DIVISION 26 – ELECTRICAL

26 0500 BASIC ELECTRICAL REQUIREMENTS

A. Electrical System Design:
   1. This design standard is intended to be a guide for Electrical Design Professionals.
   2. Whenever possible, at least three (3) manufacturers will be specified for the various classes of electrical equipment.
   3. Where noted, certain manufacturers **must** be used per Owner's standards.
   4. Utility shutdown requires completion of the "Utility Shutdown Procedure" which can be found under division 1 on the web at the following location: http://fmgt.cmich.edu/standards.html

B. Electrical Standards and Regulations:
   1. Installation of electrical work shall conform to the current issue of the National Electric Code (NEC), Michigan Building & Rehabilitation Codes and Michigan Rehabilitation Code as adopted by the authority having jurisdiction.
   2. Whenever possible, equipment will be selected that has been manufactured in accordance with the National Electrical Manufacturers Association (NEMA) standards.
   3. Equipment Selected will be UL listed.

C. Temporary Service:
   1. Consult with the Facilities Management Department regarding suitable location for all temporary electric services. If temporary electric service is to be obtained from an existing Central Michigan University system, Electrical Contractor will be responsible for providing adequate protection to the existing system, building, and all personnel.
   2. When service is obtained from an existing Central Michigan University System, the University will pay for all energy used.
   3. When temporary electric service is not available from CMU then the contractor will obtain the electrical service directly from the utility company, the Electrical Contractor shall be responsible for all arrangements and will pay all costs involved for installation and usage.

D. Work in Existing Facilities:
   1. It is incumbent upon the Electrical Design Professional to fully evaluate the existing conditions of the project area(s). Existing non-conforming electrical installations shall be addressed within the Design Documents for correction / installation per the latest edition of the NEC and Michigan Building & Rehabilitation Codes.
   2. It shall be noted within the Design Documents that all existing non-conforming electrical installations, within the project area(s) shall be corrected to the satisfaction of the Authority Having Jurisdiction (AHJ) and the CMU Project Manager.
   3. It shall be noted within the Design Documents that the contractor shall field verify existing conditions prior to the submission of their proposal and the cost of correcting the non-conforming electrical installations shall be included. If non-conforming electrical installations are found after submission of proposals, the electrical contractor will be responsible to pay all costs to repair the installation. The boundry of responsibility will be to the extent of the construction only. All installations shall meet or exceed the National Electric Code.

E. Workmanship:
   1. The university expects the highest quality of installation practices and methods. All installations are subject to review and acceptance by the CMU Project Manager and the Authority Having Jurisdiction (AHJ). Those installations that do not meet the satisfaction of the CMU Project Manager or AHJ shall be corrected at contractor expense.

F. Distributed Antenna system:

1. Refer to section 28 0537

26 0501 ELECTRICAL DEMOLITION

A. Every effort shall be made to review equipment that is no longer deemed necessary. If equipment is abandoned in place, disconnect and remove all associated electrical circuits, devices, raceways, conduit, and wire to source.

B. Provide label of abandoned equipment indicating previous use and year abandoned.

C. Coordinate utility service outages and reconnections with CMU Project Manager and Facilities Operations, refer to “Utility Shutdown Procedure.”

D. Provide code compliant temporary wiring and connections to maintain existing systems in service during construction.

E. Electrical Service upgrade or replacement shall be carefully coordinated with CMU Project Manager, Facilities Operations, and all stakeholders. Electrical shutdown shall be kept to a minimum to ensure affected facilities return to operation with minimum impact.

F. Fire alarm upgrade or replacement shall be carefully coordinated with all stakeholders as identified by the Project Manager. Maintain existing system in service until new system is accepted by CMU Project Manager.

G. Coordinate telephone/data with CMU OIT:
   1. Care shall be taken to maintain existing system until new system is complete and ready for service.
   2. If telephone/data circuits are being installed as a part of the entire construction, that requires an electrical permit, the Authority Having Jurisdiction (AHJ) will inspect the telephone/data circuits.
   3. Low voltage control (i.e.: BMS circuits) is always inspected by the AHJ.

H. Remove, relocate, and repair existing installations to coordinate new construction.

I. Remove any abandoned electrical circuiting, raceway, devices, equipment, conduit and wire to source. Patch, paint, and repair surfaces requiring such to match existing.

J. Disconnect abandoned outlets and remove devices; remove circuiting to source. Provide blank cover plates for any remaining back boxes.

K. Disconnect and remove any abandoned panel boards and distribution equipment. Coordinate with CMU Project Manager.

L. Disconnect and remove abandoned luminaires, brackets, stems, hangers, and other accessories. Coordinate with CMU Project Manager.

26 0513 MEDIUM VOLTAGE CABLE

A. Primary Cable: 15kv underground-jacketed cable, concentric neutral, MV-90 rating type, Conductor Insulation Ethylene-propylene rubber with 133% insulation level. Strand Copper

conductor with compact round, Class B, conductor and insulation screen with extruded semiconducting (SC-EPR), Insulation to be extruded ethylene propylene rubber, concentric wires to be bare copper rated at one-third neutral, outer jacket encapsulated LLDPE (Linear Low Density Polyethylene). All requirements shall meet or exceed UL 1072, AEIC CS8 and ICEA S-94-649 or S-93-639, NEMA WC74 and S-97-682. Jacket shall be printed with MV-90 to meet NEC.

B. Tape shield in lieu of concentric neutral is not acceptable.

C. All cables shall be neatly racked in all manholes, vaults, cable trays, and pits. Racking systems shall be High Strength PVC or galvanized steel.

D. During Design Development, the Design Professional shall provide pros and cons assessment for the installation of electrical manholes versus long conduit sweeps encased in concrete where change in direction is required. The final approval will be made by the Director of University Engineering and Planning.

E. Color Coding: Primary cable shall be color coded at all terminations with colored tape applied to at least one (1) foot of cable length.
   Phase A – Blue
   Phase B – Red
   Phase C – Yellow

F. Tests: High voltage d-c proof tests shall be specified on all primary cable installation in accordance with the cable manufacturer's recommendations and NETA testing standards.

G. Cable splices are not acceptable.

H. Medium Voltage terminations shall be load or dead break elbows.

26 0519 BUILDING WIRE AND CABLE

A. Service Entrance Conductors (sizes #12 thru #500 KcMil AWG): Type USE stranded copper run in conduit.

B. Branch Circuits and Feeders (sizes #12 thru #500 KcMil AWG): Type THHN/THWN stranded copper in conduit.

C. Additional Capacity Neutrals: Provide increased neutral capacity for K-rated systems or systems with high 3rd harmonic content.

D. All branch circuits shall have separate neutrals.

E. Not more than six (6) unassigned general use duplex receptacles shall be on any one 20-amphere branch circuit. Not more than four (4) desktop personal computer duplex receptacles shall be on any one 20-ampere branch circuit.

F. Wire connectors will be of the spring type, sizes #12-10 AWG, and hydraulic compression or mechanical type for #8 AWG and larger.

G. Low voltage cable for alarm and detection, will be multi-conductor as required for the particular application.

H. Electrical service entrance shall be coordinated with the existing underground distribution system. Overhead service entrance will be considered only as an alternate and must meet the approval of the Director of University Engineering and Planning.

I. The Design Documents shall indicate Available Fault Currents and the required AIC bracing for all distribution, up to and including receptacle panel level. Refer to section 26 2702 Short Circuit, Arc Flash, and Coordination Studies.

J. Feeder circuits shall be sized to allow for voltage drop. The Design Professional shall submit voltage drop calculations for review during the Design Development review. Feeders shall be sized to sustain the initial design load plus 25% of the design load for future growth.

K. Minimum size for lighting and power branch circuits shall be #12 AWG stranded. Control system circuits shall be #14 solid.

L. MC type cable may be used for single circuits to power branch receptacles contained within wall construction. All homeruns and exposed installations must be made with conduit and wired.

M. Electrical cords to portable equipment shall be type ST or SO containing an identified equipment ground wire. Ranges and dryers shall be equipped with type SRDT.

N. Use feeder busways in lieu of conduit and wire for loads in excess of 600 amperes, as determined by CMU Project Manager. Busways shall include an equipment ground bus.

26 0521 MANUFACTURED WIRING ASSEMBLIES

A. Prefabricated flexible cable assemblies can be utilized for lighting connections if approved by CMU Project Manager.

26 0526 GROUNDING AND BONDING

A. The project electrical system will be grounded in accordance with the requirements of the Michigan Building & Rehabilitation Codes and the National Electric Code.

B. All equipment and non-current carrying metal components of the electrical system will be grounded.

C. Driven ground rods at primary transformer and medium voltage switches will form part of the exterior grounding system grid. The ground system will be tied to the interior metallic water distribution system of the project.

D. Primary Transformer and Medium Voltage Switch grounding conductors and connectors shall be copper. Provide ground for the high voltage neutral, enclosures, cable shields, instrument transformer neutrals, low voltage system neutral, all conduits, and frame of the transformer or switch with copper connection.

E. Building reinforcing steel will be grounded in accordance with the requirements of the Authority Having Jurisdiction (AHJ).

F. Service grounding shall comply with the latest addition of the NEC. Extend a #4/0 AWG copper ground cable from the service entrance equipment ground bus to the street side of the main water meter. Provide bonding jumpers in accordance to NEC.

G. Equipment grounding conductors and neutral conductors shall not be electrically interconnected on the building side of the electrical service ground.

H. Where physical protection is required, grounding conductors shall be installed in Rigid Galvanized Conduit. Provide bonding bushings on both ends of conduit.

I. Flexible conduit shall not be considered as an acceptable ground path. All electrical equipment grounding must comply with NEC 250-95.

J. All electrical circuits shall have a grounding conductor.

K. All exterior light poles and bases shall have a supplementary grounding electrode that will be tied to the equipment grounding conductor and pole.

L. Provide Telecom ground and ground riser per BICSI standards. Coordinate with CMU OIT.

26 0529 HANGERS AND SUPPORTS

A. General: Electrical equipment shall be adequately supported from elements of the building.

B. Straps and hangers shall be heavy-duty malleable iron or steel.

C. Prohibited practices:
   1. Conduits above suspended ceiling shall not be supported by a ceiling suspension system but shall be attached to the structure. The use of powder-driven anchors for this purpose is not acceptable.
   2. Wire ties shall not be permitted for supporting conduit.
   3. Wood strips and wood screws shall not be used for supporting lighting fixtures.

26 0534 CONDUIT

A. All underground branch circuits shall be installed in raceway systems. Underground conduit shall be PVC schedule 40 with properly installed fittings. All interior stub-ups must be rigid galvanized steel conduit, and arranged so curved portions of bends are not visible above finished floors.

B. Encase in concrete (duct bank) all electrical service entrance and primary distribution conduits in a Red concrete envelope and locate a minimum of 36-inches below grade to top. Electrical duct bank shall cross gas lines below the gas piping without exception.
   a. Concrete to have color dye or pigment integrally mixed into the concrete, color shall be Duct bank Red or RED, Mixture of 1.5 bags per yard of concrete.
   b. All duct banks shall have a buried barricade detectable tape, similar to “Scotch” 413 marked with “Caution Buried High Voltage Cable Below”
   c. Tape shall be a minimum of 5-mil thick and 6 inches wide with a detectable tracer.
   d. Locate tape 6" below grade and at 6" above duct bank.

C. Provide a minimum of two (2) 5-inch conduits encased in concrete from the appropriate primary electric service manhole and / or associated outdoor pad-mounted primary switch to the outdoor primary pad-mounted transformer. The transformer shall be adjacent to the building exterior.

Slope conduits to drain toward the electric manhole and away from the building. Install all necessary conduits plus one spare conduit to the incoming section of the building switchgear from the primary pad-mounted transformer. Exterior Service Entrance conduits shall be concrete encased.

D. Interior Raceways and Fittings:
   1. All materials in a raceway system shall be compatible.
   2. Minimum conduit size shall be ½-inch. Any given run of conduit must be continuous of the same type of material.

E. Rigid, galvanized, threaded, UL labeled conduit shall be used on exterior walls, and in all corrosive and hazardous locations, and where subject to physical damage unless noted otherwise per NEC.

F. UL labeled galvanized steel Electrical Metallic Tubing (EMT) may be used in interior partitions and above suspended ceilings. In corrosive, hazardous and underground locations, EMT, shall not be used.

G. Plastic-jacketed rigid steel conduit shall be used in corrosive atmospheres.

H. Flexible conduit may be used only for final motor connection, final lighting connections, heating and ventilating controls, and special equipment connections. Plastic jacket shall be used on all flexible conduits except for that used in lighting fixture connections. Maximum lengths shall not exceed 72”.

I. Conduits, fittings, boxes, and accessories shall be specification items. All fittings shall be heavy duty steel or malleable iron. No running threads will be permitted. EMT fittings shall be set screw type or thread less compression type.

J. Insulated bushings and insulated throat fittings shall be used throughout EMT installations.

K. Conduit crossing of building expansion joints shall have expansion provision with grounding continuity.

L. All conduits shall be located below all concrete slabs. No embedded conduits for on grade concrete slabs. All concrete slabs above grade and a floor below, conduit shall be installed below the slab.

M. PVC conduit shall not be used for building interior installations.

N. Aluminum conduit shall not be used.

O. Intermediate conduit shall not be used.

P. HDPE Schedule 40 conduit shall be used for directional boring of conduit in existing lawn areas, mark conduit black with a red stripe or red conduit and U.L. Listed. Shur-lock couplings that are air and watertight.

Q. Directional Boring methods when used the contractor shall hydro-excavate ALL utilities crossing planned pathway.

26 0535 SURFACE RACEWAY

A. Surface Raceways shall be limited to remodeling work and multiple-outlet wiring for specified usages defined by the building program in new construction as determined by CMU Project Manager.

26 0536 CABLE TRAYS

A. Cable tray or J-Hooks will be located throughout all corridors for telephone, data, CATV, fire alarm, security, and EMS. CMU OIT will be consulted regarding size and location.

B. Provide Cable tray in all IT rooms. Coordinate with CMU OIT.

C. Ground all cable tray components per NEC.

26 0537 BOXES

A. The Design Professional shall specify required junction box, pull box, splice box and back box.

B. Wall Boxes shall be 4" square stamped metal boxes with single or double gang raised covers.

C. Floor boxes shall be of the concealed service type, with adjustable feet. Power floor outlets will be inside of the box (below the floor slab) with duplex receptacles as required. Data and communications outlets shall be in the same box as the power outlet. Provide closable in-use cast metal covers for interior floor boxes containing receptacles and data ports. No plastic covers.

D. Hand holes, or ground boxes in roadway or sidewalk area shall be made of a composite concrete cover and box. Drive over rating shall be a minimum of 15,000lbs. Manufacturer: Quazite by Hubbell or equal.

26 0540 UNDERFLOOR DUCT

A. Trench duct and under floor duct will be utilized for specified usages defined by the building program in new construction.

26 0553 ELECTRICAL IDENTIFICATION

The general purpose of the Electrical Identification and Labeling Standard is to provide a Standard for contractors, A/E's, and FM employees to adhere to when labeling electrical equipment and conduits which are located on the CMU campus. This Standard is not to be regarded as a specification but as a document providing uniformity in the completion of electrical labeling in the field.

A. All conductors, raceway systems, panel boards, branch circuits and systems will be properly identified to aid in the future operation and maintenance of the electrical systems.
   1. Fire Alarm Conduit exposed shall be RED., all boxes shall be RED.

B. All switches and receptacles shall have their circuit numbers identified on the cover plate surface. Use a label maker for this purpose.
   1. Junction box with live wires the circuits shall be labeled on the inside of the box if exposed, if the box is above a ceiling then label on the outside.

C. Electrical equipment and conduits shall be labeled, tagged and stenciled as described herein.

1. Labels shall be adhesive tape. Similar to brother P touch or DYMO.
2. Nameplates shall be plastic laminate similar to GravoPLY and engraved with information.
3. All electrical equipment shall be labeled per this standard.
4. Wire markers shall be labeled per the N.E.C.
5. Conduit markers shall be labeled per the N.E.C.
6. Underground warning tape shall be per the N.E.C.
7. Wire color code shall comply with N.E.C.
8. Install nameplates for the following:
    - Switchboards
    - Panel boards
    - Transformers
    - Service Disconnects
    - Mechanical Equipment Disconnects
    - Motor Control Centers & Motor Starters
    - Automatic Transfer Switches
    - Control Circuits
    - Circuit Breakers
    - Switches
9. Nameplates shall be located at the source and at the load for each circuit.
10. Typical naming of equipment shall be MDP-xxx, SWBD-xxx, DP-xxx, RP-xxx, LP-xxx with some indication of which floor the equipment is located.

D. Nameplate Tags:
    1. Each nameplate shall be attached using adhesive tape.
        a) Tag Size: 1 1/2" x 4"x 1/8" Plastic laminate.
        b) Tag Color:
            - Normal Power – White letters on Black background.
            - Emergency Power – White letters on Red background.

E. Main panel Tag Information shall be engraved as follows:

Line #1 **Building Code- Panel Name**
Line #2 **System Voltage**
Line #3 **Fed From**

F. Breaker Tag Information shall be engraved as follows:

Line #1 **Load being served**
Line #2 **Location-Rm# or Area**

G. Device Tag Information shall be engraved as follows:

Line #1 **Device or Panel Name**
Line #2 **Fed From**
Line #3 **Location-panel name**

For example: Main Switch Board A in Brooks Hall with system voltage and the transformer that feeds this panel:

BR-SWBD A
480/277V
BR-P3-T1

Breaker label in a SWITCHBOARD, MDP, DP or PANEL with breakers that are larger than 2" the label shall read:

MCC
RM. 0001

Device Tag sample as follows:

MCC-0A
From MDP
SWBD-A

Provide 1/8" border on top and bottom of nameplate and 1/8" spacing between lines. Center text in the nameplate.

Line 1: letter height 3/8"
Line 2: letter height 5/16"
Line 3: letter height 5/16"

Installation:

1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front.
5. Secure nameplate to inside & outside surface of door on recessed panel board in finished locations.

26 0583 ELECTRIFIED FURNITURE CONNECTIONS

A. Design Professional shall coordinate with furniture manufacturer for power requirements and connections required for electrified furniture. Provides required installations details for electric and tele/data circuits. Review installation details with CMU Project Manager.

B. Systems furniture power base shall be of size to match type of voltage (Single Phase or Three Phase) and harmonic loading. Furniture base system of three circuit and separate neutrals with ground for three phase panels and for single phase loads use a 2+2 circuit setup. All based on Steel Case systems.

26 0923 Section deleted. Refer to 26 5200 for Lighting Control.

26 1200 PAD-MOUNT MEDIUM VOLTAGE TRANSFORMERS

A. Transformer shall be liquid-filled pad-mount for outdoor application. Delta primary, Wye secondary is required for 3 phase applications, Ratings for Primary and Secondary voltage and size shall be determined by the Design Professional and approved by the Director of University Engineering and Planning. Basic impulse level: 95 KV BIL. Frequency 60 Hz, Taps – two 2-1/2% FCBN and two 2-1/2% FCAN. Temperature rise –65 deg. C., coolant shall be insulating media Fire Resistant E200 or Envirotemp FR3 seed oil fluid.

B. Operating voltage is 13.2KV with transformers rated at 12.47KV. Adjust Taps in the field for proper voltage.

C. Quality Assurance:
   1. Transformers shall be manufactured in accordance with the latest applicable NEMA standards and ANSI C57.

D. Transformers shall allow for oil sampling without shut down and without entrance to transformer enclosure.

E. The transformers construction shall be compartmental type, self-cooled, tamper-proof, and weatherproof for mounting on a concrete pad. There shall be no exposed screws, bolts, or other fastening devices, which are externally removable. The transformers shall be of the sealed tank construction. The cover shall be bolted on and the fastenings tamperproof. The transformer shall remain effectively sealed for a top oil temperature range of 50 deg. C to 10 deg. C. When required, cooling panels shall be provided on the back and sides of the tank. Lifting eyes and jacking pads shall be provided.

F. The core and coil assembly shall be wound core type with copper windings. The Design Professional shall provide cost comparison of aluminum wound transformers vs. copper. Provide long term cost of ownership along with pros/cons. Final approval of aluminum windings is required by the Director of University Engineering and Planning. The assembly shall be designed to reduce losses and noise and provide adequate short-circuited strength and heat dissipation. All delta-wye connected transformers shall be of 5-legged core type design. Internal leads are to be insulated. A tap changing mechanism shall be provided for accurate voltage adjustment without opening the transformer tank. The tap changing mechanism shall be externally operated and shall be for de-energized operation only.

G. The high and low voltage compartments shall be located side-by-side separated by a steel barrier. When facing the transformer, the low voltage compartments shall be on the right. Terminal compartments shall be full height, air filled with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened. The low voltage door shall have a 3-point latching mechanism with vault type handle having provisions for a single padlock. The doors shall be equipped with lift-off stainless steel hinges and doorstops to hold the doors open when working in the compartments. The front sill of the compartment shall be removable to allow the transformer to be rolled or skied into position over conduit stubs. ANSI tank grounding provisions shall be furnished in each compartment.

H. High voltage termination shall be dead front and conform to ANSI S57.12.26 requirements. Bushing wells and inserts to match cable termination elbows shall be provided. Parking stands welded to tank wall adjacent to bushings shall also be provided. Termination shall be arranged for radial feed if at end of line or loop feed is required. Bushings to be externally clamped.

I. Low voltage terminations and equipment: The low voltage bushings shall be molded epoxy and provided with blade type spade terminals with NEMA stands hold spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing grounded to the transformer tank by a removable grounding strap. Wye-wye connected transformers shall have the high and low voltage neutrals internally tied with a removable link for testing.

J. Accessories:
   1. All transformers shall be furnished with lightning arrester mounting provisions, nameplate in low voltage compartment, 1-inch upper filter press and filling plug, liquid level indication, 1-inch drain valve with sampling devices, dial type thermometer, liquid level gauge, pressure vacuum gauge, pressure relief valve (self-resealing with indicator), and solid brass padlock with two (2) keys (each transformer).
   2. Vacuum Fault Interrupter and / or OCP as required by NEC.

26 1322 MEDIUM VOLTAGE SWITCHES

A. All building services shall connect to the campus primary service by the use of outdoor pad-mounted 3-way Vacuum Fault Interrupter VFI underground distribution switchgear, three (3) phase source and tap configuration. Full three (3) phase provisions shall be made where single-phase loads are tapped, i.e. provide fuses and bushing for unused phases. The three (3) phase switchgear shall be S&C or Eaton – Cooper Power System pad mounted gear.

B. All switches shall be dead front with Loadbreak elbows rated at 600 or 200 amp as designed by the Professional Engineer and as circuit dictates.

C. The switchgear shall be an integral unit consisting of separate source side and tap side termination compartments within a single enclosure. The doors shall be opened only with a pentahead socket wrench or tool.

D. The switch gear insulating dielectric media shall be either Fire Resistant E200 or Envirotemp FR3 fluid. E200 or FR3 shall be FM Global approved.

E. Switch ratings shall be 15KV, 60 Hertz, 95kV BIL. Insulation level, three-pole, externally operated switches, rated 600 amp load break, in the unit with side-mounted operating handles in an external tamper-resistant compartment. Fault-closing Rating: 22,400 amperes RMS asymmetrical. The load side of the switch shall be equipped with power fuses or VFI sized by the design engineer to coordinate with the existing underground electrical distribution system. “T” switches and feed through style shall be considered during design.

F. Switch shall be mounted on box foundation with open bottom.

G. Switch shall bear the listing of UL or FM Global testing agency.

H. Provide all necessary accessories including spare fuses, lighting arrestors, ground pads and studs, etc. Bolt all switches and box foundations to concrete pads.

I. Color of switches shall be green.

26 2200 DRY-TYPE TRANSFORMERS

A. Single and three phase transformers shall be vented type, incorporating 220 degree C insulation system and designed not to exceed 150 degrees C temperature rise above a 40 degree C ambient under full load conditions. Transformers shall be constructed with copper windings. Design Professional shall provide cost comparison of aluminum wound transformers vs. copper. Provide long time cost of ownership along with pros/cons. Final approval of aluminum windings is required by the Director of University Engineering and Planning.

B. Taps are to be provided on the primary side of the transformer; (2) 2.5% above nominal and (2) 2.5% taps below nominal.

C. Transformers must operate at audible sound levels below NEMA standard ST-20. Sound levels will not exceed:
   - 30 – 50 kVA: 45 db
   - 51 – 150 kVA: 50 db
   - 151 – 300 kVA: 55 db
   - 301 – 501 kVA: 60 db
   - 501 – 750 kVA: 65 db

D. Transformer must incorporate vibration isolation.

E. Transformers greater than 45 KVA shall be floor mounted. Transformers less than 45 KVA may be wall mounted or floor mounted. Coordinate with CMU Project Manager.

F. All final connections will be made by means of flexible metallic conduit.

G. Transformers shall be grounded per NEC.

26 2413 SWITCHBOARDS

A. Provide either circuit breaker type or fused disconnect type switchboard at building service entrances for power distribution.

B. Digital instrument metering to be provided with ‘pulse output’ contacts connected to the BMS system.

C. TVSS protection *shall* be provided. Refer to section 26 4300 Transient Voltage Surge Suppressors.

D. Switchboard shall be deadfront, front accessible, and free standing.

E. Unit to be constructed of code gauge steel and is suitable for moving on rollers and floor mounting. Each switchboard section shall have open bottom and individually removable top plate for installation and termination of conduit. All surfaces shall be painted on all exterior and interior surfaces. Front covers shall be removable, and all doors shall be hung with removable hinge pins. Enclosure shall be NEMA 1. Space shall be provided for future growth of 25% plus predicted expansion load as directed by the Director of University Engineering and Planning.

F. Buss shall be plated copper. All bussing shall meet UL Standard 891 temperature rise equipment. Bussing shall be braced to withstand the minimum of available fault current. Bussing shall have provisions for addition of future section. Bussing support joints and splices shall be made with hex-head bolts and Belleville washers. All internal connections, both high and low

voltage, shall be completed with copper bus bars rather than cable. Bus bars shall be sized for not more than 1,000 amperes per square inch of current density.

G. Aluminum Bussing will NOT be used.

H. Provide ground bus the full length and full size of switchboard.

I. The main service disconnect device shall be solid state circuit breaker totally front accessible and front connectable. Circuit breaker to be provided with solid state trip.

J. Where required by NEC or directed by CMU Project Manager, provide ground fault protection. The ground fault protection system shall include a current sensor and appropriate relaying equipment. The current sensor shall enclose all phase and neutral conductors of the circuit to be monitored. The current sensor frame shall be so constructed that one leg can be opened to allow removal of sensor without disturbing the cables or requiring drop-links in the bussing. A test winding shall be provided to simulate the flow of ground fault current through the current sensor in order to test the electric trip mechanism of the main disconnect. The ground fault relay shall be solid-state construction and have adjustable pickup for ground fault current from 200 amperes to 1200 amperes. Time delay shall be field adjustable.

K. Circuit Breakers:
   1. Group mounted molded case solid state circuit breakers are to be totally front accessible. The circuit breakers are to be mounted in the switchboard to permit installation, maintenance, and testing without reaching over any line side bussing. The circuit breakers are to be removable by the disconnect of only the load side cable terminations and all line and load side connections are to be individual to each circuit breaker. No common mounting brackets or electrical bus connectors will be acceptable.

L. Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate, as well as exercise the circuit breaker operating mechanisms.

M. Main switchboard branch circuit breakers shall be solid-state trip type breakers. They shall include adjustable trip functions for long time ampere ratings, long time delay, short time pickup, short time delay, instantaneous pickup, and, if required, ground fault pickup and ground fault delay. They shall also have an interchangeable rating plug.

N. Metering: Provide a watt-hour demand meter with associated current and potential transformers arranged to meter the entire load. The metering transformers are to be connected to the load side of the main disconnect switch. Provide watt-hour demand meter with a pulse relay for remote recorder monitoring by the campus Energy Management System.
   1. Provide a voltmeter with phase to phase and phase to neutral selector switch to indicate the secondary voltage of each transformer.
   2. Provide a 3-element indicating ammeter with a demand register arranged to indicate the secondary amperes and maximum demand of each transformer.
   3. Provide fuses in the potential circuits of all instruments.
   4. Mount all instruments on a front-hinged door providing for each access to internal connections. All wiring across this hinged door must be extra flexible.
   5. Provide barriers to isolate this metering compartment from adjacent equipment.
   6. An Eaton IQ-DP-4000 may be used in place of individual metering with communication module. SQ-D Equal.

O. Provide a 4-inch high concrete pad and cable pits with drains under switchgear. Provide continuous channel iron sills under the entire assembly.

P. Identification: Each item on the switchgear assembly is to be identified with engraved GravoPLY nameplates. See electrical identification section of this standard.

Q. All bus connections shall be silver-plated.

R. All bus bar connecting bolts and hardware shall be a minimum of 3/8-inch and shall be cadmium plated.

S. Barriers shall be provided between all cubicles.

T. Bus bar passages from one cubicle to another shall be equipped with an insulator having connections through the barrier so as to confine a fault to one cubicle.

U. At the time of completion of the job, the Contractor shall thoroughly clean the main switchboard unit inside and out, and shall tighten all electrical and mechanical connections.

V. Basis of design shall be SQ-D and Eaton (Cutler Hammer) Equal.

26 2416 PANELBOARDS

A. Power Distribution Panels: Power distribution panel boards serving large individual loads shall be 277/480 volt; 3-phase, 4-wire circuit breaker type.

B. Power Branch Circuit Panels will be served from 120/208 volt, 3-phase, 4-wire, circuit breaker type branch circuit panel boards.

C. Lighting Branch Circuit Panels will be served from 277/480 volt, 3-phase, 4-wire, circuit breaker type branch circuit panel boards.

D. Directories for panel boards shall be made only after permanent room numbers have been assigned by the University, and not by the room numbers indicated on drawings. Panel board directories shall be typewritten, neat, and legible.

E. Terminations: Only one (1) wire per terminal will be permitted.

F. Spare Breakers: Spare breakers will be provided in all panel boards. (Minimum of 6 20A/1p)

G. Spaces: Spaces for the addition of future breakers will be provided in all panel boards.

H. Panels shall be designed so that a maximum of 75% of the poles are initially used.

I. Panels shall have copper bussing and main lugs or main circuit breaker as required by the design documents.

J. Cabinets: Panel board cabinets shall be fabricated of code gauge galvanized steel, arranged for flush or surface mounting as required, with standard finish inside and outside over rust-inhibiting primer. All panels shall be at least 20-inches wide and 5-inches deep.

K. Cabinet door locks: All cabinets shall be key locked with one (1) standard key for the entire building.

L. Nameplates: see electrical identification section of this standard.

M. Basis of design shall be SQ-D and Eaton (Cutler Hammer) Equal.

26 2419 MOTOR CONTROL CENTERS

A. Motor Control Centers: Motor control center shall consist of vertical sections each 20-inches deep and 20-inches wide, joined together to form a rigid, freestanding dead-front NEMA-1 or 12 enclosure. Center shall be NEMA class II, type C construction.
B. Basis of design shall be SQ-D and Eaton (Cutler Hammer) Equal.

26 2701 ELECTRIC UTILITY SERVICES

A. Main Electrical Power
   1. Commercial power is supplied by the Consumers Energy Power Company. Incoming power is configured for 12,470 WYE/ 7,200 volt, 3 phase, 4 wire. Distribution operating voltage is 13,100 volts. The primary switches distribute underground primary service to all buildings. Other configurations exist as a part of the existing campus distribution. The Design Professional shall verify system voltage configuration that is existing or required.

26 2702 SHORT CIRCUIT, ARC FLASH AND COORDINATION STUDIES

A. The Design Professional shall provide a current and complete short-circuit study, equipment-interrupting or withstand evaluation, a protective-device coordination study and an Arc Fault study for the electrical distribution system.

B. These studies shall coordinate with existing CMU medium voltage distribution system studies. Any changes, modifications, updates, etc., to the existing medium voltage studies shall be included by the Design Professional for an overall electrical system coordination.

C. The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operations, and operations which could result in maximum-fault condition shall be thoroughly covered in the study.

D. Short-Circuit Study:
   1. The study shall be in accordance with applicable ANSI and IEEE standards.
   2. The study input data shall include the short-circuit single- and three-phase contributions from all sources, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.
   3. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panel board, pertinent branch circuit panel boards, and other significant locations through the system.
      a) For the portions of a system utilizing medium voltage breakers, separate calculations shall be made for on-half cycle (close and latch) currents and interrupting currents. Calculations shall be for three-phase and phase-to-ground faults at each bus under consideration.

b) For the portions of a system utilizing low-voltage breakers (less than 1,000 volts), calculations shall be made for three-phase and phase-to-ground interrupting currents at each bus under consideration.

E. Equipment Evaluation Study:
   1. An equipment evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the maximum short-circuit momentary and interrupting duties.

F. Protective-Device Coordination Study:
   1. A protective-device coordination study shall be performed to select or to verify the selection of power fuse ratings, protective-relay characteristics and settings, ratios, and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings.
   2. The coordination study shall include all voltage classes of equipment from the source's incoming line protective device down to and including each motor control center and/or panel board. The phase and ground overcurrent protection shall be included as well as settings for all other adjustable protective devices.
   3. Protective device selection and settings shall be in accordance with requirements of the National Electrical Code and the recommendations of ANSI/IEEE.

G. Study Report:
   1. Discrepancies, problem areas, or inadequacies shall be promptly brought to the attention of the CMU Project Manager.
   2. The results of the power-system studies shall be summarized in a final report.
   3. The report shall include the following sections:
      a) Description, purpose, basis, and scope of the study and a single-line diagram of the portion of the power system which is included within the scope of study.
      b) Tabulations of circuit breaker, fuse, and other equipment ratings versus calculated short-circuit duties and commentary regarding same.
      c) Protective device coordination curves, with commentary.
      d) The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer rations, manufacturer, type, range of adjustment, and recommended settings. All tabulation of the recommended power fuse selection shall be provided for all fuses in the system.
      e) Fault-current tabulations including a definition of terms and a guide for interpretation.

H. Arc Flash Study:
   1. An Arc Flash Study shall be performed to help protect individuals from electrical arc flash hazards. To accomplish this, an incident energy study shall be performed in accordance with the IEEE and as referenced in NFPA 70, "Standard for Electrical Safety in the Workplace", in order to quantify the hazard for selection of personal protective equipment (PPE).
   2. The Electrical Design Professional shall provide a comprehensive Arc Flash report that includes:
      a) Report summary with analysis methodology, findings, and recommendations.
      b) Summary of input data for utility source, equipment, and cables.
      c) Available fault current at each equipment location with comparison to equipment rating.
      d) Overcurrent device settings (e.g. pick-up, time delay, curve), "as found" and "as recommended".
      e) Incident energy level (calories/cm^2) for each equipment location and recommended PPE.

f) Overcurrent device coordination curves including related section of the single-line diagram.
g) Complete system single-line diagram for the system analyzed.

3. Based on the results of the incident energy study, the Electrical Design Professional shall specify a warning label(s) for electrical equipment in accordance with ANSI standards. The label must be readable in both indoor and outdoor environments for at least 3 years.

I. Implementation:
1. The Design Professional shall specify that an independent testing firm which is NETA certified shall inspect, set, test, and calibrate the protective relays, circuit breakers, fuses, and other applicable devices as recommended in the power-system study and affix labels per the Arc Flash reports.

26 2716 CABINETS AND ENCLOSURES

A. Cabinets and enclosures will be similar in external appearance to circuit breaker panels with locking door. Interiors shall be fitted with a plywood backboard and terminal strips. All equipment will be properly identified. Refer to Section 26 0553, Electrical Identification.

26 2717 EQUIPMENT WIRING

A. The Contractor supplying motor driven equipment will furnish and install all associated motors.

B. Power factor correction capacitors will be used for all motor loads 5 HP and larger.

C. Control: Capacitors will be switched with the motor and are to be sized in accordance with motor manufacturer's recommendations for maximum corrective KVAR rating.

D. Capacitors are **not** to be used on motors controlled from variable frequency drives (VFD's).

E. Motors ½ HP and larger shall be 3-phase.

F. Motors under ½ HP shall be single phase.

G. Motor Control: A motor control center shall be provided for 3-phase motors as recommended by the Design Professional and approved by CMU Project Manager, except for lift and elevator motors.

H. Single-phase motors shall be fed from panel boards.

I. Elevator and lift motors shall be fed from separate circuit breakers in the main switchboard.

26 2726 WIRING DEVICES

A. All devices shall be labeled with the panel and circuit designation.

B. Switches: Specification grade 20-ampere flush toggle type rated 120/277 volt.

C. Low Voltage Switches: Specification grade, SPDT contact, flush toggle type; momentary contact, spring return to center (OFF).

D. Low Voltage Dimmers: Slide style to match type and style of luminaire, 0-10V, 120/277V. Color by design professional. Products to match entire building or project.

E. General Convenience Outlets: Specification grade, duplex receptacles rated 120 volt, 20-amp, 3 wiring grounding type. Verify color with CMU Project Manager.

F. Generator Convenience outlets: Specification Grade, Duplex receptacles rated 120 volts, 20 Amp, grounding type. Color RED.

G. Specialty generator receptacles shall match equipment and be color RED.

H. Device Plates:
   1. Brushed stainless steel in finished spaces or as recommended by Design Architect and approved by CMU Project Manager.
   2. Galvanized steel in unfinished spaces.
   3. Smooth stainless steel in kitchen areas.

I. Ground Fault Circuit Interrupter (GFCI): GFCI receptacles shall be used to reduce shock hazards. (5 MA trip); typical locations:
   1. Custodial rooms at shelf height.
   2. Mechanical rooms, Garages, kitchens, vending machines
   3. Toilet rooms.
   4. GFCI receptacles with in-use weatherproof covers will be provided on the exterior of the building, at building entrances and other locations designated by the CMU project manager.
   5. Elevator machine rooms and elevator pits.
   6. Where required by NEC.

J. Convenience outlets shall be duplex, grounded type, heavy duty. At least one general use convenience outlet shall be installed in each hallway, utility room, mechanical room, and additional rooms as directed by the Project Manager.

K. Special Receptacles: Special purpose receptacles such as range outlets, and additional devices as directed by the Project Manager., will be provided with locations and types as determined by consultation with the CMU Project Manager.

L. Installations of critical equipment (such as -80 freezers) shall be equipped with remote alarm monitoring. This alarm shall be installed by CMU OIT and monitored by CMU PD. The CMU Project Manager shall verify that remote monitoring is required by the user as there is associated annual operating cost which is charged to the user department.

M. Provide Arc Fault (AFCI) receptacles or breakers as required to comply with Michigan Building & Rehabilitation Codes. Advise CMU Project Manager of such requirements.

N. Provide duplex receptacle equipped with dual “USB” ports as directed by CMU Project Manager.

O. Provide 120V duplex receptacle on each floor of stairwell.

P. Occupancy Sensors: Refer to Section 26 5200 Interior Lighting Control.

Q. When room scheduling touch screens are requested on Campus, the only approved unit is the Crestron TSS-7 (TSS-7-B-S) in black version. Refer to website Crestron http://www.crestron.com/products/model/TSS-7

Crestron Electronics, Inc.
6 Volvo Drive
Rockleigh, NJ 07647

Crestron offers a multi-surface mounting kit and a mullion mounting kit. Crestron specifies that this panel can also be installed over a 2-gang electrical box or plaster ring, horizontally-oriented 1-gang electrical box or plaster ring, or small cutout. In any fire rated walls a fire-rated box will be required. The unit is powered via the Ethernet connection so no separate power will be required. The unit does require an Ethernet connection which is to be run in the wall either through a conduit or within the wall itself. Exposed wireway is only allowed if no other path is available and has to be approved by the Director of University Engineering and Planning and the Director /Network, Information Technologies. If Wiremold is to be used, it should be run in the least conspicuous manner possible and hidden from view as much as possible. The wireway will have to be painted to match the adjacent wall surface.

26 2813 FUSES

A. Fuses: Fuses will be provided for all fusible equipment. Fuse type and size shall be selected for the intended use and shall be clearly indicated in the Design Documents.

26 2818 ENCLOSED SWITCHES

A. Heavy duty fused or non-fusible disconnects will be furnished for all motors and equipment not in sight of respective panel or starter/disconnect.

B. All disconnects shall be capable of being ‘padlocked’ in the ‘OFF’ position.

C. NEMA enclosures shall be specified for correct application.

D. Basis of design shall be SQ-D and Eaton (Cutler Hammer) Equal.

26 2913 ENCLOSED MOTOR CONTROLLERS

A. Manual motor starters will be provided for motors 1/3 HP and smaller.

B. In general, motors 1/2 HP and larger will be provided with magnetic motor starters. Refer to Mechanical standards for Variable Frequency Drive controllers.

26 3213 PACKAGED ENGINE GENERATOR

A. Provide emergency / standby generator for the following loads at a minimum:
   1. Emergency lighting per code.
   2. Building Monitoring System (BMS), Fire Alarm System (FA), and Security System (SEC).
   3. Sump pumps and Lift Station.
   4. Walk in coolers and freezers (Shall also be alarmed back to the CMU Power House).
   5. Selected air-handlers when associated with laboratories.
   6. One (1) elevator per building.
   7. Steam condensate return pumps.
   8. Low temperature freezers and refrigerators for laboratories. Approved by CMU Project Manager. (Shall also be alarmed back to the CMU Power House)

B. Natural gas generators shall be specified for sizes of 250kW or less. Diesel generators equipped with belly tanks shall be specified for generators greater than 250kW. Onan, Kohler, Cummins and Michigan Caterpillar approved manufacturers.

26 4300 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. General:
   1. The purpose of installing the Environmental Potentials (EP) TVSS products on CMU's electrical distribution systems is to remove all of the electrical disturbances (spikes, surges and high frequency noise) from the distribution systems as it is generated. These electrical disturbances will be absorbed and kept within the device. The device(s) will convert the electrical disturbances to thermal energy and dissipate it in the form of heat. The devices will not shunt the disturbances to neutral or ground. The EP TVSS product shall keep Crest Factor as close as possible to 1.4. This product technology will also reduce conductor skin effect and di/dt and dv/dt for improved motor efficiencies.

B. Applications:
   1. The Design Professional shall contact the EP manufacturer's representative for application guidelines of the EP TVSS devices. The EP manufacturer's representative shall also review and comment at 90% CD review for inclusion into the design as directed by the CMU Project Manager. (Tom Erdman 989-652-2431 New Technologies 888-780-7839)

C. System Commissioning:
   1. A Power Quality Study will be completed to verify power quality standards have been met, and proper installation and operation of TVSS equipment. This study shall be submitted to the CMU Project Manager.

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26 5100 INTERIOR LIGHTING

A. Scope:
The Interior Lighting Design Criteria shall be used as the basis of CMU lighting design. The Design Engineer may be required to deviate from this standard dependent upon the specific project requirements. Any deviations from this standard shall be approved by the CMU Project Manager and the Director of University Engineering and Planning prior to implementation.

B. Standards & Regulations:
The design criteria for interior lighting systems shall follow the current IESNA recommendations for lighting design, comply with the latest edition of the ASHRAE/ IESNA 90.1, IEEE, CMU Energy Guidelines and any subsequent CMU requirement. The requirement of this section must be coordinated with the CMU Energy Guidelines & the use of historical data for optimum design.

C. System Design and Performance Requirements:

   1. Design Criteria

      a. All lighting fixtures shall be served from 277/480 volt, 3-phase, 4-wire lighting distribution system, when possible. Exception: Residence Halls.

      b. LED lighting will be used in all locations for area illumination.

c. Design lighting systems to achieve required levels of illumination while minimizing energy consumption. Interior lighting systems must operate at the highest practical voltage level available. Specify high reflectivity interior finishes achieving the following minimum reflectance:

- Ceilings: 80 percent
- Walls: 50 percent
- Floors: 20 percent

**Adjust reflectance's to match type and color of floors, ceilings and walls. Also furniture walls and surfaces.

d. Long Term Cost of Ownership Analysis may be required to determine the most cost effective lighting solution.

e. Provide compliance documentation as outlined by ASHRAE 90.1. Refer to ComChek DOE's Building Codes Program. www.energycodes.gov

2. Use control devices, such as blinds, diffusers, and light shelves to control distribution, brightness, and glare.

a. Natural Daylighting controls per ASHRAE 90.1 verify with CMU Project Manager.

3. Determine the input watts for each luminaire type.

a. Calculate the system Lighting Power Density (LPD), for the different spaces lighted by the various luminaire types, in lumens per square foot.

b. Submit illuminance calculations (point by point) for all areas for both emergency and normal operation.

c. LED lighting design shall maximize the use of recessed and direct/indirect 2'x4', 2'x2' luminaires, and specialty lighting as approved by CMU Director of University Engineering and Planning. Color temperature shall not be greater than 3500K. CRI greater than or equal to 80. Projected life of 50,000 hours at 70% lumen output minimum (L70). LED systems shall be modular and allow for separate replacement of LED modules and drivers. LED drivers shall be 0-10V continuous dimming that works with any 0-10V control/dimmer. Electronic drivers shall be rated for 120-277V applications. LED fixtures shall be equipped with high grade optical acrylic lenses to provide a directed optical distribution for optimal light uniformity, enhanced visual comfort and efficiency.

d. All lenses, drivers, ballasts, fuses, and all other fixture components shall be available for purchase as individual replacement components for maintenance and repair.

e. LED luminaires shall have a minimum of 5 year warranty

4. Design for maintained light levels that use realistic maintenance factor of 0.85 Light Loss Factor (LLF).

5. Design interior lighting systems to achieve the following levels of illumination, measured in maintained horizontal footcandles on a working surface located 30 inches above floor level, within a tolerance of plus 20 percent or minus 5 percent and subject to the approval of CMU Project Manager and Director of Utilities and Energy.

6. The following lighting and power density recommendations have been adopted for the common tasks performed in buildings. Lighting levels for various function areas have been identified. These lighting levels have been selected based on criteria established by the Illuminating Engineering Society (IES) and CMU historical data. Lighting Power Density must be equal or be less than ASHRAE 90.1. CMU historical data must be considered.

Functional Area with Light Level	**fc**
Classrooms	45
Cafeteria Eating Area	20
Cafeteria Preparation Area	70
Conference Rooms	30
Corridors / Lobbies	20
Computer Lab	30
Elevators	20
Science Labs	70
Locker Rooms	20
Loading Docks	30
Lounges	20
Library – Reading Area	45
Library - Stacks	30
Library – Check in/out	45
Lecture Hall Seating Area	35
Lecture Hall Instruction Area w/o Video Recording	45
Mechanical, Electrical & OIT Rooms	25
Offices (Private) w/o Task Lighting	35
Offices (Private) with Task Lighting	25
Open Office with Task lighting	25
Rest Rooms	20
Work Rooms	40
Vending Area	20

7. Clarification of Lighting Recommendations

a. Light levels can be achieved with the associated lighting power densities (installed lighting wattage divided by space square footage) when fixtures are LED. Areas that have dark colored ceilings, walls or floors may require higher lighting power densities to obtain the indicated light levels. Higher lighting levels and power densities must be justified by the designer and approved by CMU Project Manager and Director of University Engineering and Planning.

c. In occupancies where specialized tasks are performed (for example, at serving areas in dining halls and at mirrors in toilet rooms), the illumination levels listed might not be

sufficient for adequate illumination. At such locations, increase the ambient lighting levels as necessary. Ambient lighting may also be supplemented by task lighting with the approval of the Project Manager (the ambient level should not be less than one-third the level at the task).

d. Lighting levels for Specialized Tasks: Laboratories, shops and work areas where critical or very fine tasks are performed, or areas where poorly printed or reproduced material is used may requires higher light levels. These higher levels shall be directed to the task area only. Ambient lighting levels shall not be increased to meet the needs of particular tasks.

e. In general, illumination levels in excess of seventy (70) foot-candles shall be provided by task lighting only.

f. Lighting Power Density: The designer shall use the foot-candles level's schedule when calculating the Lighting Power Density (LPD) and they should not exceed the LPD outlined in ASHRAE 90.1. Designers unable to meet these criteria shall clearly demonstrate reasons for exceptions to the CMU Project Manager, Director of University Engineering and Planning, and Director of Energy and Utilities.

D. Interior Building Lighting:

1. Incandescent and fluorescent lighting is not acceptable.

2. LED fixtures shall be all metal with hinged shielding louver or lens. Hinges shall operate and release without deforming louver.

E. Exit Signs:

1. Exit signs shall be 'RED' LED style for energy efficiency and equipped with battery back-up. Where emergency generator is available, circuit to generator in lieu of battery back-up.

F. Emergency and Night Lights:

1. Emergency lighting will be provided per code and equipped with battery back-up. Where emergency generator is available, circuit to generator in lieu of battery back-up.

2. Provide a point by point layout of the emergency lighting that will meet Michigan Building & Rehabilitation Codes. Submit to the AHJ and the CMU Project Manager.

3. Provide emergency lighting in each multi stall restroom.

4. Emergency light fixtures shall not operate 24/7, they are not to be used as night lights.

5. Emergency transfer devices shall be provided at all switched emergency lighting per code.

   a. Approved manufacturers: Bodine.

b. Emergency transfer devices to be located in nearest storage, electrical, mechanical or Janitor closet. Where this is not possible, group together above accessible ceiling space.

G. Night lighting will be kept to a minimum.

1. Possible locations required are vestibules for security purposes and where required for security cameras and Multi stall bathrooms. Review locations with CMU Project Manager, Director of University Engineering and Planning, and Director of Energy and Utilities.

2. Residence halls to have corridor night lighting at 50%. Provide override switch in designated location.

26 5200 INTERIOR LIGHTING CONTROL

A. The Design Engineer shall develop project specific lighting control strategies with the CMU Project Manager for the approval by the Director of University Engineering and Planning. These strategies shall include; Occupancy / Vacancy Sensing, Scheduling, and Low voltage 0-10 volt Dimming.

B. Day Light control shall be per ASHRAE 90.1 with Michigan exceptions.

C. If directed by CMU Project Manager, use natural Day light control devices at windows to control distribution, brightness, and glare. Natural light control devices may be such things as blinds, diffusers, and light shelves or other devices as approved by the CMU Project Manager and the Director of University Engineering and Planning.

D. Definitions:
1. Screen lighting is defined as the lighting at the audio/visual screen or monitor location. Screen lighting is typically in the front of the room.
2. Window lighting is the artificial light in the room that is within 15 feet in front of exterior windows.
3. Perimeter lighting is defined as the lighting that is within 15 feet of room perimeter building walls. Perimeter lighting is not window lighting.
4. General lighting is defined as room lighting that is not part of the screen lighting or window lighting.
5. Natural lighting is the light found in nature coming from the sun. Natural light occurs during daylight hours.
6. Manual control shall be low voltage or line voltage to meet ASHRAE 90.1.
7. All controls to meet ASHRAE 90.1
8. All occupancy sensors shall be Dual Technology style with adjustments to shut off the infrared or ultrasonic.

E. Standard Classroom lighting shall be zoned in three groups; screen lighting, general lighting, window lighting. Occupancy sensor system used to control these zones. Provide a relay contact for the HVAC system. Provide interface to the Crestron AV desk unit. Manual control may lower this design set-point. All lighting shall be dimmable with 0-10 volt dimming. Basis of design shall be WattStopper. Equal equipment by Lutron.

1. Scene control shall consist of:
    a. Auto ON occupancy sensor detection - all lights to 50% as entering the room.
    b. Manual ON - All lights are on 100%.
    c. Class Instruction at desk and door entry – Screen lights 100% on. General lighting and Window lighting at 50%. Manual control to raise and lower lights.
    d. A/V instruction at desk and door entry– Screen lights are off. General lighting and Widow lighting at 50%.
    e. All OFF at desk and door entry- All lights off.
    f. Auto all off via Occupancy sensor with no motion for 15 min.

F. Active Learning Classroom shall be zoned in three groups; general lighting, perimeter lighting, window lighting. Occupancy sensor system used to control these zones. Provide interface to the Crestron AV desk unit. Manual control may lower this design set-point. Basis of design shall be WattStopper. Equal equipment by Lutron.
    1. Scene control shall consist of:
        a. Auto ON occupancy sensor detection- all lights to 50% as entering the room.
        b. Manual ON at desk and door entry - All lights are on 100%.
        c. Class Instruction and A/V instruction at desk & door entry – All lighting at 50%.
        d. All OFF at desk and door entry-
        e. Auto all off via Occupancy sensor with no motion for 15 min.

G. Lecture Halls and Auditoriums shall be zoned in three (or more) groups; screen lighting, general lighting, window lighting. (The Design Engineer shall consider optional zones such as, but not limited to, podium lighting, aisle egress lighting and accent lighting.) Occupancy sensor system used to control these zones. Provide a relay contact for the HVAC system. Provide interface to the Crestron AV desk unit. Basis of design shall be Wattstopper or Lutron.
    1. Scene control shall consist of:
        a. ON – General lights are on.
        b. Class instruction / Lecture – Screen lighting is on 100%. General lighting and window lighting is set to 50% of design FC. Manual control to raise and lower lights.
        c. A/V – Screen lighting off. General lighting and window lighting is set to 25% of design FC.
        d. Recording – If required, the design engineer shall determine correct lighting and control requirements for the purposes of video recording or distance learning.
        e. OFF- All lights off after 15 minutes of no motion.

H. Science Labs shall have three (3) lighting levels; off, 50% lighting, and 100% lighting. When entering a dark lab and occupancy is sensed, the lab shall go to 50% lighting. During occupancy, the lab may go to 100% with manual override. Provide a relay contact for the HVAC system. Provide interface to the Crestron AV desk unit. Basis of design shall be WattStopper. Equal equipment by Lutron. Discrete task lighting at lab benches shall be equipped with independent occupancy sensors. The design engineer and CMU Project Manager shall work with the user to identify critical tasks in lab areas where occupancy lighting control may not be desired.

I. Computer labs shall have three (3) lighting levels; off, 50% lighting, dimmable and 100% lighting with manual controls. Manual control may lower this design set-point. When occupancy is sensed, lighting will go to 50%, manual override to 100%. Provide a relay contact for the HVAC system. Provide interface to the Crestron AV desk unit. Basis of design shall be WattStopper. Equal equipment by Lutron.

J. Corridors and lobbies shall be on / off control via occupancy sensors, when no motion is sensed then lighting is reduced to 50% then all off after another 30 min. Schedule controlled on / off

during normal hours of operation and occupancy sensor controlled afterhours shall be reviewed for 24/7 operation facilities. Manual on/off control in remote location. All determinations of operation by CMU Project Manager and Director of University Engineering and Planning. Basis of design shall be WattStopper. Equal equipment by Lutron. See night light discussion contained in this standard for further information.

K. Open offices shall be zoned in two groups; window lighting and general lighting. Manual control with dimming may lower this design set-point. Manual on/off local control, also with partial auto on to 50% with occupancy sensors and manual adjustment override to 100%, and auto full off. Occupancy sensor system used to control the open office. Basis of design shall be WattStopper. Equal equipment by Lutron.

L. Private offices shall have three (3) lighting levels; off, 50% lighting, and 100% lighting. When occupancy sensing the office shall go to 50% lighting. The private office shall go to 100% with manual command. If occupancy is not sensed for 15 minutes, all lighting shall go off. Settings may be lower if requested by manual dimming control. Basis of design shall be WattStopper. Equal equipment by Lutron.

M. Conference rooms shall have three (3) levels of switching; off, 50% lighting and 100% lighting. When occupancy is sensed, the conference room shall go to 50% lighting. The conference room shall go to 100% with manual command. If occupancy is not sensed for 15 minutes, all lighting shall go off. Settings may be lower if requested by manual or dimmable control. The Design Engineer must coordinate with the A/V equipment that may be required in conference rooms for video presentations, video conferencing or other project requirements. Basis of design shall be WattStopper. Equal equipment by Lutron.

N. Other areas , but not limited to, study rooms, locker rooms, loading docks, work rooms, and vending areas, shall have occupancy sensor partial auto on to 50%, 100% local control on / off and auto off . Occupancy sensor system used to control these areas. Basis of design shall be WattStopper. Equal equipment by Lutron.

O. Rest rooms shall occupancy sensors to 100% on and off with local control, a night light shall be installed in all multi stall bathrooms. Basis of design shall be WattStopper. Equal equipment by Lutron.

P. Display lighting shall be controlled by time of day lighting control system for on / off control. There shall be no local control. Basis of design shall be WattStopper. Equal equipment by Lutron.

Q. Mechanical rooms, electrical rooms, and OIT rooms shall not be equipped with occupancy sensor controls, local manual control on/off only.

R. Residence hall spaces living quarters shall have local switching in all residence rooms. Corridors shall have occupancy sensors to reduce light to 50% while no motion is detected. Remote switch shall override the sensors to 100%. Basis of design shall be WattStopper. Equal equipment by Lutron.

S. Dining Rooms and Food courts shall consist of lighting control and, in some cases, scene setting. The Design Professional and CMU Project manager shall work with the user group to identify lighting requirements to include, but not limited to general lighting, accent lighting, and window lighting, to identify required lighting controls. Provide a relay contact for the HVAC system. Occupancy and daylight harvesting sensor system used to control these areas shall be Basis of design by WattStopper. Equal equipment by Lutron.

T. Design professional, during Design Development, shall provide CMU a matrix of each room number, description and the criteria based on ASHRAE 90.1 and this standard. Show all exceptions to ASHRAE. Refer to "Lighting Controls Matrix.xlsx" on the website. https://www.cmich.edu/fas/fmgt/pep/Pages/default.aspx

U. Refer to Division 26 "Lighting Control Details" at the following web address: https://www.cmich.edu/fas/fmgt/pep/Pages/default.aspx

26 5600 EXTERIOR CAMPUS LIGHTING

A. Lighting Fixtures:
   1. Exterior lighting to comply with the latest edition of the Illuminating Engineering Society's minimum recommendations.
   2. ASHRAE/IESNA Standard 90.1 Exterior Lighting section will be used to establish lighting power densities. Central Michigan University, located in Mount Pleasant, MI, is categorized by RP-33-99 of IESNA as Lighting Zone 3, Medium Ambient Brightness.
   3. Light trespass from campus onto neighboring properties shall be minimized as described in these standards. CMU will also meet the intent of the City of Mt Pleasant Light Pollution Ordinance. Refer to the City of Mt. Pleasant Light Pollution Ordinance.
   4. To ensure comfort and security, on-campus lighting shall provide uniform lighting levels along walkways, parking lots, and building entrances as identified in the Site Lighting Levels table below.

B. Building Mounted Site Lighting Fixtures:
   1. Exterior entrance lighting shall be LED type. Recessed soffit or wall bracket type fixtures to be used where applicable. At least one fixture near emergency exit shall be powered on emergency generator or by emergency battery unit. The location of fixtures shall be coordinated with the Director of University Engineering and Planning.

C. Pole Mounted Site Lighting Fixtures:
   CMU campus standard for walkway and parking lighting is KIM Lighting Archetype AR/SAR series.
   1. Standardization:
      a. Refer to Division 26 "Light Pole Details" Sheet E-1, E-2, E-3, E-4 at the following web address: https://www.cmich.edu/fas/fmgt/pep/Pages/default.aspx
      b. Any deviations from the standard fixture will have to be specifically approved through the standards deviation form. Refer to Division 1 of the design standards
   2. Lamp Type:
      a. CMU will standardize on the LED type.
      b. LED lighting source shall be specified for pole mounted exterior lighting 10' above grade and higher.
   3. Light Levels - Refer to site lighting levels
   4. City of Mt Pleasant Light Pollution Ordinance:
      a. Refer to the City of Mt. Pleasant Light Pollution Ordinance.
      b. Exterior up lighting is prohibited.
   5. Control:
      a. Photo-electric control shall be provided for all exterior lighting. One control shall control all lights. The control circuit shall have a hand-off-auto switch of reselecting the mode of control for overrides the auto position.

6. Bollard Lighting:
   a. Prohibited on the Campus of CMU.
7. Site lighting purchasing procedures:
   a. KIM Lighting and CMU have a purchasing agreement in place. The following purchasing procedures are to be used:
   b. Third party design:
      i. CMU Project Manager advises distributor, CMU Purchasing, and KIM representative of upcoming project. Include scope of work with tentative schedule.
      ii. Third party Design Professional shall work with KIM rep during design for photometrics and applications.
      iii. KIM creates project specific purchasing authorization number. This number is forwarded to CMU project manager, third party Design Professional, CMU purchasing and distributor.
      iv. This authorization number is communicated to successful electrical contractor by the Project Manager, and then to the distributor by the successful electrical contractor for the specific project at the time of order placement.
      v. Contractor purchases product with pre-determined pricing.
      vi. Delivery to the contractor for installation, check, test, and start and Warranty.
   c. In-house design:
      i. CMU Project Manager advises distributor, CMU Purchasing, and KIM representative of upcoming project. Include scope of work with tentative schedule.
      ii. CMU Project Manager shall work with KIM rep during design for photometrics and applications.
      iii. KIM creates project specific purchasing authorization number. This number is forwarded to CMU Project Manager, CMU purchasing, and distributor.
      iv. This authorization number is communicated to successful electrical contractor by the Project Manager, and then to the distributor by the successful electrical contractor for the specific project at the time of order placement.
      v. Contractor purchases product with pre-determined pricing.
      vi. Delivery to the contractor for installation, check, test, start and Warranty.
   d. Facilities Operations:
      i. Facilities Operations manager advises distributor, CMU purchasing (and University Stores) and KIM representative of required maintenance purchases.
      ii. Facilities Operations manager work with KIM rep for applications.
      iii. KIM creates project specific purchasing authorization number. This number is forwarded to Facilities operations manager, CMU purchasing and distributor.
      iv. This authorization number is used for discrete Facilities Operations purchases for maintenance and repair.
      v. Facilities Operations with University Stores purchases product with pre-determined pricing.
      vi. Delivery to the Facilities Operations for maintenance and repair or stock.
   e. Accounting/Reporting:
      i. KIM rep shall create CMU Purchasing log to track quantity and CMU cost.
      ii. Purchasing log would be submitted to CMU Purchasing to verify pricing and good practices.
      iii. Semiannual meeting with CMU Purchasing to review purchasing log.

8. Site lighting levels:

	DESIGN LEVEL – AVG FC	RATIO	LIGHT SOURCE	MIN FC	POLE HEIGHT
PARKING LOTS – MEDIUM (1)	0.4	20:1 MAX/MIN	LED	0.1	30’
WALKWAYS	0.4	4:1 AVG/MIN	LED	0.1	10’
CENTRAL AVENUE & RIBS	0.4	4:1 AVG/MIN	LED	0.1	16’
‘A’ STREETS	0.4	4:1 AVG/MIN	LED	0.1	24’
‘A’ STREET PARKING	0.3	4:1 AVG/MIN	LED	0.1	24’
‘B’ STREETS	0.4	10:1 MAX/MIN	LED	0.1	24’
ROADWAYS – MEDIUM (4)	0.25	20:1 MAX/MIN	LED	0.1	24’ or 30’
BLDG ENTRANCES - ACTIVE	1.0	25’ FROM DOOR OR UNDER CANOPY	LED		
BLDG ENTRANCES - INACTIVE	0.4	10’ FROM DOOR OR UNDER CANOPY	LED		

9. Other related requirements:
   a. All exterior area and security lighting shall be powered from one location within the building, preferably from the main electric room.
10. Temporary Construction Site Lighting:
   a. Specifications shall include temporary exterior security lighting of the construction area. Temporary exterior lighting fixtures shall be equipped with metal halide lamp or LED type and shall be shielded so that light does not spill off of the construction site.
   b. Contractor shall maintain all temporary exterior lighting and provide for repairs as necessary.
   c. Permanent building exterior lighting may be utilized during construction, as long as it does not spill off the construction site.
   d. Contractor shall maintain site walkway exterior lighting, on both temporary and permanent walkways at levels indicated in the CMU Design Standards.
11. Any permanent exterior fixtures used during construction shall be thoroughly cleaned and new lamps installed at final acceptance.

D. Temporary Construction Interior lighting:
   1. Contractor shall provide and maintain temporary interior lighting as necessary to complete the work in a safe manner and as required by state and safety codes.
   2. All Temporary lighting shall be dark sky compliant and cutoff at a 50 degree angle. No light shall trespass the confinement of the construction site.

3. Permanent building interior lighting may be utilized during construction if lighting controls are in place and operational to on-off cycle permanent fixtures.
4. Any permanent interior fixtures used during construction shall be thoroughly cleaned and new lamps installed at final acceptance.

END OF DIVISION 26 ELECTRIAL

DOCUMENT CONTROL PAGE:

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3.02.07	Converted to the 2004 CSI format. Revised Section 26 0513 (A). Revised Section 26 0537 (C). Revised Section 26 4300 to better define requirements.	Steve Lawrence
12.12.07	Revisions need after the Satellite Energy Facility went on-line. Revised Section 26 5600 (7) referencing Bollard Style Lighting. Revised Section 26 2416 removed isolated grounds. Revised Section 26 3213 to include additional item to be connected to the emergency generator.	Steve Lawrence
2.22.08	Revised section 26 1322 Medium Voltage Switches item B	Steve Lawrence
5.28.08	Revised section 26 0526 Grounding and Bonding sub-sections C and G to include Medium Voltage Switches.	Steve Lawrence
10.01.09	Revised section 26 5600 section A, B, and C to meet LEED intent	Steve Lawrence
1.30.12	Revised section 26 3213 Packaged Engine Generator	Steve Lawrence
3.13.12	Revised section 26 4300 Transient Voltage Surge Suppressors	Steve Lawrence
6.26.12	Revised section 26 24 13 L.7 removed Westinghouse IQ Data Plus Unit. Replaced with Eaton IQ-DP-4000.	Steve Lawrence
9.20.12	Revised sections 26 0501, 26 0513, 26 0519, 26 0536, 26 1200, 26 1322, 26 5100, and 26 5600	Steve Lawrence
12.12.13	Revised section 26 5600 Exterior Campus Lighting; Added section 10, 11, and 12	Steve Lawrence
5.7.14	Revised entire Division 26 Electrical Standard	Steve Lawrence

11.7.14	Revised entire section 26 5100 Interior Lighting	Steve Lawrence
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