system required to obtain 3 ohms. The contractor shall only be required to install the indicated system.

.2 SERVICE GROUND: Grounding rods shall be a minimum size of 5/8" x 10' copper clad steel and shall not be placed in back-fill. It shall meet current NEC requirements and other applicable codes.

.2.1 Interconnection of the service ground, system neutral, and equipment ground conductors shall be made within the service equipment.

.2.2 Grounding path through feeder conduits must be kept at less than five ohms resistance. The entire feeder conduit shall include a grounding conductor. The equipment enclosure (transformer case, etc.) shall not be used as a grounding path.

.2.3 Grounding conductors shall be 600-volt insulated installed in rigid PVC or rigid galvanized conduit. No metal parts such, as locknuts shall surround the ground conductor. If metal is used, protective conduits for ground conductors shall be bonded at both ends to reduce impedance in the ground path under fault current flow. All conduit connections shall be threaded and then welded.

.2.4 LIGHTNING PROTECTION: It is well documented that insulation levels of overhead lines is considerably higher than insulation levels of terminal apparatus including transformers, switchgears, pothead, etc. which make up or comprise the service entrance to buildings. Such overhead lines (University overhead lines at Airport, West & Midwest, and Regional Campuses) are vulnerable to over voltage, mostly from direct or indirect lightning voltages and switching surges. It is a

fundamental characteristic of the traveling voltage waves to increase in voltage when they arrive at equipment having a surge impedance higher than that of incoming line and the magnitude of such incoming waves will approximately double at breaker. Therefore, this standard requires that all equipment connected by cable to overhead circuits shall have lightning/surge arrester protection at each end of the cable to guard against the possibility of transient over voltages. It is of great importance that protection against direct strokes is provided at outdoor substation installations in the form of grounded **masts** or overhead ground wires stretched above the installation to intercept lightning strokes, which might otherwise terminate on the lines or apparatus. It is also required that entrance equipment such as transformers, circuit breakers, etc be protected against direct stroke from traveling waves by installing lightning arresters that possess protective characteristics below the impulse insulation strength of the terminal apparatus.

.2.4.1 This standard requires that lightning/surge arresters be installed as close as possible to the HV/MV terminals of the Power Transformer and all other equipment requiring surge protection be grouped as close as possible to the arresters. Use the station type arrester for the best protective level and highest surge discharge ability for important and critical installations. But the intermediate class type arrester shall be used for less critical installations and mostly for feeder protection (See Section 26 13 00.5.1 for the type.)

.2.4.2 PROTECTION OF POWER STATIONS AND SUBSTATIONS: The Protection of Power Stations (OSU Electric Stations) and Substations (McCracken Electric Substations) shall include the protection of station equipment by means of surge arresters of the type described in Para. .2.4.1 of this section. These arresters should be mounted on, or closely connected to, the frames of the principal equipment which is being protected, especially transformers. It is also permissible to mount them on the steel frame work of the station or substation where all components are closely interconnected by means of grounding grid.

.2.4.3 This standard requires the following additional protective measures:

A. Substation grounding network resistance shall not exceed 5 Ohms (5Ω). Lower values are preferred.

B. Ground Conductors: The surge arrester grounding conductor shall be connected into the common station ground bus. The grounding conductor shall be run as directly as possible between the arresters and ground and be of low impedance and ample current carrying capacity. (See Section 26 20 06.2.4). These requirements must comply with National Electrical Code. (ANSI/NEMA 81-1990 (19, Article 190-193)).

C. Indoor locations: Arresters that are installed inside the buildings shall be enclosed or shall be located well away from passageways and combustible parts.

D. Installation: This standard requires that arresters must be located and installed in such a manner that the expulsion of gales or the arrester disconnect is not directed upon energized parts.

E. All protective lightning rods used for building or facility protection must have a Master Label pasted on them.

26 20 00. LOW-VOLTAGE ELECTRICAL TRANSMISSION: (Cont'd)

26 20 06. GROUNDING SYSTEM: (Cont'd)

.3 TRANSFORMER GROUNDS:

.3.1 Building Service Transformers: Secondary neutrals shall be grounded separately from the neutral ground at the service main, unless close coupled in unit substation construction.

.3.2 Low Voltage Transformers: Secondary neutrals shall be grounded in the low-voltage service equipment, as required by NEC for services.

.4 EQUIPMENT GROUNDS: A wire equipment ground shall be installed within the branch circuit conduit and be grounded to the cabinet of the panelboard to an uninsulated ground bus. The neutral bar of the panel shall not be used for equipment grounds.

.4.1 Equipment grounds and the identified neutral shall not be electrically interconnected on the building side of the service ground.

.5 CONVENIENCE OUTLETS: Specify that a wired ground be provided for continuity of ground path from the device-grounding pole. Provide ground fault interrupter outlets in wet conditions and where required by NEC and other related codes.

.6 EXTERIOR LIGHTING POLE: For steel-framed structure, explore a concrete-encased reinforcing bar electrode. A steel rod similar to the reinforcing bar shall be used to join, by welding, a main vertical reinforcing bar to an anchor bolt. The bolt shall be permanently connected to the base plate of the steel column supported on that footing. The Electrical System may then be connected for grounding to the building frame by welding or by a bronze bolt tapped into a structural member of that frame. For Electrical Systems grounding, specify that ground rod or ground copper wire be provided for equipment grounding at each light fixture. All underground PVC conduits to the light poles shall contain a dedicated ground copper wire in combination with equipment grounding. It shall be designed to provide a safe method of protecting electric distribution systems by causing the overcurrent or ground fault protective equipment to disconnect the circuit in case of ground fault.

26 27 00. LOW-VOLTAGE DISTRIBUTION EQUIPMENT

26 27 03. DISTRIBUTION:

.1 DESIGN: If feasible, the secondary main breaker shall be made a part of the building distribution switchgear or switchboard. In no case shall the switchgear or switchboard or panelboard be directly attached to the transformer. A minimum 12-inch space with solid barrier is required to reduce the transfer of transformer heat to the low voltage section. Reduction of heat transfer may be accomplished with secondary throat or ventilated transition section.

.1.1 Tiebreakers, if used, shall be key interlocked with the main secondary disconnecting means requiring the spare key to parallel sections.

.2 EQUIPMENT: Metal-Enclosed switchgear or distribution boards shall be used in buildings or University Facilities at 600V and below for Service Entrance Power, lighting distribution and as the secondary sections of Unit Substations. The following components shall be specified as required:

A. Service Protectors
B. Model-Case circuit breakers, group, or individual mounted.

26 27 03. DISTRIBUTION: (Cont'd)

C. Fusible switches
D. Motor Starters
E. Low Voltage AC Power circuit breaker (generally limited to main or tie position)
F. Bolted contact pressure switches
G. Transfer devices or switches
H. Instrumentation, metering and relaying

.2.1 Type of Molded Case Circuit Breakers: These devices are available in the following general types: Thermal-Magnetic Dash Pot, Magnetic only, Integrally Fused, Current Limiting, and High Interrupting Capacity. It is required that all circuit breakers that are equipped with solid state trip unit must comply with Section 26 20 03.1 of this Standard.

.2.1.1 Air circuit breakers shall be draw out type, installed in individual compartments.

A. Interrupting ratings of air circuit breakers and molded case breakers shall not be applied in "cascade".

.2.2 The handle operating force on all equipment shall be 75 pounds or less.

.3 PROVISIONS FOR ADDITIONAL CIRCUITS:

.3.1 Size of Switchgear or switchboard: Select a size that will provide sufficient spare spaces, complete with bus and hardware, for a reasonable forecast of future installation of circuits. A minimum of one fully bussed spare section shall be provided. Provide the following spare switches at the design stage:

four 30 amp/ 3 poles
four 60 amp /3 poles
two 100 amp / 3 poles
one 200 amp /3 poles

.3.2 Additional Section: Provide space and the bus arrangement for the addition of future switchgear or switchboard sections.

.4 INSTRUMENTATION shall be per section 26 20 04. metering.

.5 SERVICE TO FIRE PUMPS: Fire pumps shall be served and protected as required in NFPA No. 20.

.6 Use switchboard instead of panelboard for emergency systems for the purpose of future growth and expansion. The switchboard shall be equipped with metering systems as required in Section 26 20 04. of this Standard.

.7 When adding switches, circuit breakers, bus plugs or motor starters to existing equipment, the Associate shall include the following on his/her design documents:

.7.1 The manufacturers' nameplate data including manufacturer and catalog information of the existing equipment.

.7.2 If the equipment is no longer manufacturered (i.e., Continental, Arrow Hart, Crouse Hinds, etc.) the Associate will contact a company that specializes in obsolete equipment and obtain the bidding information.

26 27 04. FEEDER CIRCUITS:

.1 SYSTEM DESIGN: Design feeders for a voltage drop of not more than 2 percent between terminals and capacity for 30 percent load growth above initial design, unless greater growth is designated by the University in the initial planning conference.

.2 FEEDERS: Feeder ratings shall not be such a large percentage of the main that coordination of time and current and interrupting capacities cannot be achieved.

.3 WIRING: Specify that all feeders be installed in full-weight rigid conduit.

26 27 05. GENERAL PURPOSE POWER AND LIGHTING CIRCUITS: Voltage drop in branch circuits must be considered in design. Increase conductors a minimum of one size when 120 volt branch circuit home runs exceed 75-feet.

.1 LIGHTING CIRCUITS shall not be loaded to exceed 60 percent of panel breaker rating.

.2 SERVICE CIRCUITS: Not more than six unassigned general use duplex convenience outlets shall be on any one 20-ampere branch circuit.

.3 BRANCH CIRCUIT PANELS: Panels for lighting, convenience outlets, small motors, and equipment shall be molded case circuit breaker type with thermal-magnetic trip and a-c and d-c ratings. Maximum number of poles in any panel shall not exceed 42. Provide for spare circuits.

.3.1 Breakers shall be 20-ampere, 1-pole breakers, mounted in the panel with bolted bus connections.

.3.1.1 Trip rating of breakers for lighting and general use convenience outlets shall be 20-ampere. Provide other sizes as required for special loads.

.3.2 Sub-Feed Breakers: Panels shall not have sub-feed breakers. If multiple panels are supplied from a long feeder, use sub-feed lugs or separate splice box with full size tap to panel mains.

.3.3 When installing new branch circuit lighting panels on a project the following shall be considered:

.3.3.1 All new panels shall be 42 pole minimum. Designers shall provide each new panel with a minimum of 15% spare 20 amp single pole circuit breakers and 15% spaces. Designers shall consider an additional panel when these minimums cannot be met.

.3.3.2 New panels shall be 200 Amp minimum for 208Y/120 volt, 3 phase, 4 wire service and 100 Amp minimum for 480/277 volt, 3 phase, 4 wire service. Do not provide 240/120 volt, 3 phase, 4 wire tapped delta systems. Where 240 volts is required consider use of buck/boost transformers.

.3.3.3 Any new or existing building with three-phase service shall only have three phase panels provided. All exceptions must be approved by the University Engineer’s Office.

26 27 05. GENERAL PURPOSE POWER AND LIGHTING CIRCUITS: (Cont'd)

.3.3.4 Do not provide panel feeders, fusing, or main circuit breakers at less than the panel main device rating.

.4 POWER PANELS shall be equipped with molded-case circuit breakers of adequate interrupting capacity, or shall be switch and fuse construction using time-delay fuses.

26 29 00. LOW VOLTAGE CONTROLLERS

26 29 03. MOTORS AND MOTOR CONTROLS:

.1 RELATED WORK: Air-conditioning chiller starters and fire pump controllers shall be specified with the equipment in Divisions 23 and 21. Wiring from switchgear or switchboard to this equipment shall be specified in Division 26.

.2 NEMA AND NEC REQUIREMENTS:

.2.1 MOTORS AND MOTOR CONTROL EQUIPMENT shall conform to NEMA voltage ratings.

.2.2 MOTOR BRANCH CIRCUIT PROTECTIVE DEVICES shall meet the requirements of NEC 430.

.3 MOTOR CONTROL CENTERS: Class I, Type C with terminal strip terminations.

.3.1 LOCATIONS: Centers shall not be located where ambient temperature could cause de-rating of overload devices.

.3.2 OVERLOAD HEATER CHARTS shall be furnished, mounted inside doors of cabinets or separately framed and mounted outside the equipment.

.4 REDUCED VOLTAGE STARTERS: Motors, sizes shall be such that the inrush current exceeds 40 percent of the building transformer rating. Motors shall be equipped with reduced voltage starters of the closed transition auto transformer or star-delta type, or solid state soft start, or current ramp starters.

.5 OPERATING PROTECTION:

.5.1 CERTIFICATION by the motor manufacturer that motors meet the voltage requirements of NEMA.

.5.2 OVERLOAD RELAYS: Poly-phase motor controls shall be equipped with three overload relays. Reduced voltage starters shall provide overload protection during the starting step.

26 29 **05**. MOTOR STARTER APPLICATIONS:

.1 TYPE OF STARTERS: Alternating current (AC) magnetic-fused-type starters, NEMA Class E2 in accordance with ANSI/NEMAICS2-1983(26) shall use current limiting power fuses and magnetic air break contactors. Each starter shall be completely self-contained, pre-wired, and with all components in place. Air break contactors if employed shall be current rated based on motor horsepower requirements. It is important to know as a guideline that combination starters will

26 29 **05**. MOTOR STARTER APPLICATIONS: (Cont'd)

provide an interrupting fault capacity of 260MVA symmetrical on a 2300V System, and 520MVA symmetrical on a 4160 or 480V System. This starter must comply with ANSI/NEMA ICS2-1983 (26), Class E-2 controllers NEC 2005-760 and applicable IEEE and current ANSI Standards.

.1.1 Starters for motors from 2300-13,200V shall be designed as integrated complex units based on maximum horsepower ratings for use with squirrel cage, wound rotor, synchronous, and multispeed motors for full or reduced voltage starting.

.1.2 Starters for 600V and below, the design must conform to ANSI/NEMA ICS2-1983(26). This is a requirement for magnetic controller ratings of 115-575V. AC Motor starters and contactors may be used for controlling the circuit to the motor. This standard requires that starters should be carefully applied on circuits and in combination with joint short-circuit protective devices such as circuit breakers, fusible disconnects that will limit the available fault current and let through energy level that starter can safely withstand. This withstand must meet the requirements of ANSI/UL 508/1983(29), and ANSI/NEMA ICSI-1983(25), (26) which cover controls, systems, and devices.

.1.3 The starters shall not be used without an adjacent line-switch, if unfused disconnect switch is used or installed, it must be closed to each motor as much as possible. This standard forbids the installation of a remote switch with lock arrangement, switchgear, switchboard or a unit in a Control Center.

26 30 00. FACILITY ELECTRICAL POWER GENERATING AND STORAGE EQUIPMENT

26 30 10. EMERGENCY POWER SYSTEMS:

.1 ALTERNATE POWER SOURCES: The University Master Plan provided for connecting groups of buildings with parallel power circuits for obtaining electric power supply to a building from alternate sources. Where the interruption of electric power supply to a building would result in hazard to life or property, major loss of research or equipment, provision shall be made for an emergency supply of power, to be used in the event of failure of the normal supply. Details of the plans as they apply to the project shall be explained and included in the early **Design/Development** submittal and conferences. If tie-in on existing circuit or feeder is not practical at present, provision shall be made for future tie-in. Emergency Power Systems are of two basic types:

A. An Electric Power Source set apart from the Prime Source of Power Operating in parallel, that maintains power to the critical loads should the Prime Source fail.

B. An available reliable Power Source to which critical loads are rapidly switched automatically when The Prime Source of Power fails. (AC Source)

.1.1 Automatic Transfer Equipment: Reliable equipment and transfer switch must be specified.

.2 EMERGENCY STANDBY SYSTEMS: It is required that provision be made by designing an emergency system/standby power source supplied by:

A. Engine Generator
B. Central Battery
C. Separate Emergency Source

26 30 10. EMERGENCY POWER SYSTEMS: (Cont'd)

.2.1 Emergency generator drives shall be natural gas engines. When emergency generators are specified, the Associate must include requirements for demonstrated load tests by a factory representative. Diesel oil shall not be used as a source for emergency generator drives (except the hospital).

.2.2 Lights, when an emergency lighting or generator system is available, should be included at the generator, all mechanical equipment spaces, and in electric transformer and switchgear or switchboard spaces. Substation lighting and receptacles should be included in the system.

.2.3 Electrical Equipment fed from an emergency generator or any two sources shall have the face painted yellow or a yellow band around it unless in a public area. In both public and non-public areas the equipment shall have a distinctive warning sign and indicate the location of both sources of power.

.3 AN EMERGENCY PANELBOARD shall be provided for:

.3.1 Exit lights.

.3.2 Minimal hallway and stairway lighting and telephone power.

.3.3 Fire alarms, building security equipment, and fire protection systems; this does not eliminate the need for batteries. Batteries shall be tested to indicate amp-hour availability. The Manufacturer shall provide documentation that indicates conformance with repaired rating to the University.

.3.4 Elevators and/or elevator rooms when required by OBC.

.3.5 Traffic signals fed from the building.

.3.6 EMERGENCY ILLUMINATION: Emergency illumination shall be part of emergency lighting that shall include illuminating all required means of egress lighting, illuminated Exit Signs, Stairwell Lights, and all locations where emergency lighting must provide at least code required minimum illumination to allow easy and safe egress from the area involved.

.4 WIRING FOR EMERGENCY SYSTEMS shall be in separate conduits. Specify that all emergency system junction boxes and covers shall be painted red.

.4.1 Switches for emergency lighting circuits shall not be accessible to the public.

.5 TRANSFER SWITCH: Transfer switch is a vital part of the proper operation of the system. In addition to current carrying abilities, transfer switch must be able to withstand voltage surges to meet reliability requirements. Special consideration over normal circuit devices or breakers should be given to transfer switch because of its application requirements. Its design must include normal duty, and fault current ratings of the switch. These play an important part of transfer switch application and protection scheme. It shall be capable of closing into high currents, of fault currents without damage, and withstanding severe duty cycle in switching normal-rated load. The design, and operation of transfer switch must meet the requirements of this Standard and the following Codes and Standards: NSI/NFPA 70-1987(12) (National Electrical Code (NEC), NFPA 99-2002 and NEC 700-2005.

26 37 00. ELECTRICAL PROVISION FOR ELEVATORS

.1 WIRING AND SWITCHING: Wiring shall be extended to fused switches located in elevator room.

.2 EMERGENCY CIRCUIT: An emergency circuit to mid point of the hoistway shall be provided for the elevator cab light, fan, and equipment room.

.3 PIT INSTALLATIONS: Refer to Division 14. A light, light switch, and GFCI convenience outlet must be provided in the pit of each elevator, each on separate circuits.

26 40 00. ELECTRICAL AND CATHODIC PROTECTION

26 41 00. FACILITY LIGHTNING PROTECTION:

.1 Each building shall be considered individually to determine the necessity for lightning protection. If it is deemed necessary to provide lightning protection, design and specify an Underwriter's Laboratory Master Label System. If it is decided that lightning protection is not necessary, this decision should be made a matter of record. A listing of the people consulted shall be included in the conference memos.

.2 GROUNDING SYSTEM REQUIREMENT: Because of possibility that a breakdown in grounding insulation may accidentally energize all plant or facilities, this Standard requires that ground connections shall be made to the electrode by methods providing the required permanence and ampacity, such as:

.2.1 A permanently effective clamp, fitting, brace, or weld.

.2.2 A bronze plug, which has been tightly screwed into the electrode.

.2.3 All non-current carrying metallic structures or steel frame building are grounded.

The main purpose of grounding system is as follows:

To maintain low potential difference between metallic parts, ensuring freedom from electric shocks to personnel in the area.

To avoid fires from volatile materials and ignition in combustible atmospheres by providing an effective electric conductor system for the flow of ground fault currents and lightning (See Lighting Protection in Section 26 20 06 of the Standard). The connection between the grounding electrode and the earth should have a resistance less than 5 ohms.

.3 All existing lightning protection system shall be maintained during building renovations and extended to any additions to the building.

26 42 00. CATHODIC PROTECTION

.1 UNDERGROUND PIPING: Refer to 22 70 30. (15490) for cathodic protection method when such protection is determined to be appropriate.

26 50 00. LIGHTING

.1 LIGHT LEVELS-GENERAL: All new lighting installations at The University shall comply with the **Code for Energy Conservation in New Building Construction.** (Ohio Basic Building Code, Article 27, O.A.C. 4101:2-27). Lighting requirements for the most common University building areas are set forth in this standard. The referenced light levels are understood to be a **maintained** light level. Light levels are measured at a 30-inch height from the floor or at the actual work surface, and represent the **average** level for the area or workstation. Circulation areas beyond workstations should be lighted to one-third the light level of the workstation, but in no case less than 20-foot candles.

.1.1 Specify that contractors shall fuse all indoor and outdoor lighting fixtures when installed.

.2 SPECIAL LIGHTING APPLICATIONS such as Recreational Field Lighting, and Airport Runway lighting, shall comply with the latest I.E.S. Standard or as directed by the University Architect.

.3 STUDENT STUDY AREAS AND CLASSROOMS: Provide 40 to 60 foot-candle light level at workstation. Workstations equipped with video display terminals (VDT's) or computers should be illuminated with 30 to 50 foot candles as recommended by the latest edition of the Illuminating Engineering Society (IES) and National Institute for Occupational Safety and Health (NIOSH) standards.

.3.1 Switching in classrooms shall provide for switching the fixtures in the front and seating area separately to facilitate the use of overhead projectors, etc.

.3.2 Light fixtures at workstations with video display terminals or computers should be located perpendicular to device in order to minimize glare and viewing difficulty.

.4 STAFF AND FACULTY OFFICE WORK STATIONS: Provide 50 to 80 foot-candle light level at workstation.

.5 WORK STATION WHERE CRITICAL OR FINE WORK IS PERFORMED, AS IN LABORATORIES OR DRAFTING ROOMS: Provide 100 to 120 footcandle light level.

.6 CORRIDORS, STAIRWELLS, LOBBIES, WAITING ROOMS, STORAGE AND SERVICE AREAS: Provide 10 to 20 footcandle light level.

.7 REST ROOMS, LOCKERS, SHOWERS: Provide 20 to 30 footcandle light level. Provide one night light in all rest rooms and locker rooms.

.8 OUTSIDE SECURITY, BUILDING PERIMETER, PARKING LOT, OUTSIDE WALKWAYS: Provide 1 to 3 footcandle light level.

.9 LECTURE HALL AND AUDITORIUM LIGHTING: Provide 40 to 60 footcandle light level at all seating locations. For a Lecture Hall stage area, provide 40 to 60 footcandle light level. For an auditorium stage area, the lighting shall comply with the latest I.E.S. Standard or as directed by the University Architect. Provide separate switching for stage and seating area.

.10 PARKING RAMP INTERIOR: Provide 5 to 10 footcandle light level in the traffic lanes, 3 to 5 foot-candles in the parking areas, and 20 to 30 footcandle light level at the entrance/exit.

26 50 00. LIGHTING (Cont'd)

.11 TEMPORARY SITE LIGHTING DURING CONSTRUCTION: Sufficient lighting shall be provided such that Campus Police may observe the entire area. Provide a light level of 1 to 3 foot-candles. The contractor is responsible for providing temporary lighting outside of the project area if the project interrupts the normal lighting to the area.

.12 MECHANICAL ROOMS: Provide 50 to 80 footcandle light level. Mechanical room fixtures shall be “Turrett style” industrial fluorescent fixtures with wireguards. Sockets shall be protected by housing and shall not be exposed. Provide Emergency Egress lighting.

26 51 00. INTERIOR LIGHTING

.1 RECOMMENDED FIXTURES: Fluorescent fixtures using 4 foot T8 tubes are generally preferred. Incandescent lighting may be used only with the written permission of the University Architect. Any department requesting approval of incandescent lighting must be willing to accept financial responsibility for the maintenance of the incandescent lighting.

Where incandescent lamps are used as part of an equipment system or alarm, provide six spare lamps of each wattage.

.1.1 The use of High Pressure Sodium (HPS) Lamps in fixtures for lighting large or open areas is recommended by this Standard in combination with metal-halide lamps for greater energy saving. Almost without exemption, the High Pressure Sodium (HPS) lamps shall be the choice for greatest economy and least use of energy, but the use shall be limited to warehouse large areas and high ceilings.

.1.2 Mercury vapor lights are not to be used for indoor use. Exceptions, for research applications, must be submitted by the Associate for review by Technical Services.

.1.3 METAL HALIDE lamps shall only be used in areas where there is assurance that they will be turned off at least once a week; this reduces the possibility of an explosion at end of life. Their use should be limited to areas in which network television coverage is expected, accurate color rendering is required, or gymnasiums.

.1.4 FLUORESCENT FIXTURES: All fixtures shall be independently supported from the structure above. Fixtures shall be all metal with hinged shielding louvers. Recessed fixtures with hinged frame open louvers may be used where required for architectural effect. Two hundred seventy-seven (277) volt fixtures shall be used where this voltage is available. Fixtures shall meet or exceed the requirements of the **Code for Energy Conservation in New Building Construction.**

.1.5 QUARTZ LAMP FIXTURES are not recommended; if used they must have lenses to protect against exploding lamps.

.1.6 Ballasts: High Frequency Electronic type, specifically designed to use T8 lamps, instant start, to operate multiple lamps in a parallel configuration. Ballasts shall meet minimum performance standards as established by the Certified Ballast Manufacturers Association. Additional requirements shall include a maximum Total Harmonic Distortion of *20* percent, sound rating of "A", shall comply with applicable standards as set by ETL, F.C.C., NEC, I.E.E.E., be listed by UL and carry a five year replacement warranty. Separate ballasts should be provided for each lighting fixture; exception,

tandem or cross ballasting of adjacent fixtures is permitted provided the fixtures are directly connected to each other.

.1.7 Ballasts for compact fluorescent lamps shall be electronic type, and shall have the following characteristics:

A. Ballasts to be high Power Factor type.
B. Ballasts factor shall be .95 or greater.
C. Ballasts for multiple lamps shall be parallel wiring type.
D. Minimum starting temperature shall be 50 Degrees F.
E. Fixtures with multiple ballasts shall have individual fusing for each ballast.
F. Total harmonic distortion shall be less than 20%.
G. Ballast shall contain end of lamp life fault mode shutdown protection.

.2 Line Fuses: A line fuse shall be included in the fixture for each ballast in addition to the internal protection of the class "P" ballasts. Line fuses shall be appropriate for the application and wired in place by the fixture's manufacturer. Fusing for fluorescent lighting fixtures shall be non-time delay type similar to Bussman type GLR with HLR holders.

.3 Lenses shall not be specified as an alternative for louvers. If lenses are required for the job, the job shall be engineered for these units. Tempered lenses shall be specified on quartz lamp fixtures.

.4 Fluorescent Lamps: Four (4) foot 32 watt and two (2) foot, 17 watt, T8, instant start lamps with color temperature of 3500K and minimum of CRI of 74.

.5 Specify the use of exit signs utilizing Light Emitting Diodes (LED) light source with life expectancy greater than (10) Ten years.

.6 INCANDESCENT LAMPS: When approved by the University, specify the 130-volt, inside frosted lamp for general application.

.7 LIGHTING SAFETY: Stairwells in buildings shall have sufficient fixtures so that the loss of one lamp or ballast will not leave the area dark. The mounting of the fixtures shall not be at the extreme height but must be accessible for maintenance. Position fixtures only on walls over landings at a maximum height of 8 feet. Fixtures shall have lenses; no bare lamps shall be permitted.

.8 Provide the following spare parts with the listed quantities for compact and T5 fluorescent fixtures for each item and size required:

A. Fuses – 10%, minimum of 15 per amp rating
B. Fuse Holders – 10%, minimum of 5 per each type
C. Ballasts – 5%, minimum of 3 of each type
D. Lamp Sockets – 10%, minimum of 10 of each type
E. Fixture Lenses – 10%, minimum of 2 of each type

.9 All submittal reviews for Compact T5 Fluorescent fixtures shall include the following:

A. Catalog cut sheets.
B. Lists of spare parts with quantities to be furnished.
C. Samples of fixtures along with a sample of each spare part to be supplied.

26 51 00. INTERIOR LIGHTING (Cont'd)

Turn spare parts over to the university area shop supervisor and obtain signed receipt.

A copy of each approved submittal and a copy of each signed receipt shall be included in the Operation and Maintenance Manuals.

.10 Spare lamps should be provided as follows:

Lamp Type	Quantity Installed	# of Spares
H.I.D.	1-10	1
	11-20	6
	21 or more	12
Fluorescent	1-10	1
	11-20	6
	21-50	12
	51-200	36
	201 or more	72

Quantity of lamps installed and not fixtures should be calculated for each lamp type and wattage.

.11 Incandescent lighting is permitted in dedicated Telephone Equipment Rooms.

26 56 00. EXTERIOR LIGHTING

.1 LIGHTING FOR THE ENTIRE SITE, INCLUDING DRIVEWAYS, WALKS, PARKING AREAS, AND THE BUILDING PERIMETER shall be included in the contract documents.

.2 FIXTURES: High Intensity Discharge (high-pressure sodium lamps) fixtures mounted on the building or on suitable standards are required for all exterior site lighting. These fixtures shall be automatically controlled by photocell(s). More details about exterior lighting or lighting poles may be obtained from OSU Facilities Operations and Development website at http://fod.osu.edu/lighting/index.htm.

.2.1 Light Control shall be provided on all exterior lighting fixtures. The fixture shall be insect proof. Vandal proof fixtures shall be used if the fixtures are mounted 10 feet or less off the ground.

.3 FIXTURE LOCATION: Fixtures shall be located in such a manner that dark voids and excessive glare in windows are eliminated. Accessibility for servicing must be considered in locating fixtures. Consideration must also be given to light spillage onto adjacent facilities (existing or planned) such as greenhouses, which are light sensitive. Use directional or shielded lighting as necessary. Check with the University Engineer for the type of lights. Grounding rods shall be installed in all lighting poles.

.4 Outdoor Lighting Levels shall be designed as follows:

.4.1 Primary Walkways and problem areas - 2 foot-candles (FC) average and .5 FC minimum.

.4.2 Secondary Walkways and other areas - 1 FC and .25 FC minimum.

.4.3 Primary Streets - 2 FC average and .25 FC minimum.

26 56 00. EXTERIOR LIGHTING (Cont'd)

.4.4 Parking Lots - 1 FC average and .25 FC minimum.

.4.5 High Activity outdoor parking (i.e. St. John Arena) 2.4 FC average and .6 FC minimum.

.5 Design outdoor lighting to be fed from 100-amp switch, which in turn feeds 100 amp contactor with coil controlled by a photocell. Run all three phase legs and neutrals to lighting standards and fuse each pole individually. Alternate each pole to different phase legs and balance phases. Use twistlock type photo controls to control contactors.

.6 The University has no secure storage. Any existing poles, luminaires, concrete collars or screw-in bases removed for relocation at a later date must be stored off campus at the project's expense or in the staging area. Luminaires must be removed prior to pole removal and stored indoors. Any items, except for luminaires, being turned over to the University may go to the University designated storage location. Luminaires shall be taken to the M/E shop at 2560 Kenny Road.

26 58 00. LIGHTING CONTROL

.1 MULTIPLE SWITCHING: The use of multiple switching shall be evaluated for each space and condition. Where possible, switching shall be circuited to effectively use artificial (natural?) lighting from windows; to permit light reduction during partial occupancy; and to permit reduced lighting for custodial activity.

OCCUPANCY SENSORS shall not be used as the sole means of switching. Manual switches will be provided in all areas with occupancy sensors. Occupancy sensors shall not be used in mechanical rooms or rest rooms. At installation, set all sensors to maximum sensitivity and maximum time delay.

.2 REMOTE SWITCHING by means of a central control should be evaluated for new construction and for large renovation projects.

.3 DIMMING CONTROL: Where dimming is required it shall be used to control incandescent lighting and may be used for Hi-Lume **and approved** solid state dimming ballast fluorescent fixtures for low lighting levels. The control panel/panels required for the dimming system shall have the U.L. label. Each dimming module shall be U.L. tested and tested specifically for the type of load it is controlling. Each dimmer module shall possess a means of easily disconnecting power on an individual module-by-module basis.

Dimming panels shall be cooled without the use of cooling fans with no exception, and shall be capable of operating as such in an environment of 0 degree to 40 degree centigrade. Satisfactory independent laboratory test results shall be required, that at +40 degree centigrade and at full load, the maximum temperatures of both filter chokes and SCRs/Triacs are not exceeded.

There shall be one **air-gap** positive off relay for dimmer, either integral to the dimmer or mounted elsewhere in the same panel. Other advanced technological approaches that give the same or better operational result is highly recommended by this Standard.

All controls shall have the capabilities of reverting back to their previous status after any duration of power outage (power failure memory), without the use of any type of rechargeable or trickle-charge type of battery.

26 58 00. LIGHTING CONTROL (Cont'd)

LUTRON DIMMING SYSTEMS with **ten years warranty** meet University standards. Other systems must be submitted to Facilities Design and Construction, Techical Services Group for approval.

.3.1 SPECIAL REQUIREMENTS FOR FLUORESCENT DIMMING SYSTEMS: Before specifying fluorescent dimming systems, the Associate shall consider the following:

.3.1.1 100 hour "burn-in time is required for the fluorescent lamps when using the dimming ballasts.

.3.1.2 The cost of replacing the ballast and lamps when needed is 200-300% more than replacing Standard Systems.

Therefore, this Standard requires the Associate to review the application of dimming devices and submit recommendations to Facilities Design and Construction before incorporating into specifications.

.4 PARKING RAMP INTERIOR LIGHTING shall be circuited to permit lighting of dark interior areas during the day without lighting those areas which receive sufficient natural light. Automatic control of ramp lighting by photocell is required.

.5 ALL EXTERIOR AREA AND SECURITY LIGHTING shall be "dusk on and dawn off", powered from one location in the building, and controlled from the photo control, with provisions for manual override. Time clock control shall **not** be used on exterior or security lighting.

END OF DIVISION 26 - ELECTRICAL