
DIVISION 26 – ELECTRICAL

26 0500 BASIC ELECTRICAL REQUIREMENTS

- A. Electrical System Design:
1. This outline specification is intended to be a guide to the Electrical Engineering Department outlining Owner's standards
 2. Whenever possible, at least three (3) manufacturers will be specified for the various classes of electrical equipment. Such a procedure insures a favorable competitive bidding climate.
 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 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 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. When temporary electric is to be obtained directly from the utility company, the Electrical Contractor shall be responsible for all arrangements and will pay all costs involved
- D. Work in Existing Facilities:
1. It is incumbent upon the 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 addition of the NEC and Michigan Building Code.
 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 his proposal and the cost of correcting the non-conforming electrical installations shall be included. No additional costs for the correction of non-conforming electrical installations shall be paid by the university.
- 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 the contactors expense.

26 0501 ELECTRICAL DEMOLITION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Disconnect existing electrical systems in walls, floors and ceilings indicated for removal.

- C. Coordinate utility service outages and reconnections with Utility Company and/or Owner.
- D. Provide temporary wiring and connections to maintain existing systems in service during construction.
- E. Existing Electrical Service: Maintain existing system in service until new service is complete and existing loads are reconnected.
- F. Existing Electrical Feeders and Branch Circuits: Maintain feeders and branch circuits in service until replacement circuits are installed and ready to connect.
- G. Existing Fire Alarm System: Maintain existing system in service until new system is accepted.
- H. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service.
- I. Remove, relocate and repair existing installations to accommodate new construction.
- J. Remove abandoned wiring to source of supply.
- K. Remove exposed abandoned conduit and boxes, including abandoned conduit above accessible ceiling finishes.
- L. Disconnect abandoned outlets and remove devices.
- M. Provide blank device plate for abandoned outlets which are not removed.
- N. Disconnect and remove abandoned panelboards and distribution equipment.
- O. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- P. Disconnect and remove abandoned luminaires, brackets, stems, hangers and other accessories.

26 0513 MEDIUM VOLTAGE CABLE

- A. Primary Cable: 15KV, XLP insulated cable with concentric neutral and 133% insulation, PVC jacket, UL listed as type MV-90. Conductors shall be sized for a minimum load of 200 amps. Meet or exceed electrical and physical requirements of the latest addition of ANSI / ICEA S-94-649, IPCEA S-68-516, NEMA WC-8, and UL 1072 Std.
- B. All cables shall be neatly racked in all manholes, vaults, cable trays and pits.
- C. Cable splicers shall be NETA certified and approved by the Plant Engineering and Planning Department in advance of the work.
- D. 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

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

26 0519 BUILDING WIRE AND CABLE

- A. Service Entrance Conductors (sizes #12 thru #500 MCM AWG): Type USE stranded copper run in conduit.
- B. Branch Circuits and Feeders (sizes #12 thru #500 MCM AWG): Type THHN/THWN stranded copper run in conduit.
- C. Additional Capacity Neutrals: Provide increased neutral capacity for K-rated systems or systems with high 3rd harmonic content.
- D. Where there are multiple feeder circuits and a common neutral, increase the neural circuit one size.
- E. If neutrals are shared by more than one circuit, the neutral shall be increased one size larger than the current carrying conductor.
- F. Connectors: Wire connectors will be of the spring type, sizes #12-10 AWG, and hydraulic compression or mechanical type for larger than #10 AWG.
- G. Low Voltage Cable: Low voltage cable for alarm and detection, etc., will be multi-conductor as required for the particular application.
- H. Incoming electrical service 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 Plant 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.
- 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 50% of the design load for future growth.
- K. Branch Circuits: Lighting branch circuits shall not be loaded to exceed 50% of panel breaker ratings. Not more and six (6) unassigned general use duplex convenience outlets shall be on any on 20-ampere branch circuit.
- L. Minimum size for lighting and power branch circuits shall be No. 12 AWG stranded. Control system circuits shall be No. 14 solid.
- M. Circuit wiring through ballast channels of fluorescent fixtures shall be 600 volt 90 degree C insulated.
- N. Electrical cored to portable equipment shall be type ST or SO containing an identified equipment ground wire. Ranges and dryers shall be equipped with type SRDT.

- O. Joints in No. 10 and smaller wire shall be made with threaded-on plastic or nylon insulated connectors, or crimped-on copper sleeves insulated with plastic electrical tape. Hard insulated connectors shall not be used. Joints in No. 8 and larger conductors shall be made with pressure-type mechanical connectors insulated with plastic electrical tape.
- P. Use feeder busways in lieu of conduit and wire for loads in excess of 600 amperes. busways should include an equipment ground bus housing.

26 0521 MANUFACTURED WIRING ASSEMBLIES

- A. At the contractor's option prefabricated flexible cable assemblies can be utilized for lighting connections.

26 0526 GROUNDING AND BONDING

- A. General: The entire project will be grounded in accordance with the requirements of the National Electric Code.
- B. Metal Parts: All equipment and non-current carrying metal parts of the electrical system will be grounded.
- C. Ground Grid: 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. Building Steel: Building reinforcing steel will be grounded in accordance with the requirements of the Authority Having Jurisdiction.
- E. Service Ground: 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
- F. Equipment grounds and identified neutral shall not be electrically interconnected on the building side of the service ground.
- G. Primary Transformer and Medium voltage Switches: 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.
- H. Where physical protection is required, grounding conductors shall be installed in Rigid Galvanized Conduit. Provide bonding bushings on both ends.
- 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.

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 to the University.
 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. Exterior Raceways and Fittings: All underground cables, except campus lighting cables, shall be installed in raceway systems. Underground conduit may be an impregnated fiber duct or an acceptable plastic styrene duct provided with properly installed fittings.
- B. Encase all service conduits in a concrete envelope and locate a minimum of 30-inches below grade, except for area and street lighting. Ducts shall cross gas lines below the gas piping without exception.
- C. Incoming Conduits: Provide two (2) 4-inch conduits encased in concrete from the appropriate electric service manhole and associated outdoor pad-mounted 3-way oil switch to an outdoor pad-mounted transformer adjacent to the building. Slope conduits to drain toward the electric manhole. From the pad-mounted transformer extend all necessary conduits a pit under the Incoming section of the unit substation inside the building.
- D. Interior Raceways and Fittings: All materials in a raceway system shall be compatible. Minimum conduit size shall be ½-inch. Any given run of conduit must be continuous of the same type of material.
- E. Rigid Conduit: Rigid, galvanized, threaded, UL labeled conduit shall be used in slabs, underground, in exterior walls, in all corrosive and hazardous locations, or where subject to physical damage.
- F. EMT: UL labeled galvanized steel Electrical Metallic Tubing (EMT) may be used in interior partitions and above suspended ceilings, except in corrosive and hazardous locations.
- G. Plastic-jacketed rigid steel conduit shall be used in corrosive atmospheres.
- H. Flexible Conduit: 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 those allowed by NEC.
- I. Fittings: 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 threadless compression type steel couplings and connectors in interior partitions and above suspended ceilings.
- 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. Plastic conduit shall not be used.
- M. Aluminum conduit shall not be used.

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

26 0536 CABLE TRAYS

- A. Cable tray will be located throughout all corridors for telephone, data, CATV, fire alarm, security, and EMS. IT department of CMU will be consulted regarding size and location.
- B. Provide Cable tray in all IT rooms
- 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: 4" square stamped metal boxes with single or double gang raised covers.
- C. Floor Boxes: 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 one duplex receptacle on one side only. Low tension floor outlets for data and communications shall be in the same box as the power outlet but on the opposite side. Provide closable in-use covers for interior floor boxes containing receptacles and data ports. Refer to Section 16140, Wiring Devices.

26 0540 UNDERFLOOR DUCT

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

26 0553 ELECTRICAL IDENTIFICATION

- A. All conductors, raceway systems, panelboards, branch circuits and systems will be properly identified to aid in the future operation and maintenance of the electrical systems.
- B. All switches and receptacles shall have their circuit numbers identified on the back (inside) of the cover plate with permanent marker pen.
- C. 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.
- D. 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.

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

1. Labels shall be embossed adhesive tape.
2. Nameplates shall be made from GravoPLY and engraved with information.
3. All electrical equipment shall be labeled per the CMU 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
 - Panelboards
 - 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

F. Nameplate Tags

1. General information

Campus Voltage Configurations	Label Series
12,470 Volt, 3 phase, 3 wire	12.47
7,200 Volt, 1 phase, 3 wire	7.2
480 Volt, 3 phase, 3 wire	400
480/277 Volt, 3 phase, 4 wire	400
120/280 Volt, 3 phase, 4 wire	200
120/240 Volt, 1 phase, 3 wire	100
Emergency	300

- Each nameplate shall be attached using corrosive-resistant mechanical fasteners.
- Tag Size: 1 1/2" x 4"x 1/8" GravoPLY
- Tag Color:
 - Normal Power – White letters on Black background
 - Emergency Power – White letters on Red background

G. Tag Information shall be engraved as follows:

- a) **Building Code-Source panel-overcurrent device number**
Line # 1 (BR-SubA-401)
- b) **Load being serviced**
Line # 2 (MCC-A)
- c) **Location**
Line # 3 (Basement, First Floor, Etc.)

The 100, 200, 300, 400 numbers are reserved for main switches.

Switches shall be numbered sequentially (Example: 401, 402, 403, etc.) after main switch (Example: 400).

For example: switch 401 in substation 'A' in Brooks Hall serving the basement motor control center would have the following label:

<p>BR-SUBA-401 MCC BASEMENT</p>
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Line 1 letter height 3/8"
Line 2 letter height 5/16"
Line 3 letter height 5/16"

Provide 1/8" border on top and bottom of nameplate and 1/8" spacing between lines. Center text in nameplate so as to provide room for the mechanical fasteners.

Installation:

1. Install nameplate parallel to equipment lines
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
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 using screws or rivets.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.

26 0583 ELECTRIFIED FURNITURE CONNECTIONS

- A. Install and wire all electrified furniture connection whips furnished with the modular office furniture.

26 0923 LIGHTING CONTROL EQUIPMENT

- A. Connections from the BMS system will be made to lighting control relay panel for automatic control of lighting in all common spaces, corridors and exterior. .
- B. Common spaces to be controlled as follows:
 1. Corridors/Bathrooms/Stairs: BMS to control with occupancy sensor override. During occupied hours BMS will schedule lighting ON/OFF. During unoccupied hours occupancy sensors will turn lighting ON/OFF.
 2. Display lighting: BMS to control. During occupied hours BMS will schedule lighting ON/OFF. No local control.
 3. Vestibules: BMS control via schedule with light sensor override. BMS will schedule lighting ON/OFF, light sensor will turn lighting off when not required during occupied hours. Note: vestibules may require night lighting.
 4. Exterior Building mounted or Site lighting: BMS control via schedule with exterior light sensor override. BMS will schedule lighting ON/OFF, exterior light sensor will turn lighting on when required during occupied hours.
- C. Residence hall spaces to be controlled as follows:
 1. Local switching in all residence rooms

2. Corridors: Lighting control system to schedule lighting ON/OFF. During unoccupied hours lighting to be at 50%
 3. Stairs: Lighting system control with light sensor override. Lighting to operate 24/7, light sensor will turn lighting off when not required during occupied hours.
- D. Local occupancy sensors shall be utilized where possible in enclosed spaces. Spaces to be controlled as follows:
1. Small offices: Local occupancy sensors to be used to control lighting off, local switch is for manual "ON" control.
 2. Small conference rooms: Local occupancy sensor to control lighting ON/OFF. Local switch is for manual off control for AV presentations.
 3. Classrooms: Local occupancy sensor to control lighting ON/OFF. Local switch controlling fluorescent lighting is for manual off control for AV presentations. Local dimming switch controlling incandescent downlight is for manual on control during AV presentations. Provide auxillary contact for BMS contractor to control mechanical equipment.
 4. Small storage/Janitor rooms: Local occupancy sensor to be used to control lighting ON/OFF.
 5. Verify where additional auxillary contact for control of mechanical system may be required to reduce operating costs.

26 1200 PAD-MOUNT DISTRIBUTION

- A. Transformer shall be 3-phase, liquid-filled pad-mount for outdoor application. Ratings for Primary and Secondary voltage and size shall be determined by the Design Professional and approved by the Director of Plant Engineering and Planning. Basic impulse level: 95 KV BIL. Frequency 60 Hz, Taps – two 1-1/2% FCBM and two 2-1/2% FCAN., Temperature rise –65 deg. C., Coolant shall be insulating oil or R-temp fluid.
- B. Quality Assurance: Transformers shall be manufactured in accordance with the latest 2 applicable NEMA standards and ANSI C57.
- C. Transformers shall allow for oil sampling without shut down. And without entrance to transformer enclosure.
- D. Construction: The transformers 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.
- E. Core and coil: The core and coil assembly shall be wound core type with copper windings. The assembly shall be designed to reduce losses and noise and provide adequate short-circuited strength and heat dissipation. All wye-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.
- F. Cabinet: 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.

- G. 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.
- H. 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.
- I. Accessories: 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).

26 1322 MEDIUM VOLTAGE SWITCHES

- A. Liquid filled "T" style switches will be provided.
- B. All building services shall connect to the campus primary service by the use of outdoor pad-mounted 3-way primary 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 Manual PMH model pad mounted gear or approval equal. Switches and fuses shall be clearly visible when compartments are open. 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. Switch ratings shall be 14.4KV, 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 S&C SML-20 power fuses sized by the design engineer to coordinate with the existing underground electrical distribution system. Switch shall be mounted on box foundation with open bottom. Switch shall bear the label of a 3rd party testing agency. Provide all necessary accessories including spare fuses, lighting arrestors, ground pads and studs, etc. Color of switches shall be green.

26 2200 DRY-TYPE TRANSFORMERS

- A. 480V primary, 120/208V secondary, dry type transformers to be provided as required.
- B. 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.

- C. Taps are to be provided on the primary side of the transformer; (2) 2.5% above nominal and (2) 2.5% taps below nominal.
- D. Transformers must operate at audible sound levels below NEMA standard ST-20. Sound levels will not exceed:
 - a. 30 – 50 kVA: 45 db
 - b. 51 – 150 kVA: 50 db
 - c. 151 – 300 kVA: 55 db
 - d. 301 – 501 kVA: 60 db
 - e. 501 – 750 kVA: 65 db
- E. Transformer must incorporate vibration isolation.
- F. Transformers shall be floor mounted.
- G. All final connections will be made by means of flexible metallic conduit..
- H. Transformers shall be grounded per NEC

26 2413 SWITCHBOARDS

- A. Provide either circuit breaker type or fused disconnect type switchboard at service entrances for power distribution.
- B. Digital instrument metering to be provided with 'pulse output' contacts connected to the BMS system.
- C. TVSS protection to be provided.
- 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 50% of initial load.
- F. Buss shall be plated copper. All bussing shall meet UL Standard 891 temperature rise equipments. 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.
- G. Provide ground bus the full length of switchboard.
- H. The main service disconnect device shall be solid state draw out circuit breaker totally front accessible and front connectable. Circuit breaker to be provided with solid state trip.
- I. 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.

- J. Circuit Breakers: 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.
- K. 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.
- L. 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, ground fault pickup and ground fault delay. They shall also have an interchangeable rating plug.
 - 1. 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.
 - 2. Provide a voltmeter with phase to phase and phase to neutral selector switch to indicate the secondary voltage of each transformer.
 - 3. Provide a 3-element indicating ammeter with a demand register arranged to indicate the secondary amperes and maximum demand of each transformer.
 - 4. Provide fuses in the potential circuits of all instruments.
 - 5. 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.
 - 6. Provide barriers to isolate this metering compartment from adjacent equipment.
 - 7. A Westinghouse IQ Data Plus Unit may be used in place of individual metering.
- M. Provide a 4-inch high concrete pad and cable pits with drains under switchgear. Provide continuous channel iron sills under the entire assembly.
- N. Identification: Each item on the switchgear assembly is to be identified with engraved lamicoid nameplates.
- O. Buss bars: 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.
- P. All bus connections shall be silver-plated.
- Q. All bus bar connecting bolts and hardware shall be a minimum of 3/8-inch and shall be cadmium plated.
- R. Barriers shall be provided between all cubicles.
- S. 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.

- T. Cleanup: 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.

26 2416 PANELBOARDS

- A. Power Distribution Panels: Power distribution panelboards serving large individual loads shall be 277/480 volt; 3-phase, 4-wire circuit breaker type.
- B. Branch Circuit Panels: Power will be served from 120/208 volt, 3-phase, 4-wire, plug-on circuit breaker type branch circuit panelboards.
- C. Branch Circuit Panels: Lighting will be served from 277/480 volt, 3-phase, 4-wire, plug-on circuit breaker type branch circuit panelboards.
- D. Directories for panelboards shall be made only after permanent room numbers have been assigned by the University, and not by the room numbers indicated on drawings. Panelboard 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 panelboards.
- G. Spaces: Spaces for the addition of future breakers will be provided in all panelboards.
- H. Panels shall have copper bussing and main lugs or main circuit breaker as required by the design documents.
- I. Cabinets: Panelboard 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.
- J. Cabinet door locks: All cabinets shall be key locked with one (1) standard key for the entire building.
- K. Nameplates: refer to Section 16075, Identification
- L. Panels shall be designed so that a maximum of 75% of the poles are initially used.

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 enclosure. Center shall be NEMA class II, type C construction.

26 2701 ELECTRIC UTILITY SERVICES

- A. Main Electrical Power
 - 1. Commercial power is supplied by the Consumers 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 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 16075, 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 h.p. and larger shall be 3-phase.
- F. Motors under ½ h.p. shall be single phase.
- G. Motor Control: A motor control center shall be provided for all 3-phase motors, except for lift and elevator motors.
- H. Single-phase motors shall be fed from panelboards.
- I. Elevator and lift motors shall be fed from separate circuit breakers in the main switchboard.

26 2726 WIRING DEVICES

- A. Switches: Specification grade 20-ampere flush toggle type rated 120/277 volt.
- B. Low Voltage Switches: Specification grade, SPDT contact, flush toggle type; momentary contact, spring return to center (OFF).
- C. General Convenience Outlets: Specification grade, duplex receptacles rated 120 volt, 20-amp, 3 wiring grounding type.
- D. Device Plates:
 - 1. Brushed stainless steel in finished spaces.
 - 2. Galvanized steel in unfinished spaces.
 - 3. Smooth stainless steel in kitchen areas.
- E. 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 near points of service of equipment.
 - 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.

- F. 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, etc.

- G. Special Receptacles: Special purpose receptacles such as range outlets, etc., will be provided with locations and types as determined by consultation with the Owner.

- H. Provide 120V duplex receptacle on each floor of stairwell.

- I. Occupancy Sensors: Refer to Section 16580 Lighting Control.

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 with locks and 'Tags' installed by the Maintenance staff.

- C. NEMA 1 or 3R enclosures for dry or wet locations, respectively, will be provided.

26 2913 ENCLOSED MOTOR CONTROLLERS

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

- B. Magnetic Starters: In general, motors 1/2 HP and larger will be provided with magnetic motor starters.

26 3213 PACKAGED ENGINE GENERATOR

- A. Provide emergency 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.

- B. Natural gas generators for sizes of 250kW or less are preferred by University. For loads over 500kW consider multiple generators.

26 4300 TRANSIENT VOLTAGE SURGE SUPPRESSORS

- A. General
 - 1. The purpose of installing the Environmental Potentials (EP) family of 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 following outlines the general applications of the EP TVSS devices. The design professional shall contact the manufacturer for concurrence with device selection for their discrete CMU project.
 - a. EP2500 (Main Distribution Panel unit)
 1. Voltage and Phase configurations to suit application
 2. Product has less than 1 ohm of impedance
 3. Only installed on the main service entrance panel (main switch board)
 4. Must be installed on 30 amp breaker
 5. Unit internally fused at five amps
 6. Lead lengths must be kept as short as possible
 7. If lead lengths need to be lengthened a #10 wire or larger must be used. This is to keep the impedance to the unit as low a possible
 - b. EP2000 (Sub-Panel unit)
 1. Voltage and Phase configurations to suit application
 2. Product has less than 1 ohm of impedance
 3. Lead lengths must be kept as short as possible
 4. If lead lengths need to be lengthened, #10 or larger must be used. This is to keep the impedance to the unit as low a possible
 5. Mounted on all distribution panels, sub-panels, MCC's and UPS units
 6. Must be installed on 30 amp breaker
 - c. EP2700 (High Frequency Filter)
 1. High frequency filter only. No surge suppression. Cannot be mounted as a stand alone filter
 2. Must be installed on 30 amp breaker
 3. Must be on the same panel as an EP2000
 4. Lead Lengths must be a little longer than EP2000
 5. Voltage and Phase configurations to suit application
 6. Product has less than 1 ohm of impedance
 7. Lead lengths must be kept as short as possible
 8. If lead lengths need to be lengthened, #10 or larger must be used. This is to keep the impedance to the unit as low a possible
 - d. EP2775 & EP2750 Ground Filter
 1. Purpose is to remove ground loops
 2. 2775 is 85 ampere rated and is installed on the main service
 3. 2750 is 30 ampere rated and installed in a sub-panel
 4. Both filters are a wired in series with one of the ground wires in the panel

C. Required quantities of devices

1. Main Distribution Panels per each one in the building
 - a. EP2500
 1. Services under 1000 ampere in size (one unit)
 2. Service between 1000 and 3000 ampere (two units)
 3. Service above 3000 ampere (three units)
 - b. EP2775
 1. One per MDP
2. Distribution Panels 800 amp and smaller
 - a. EP2000 (1)
 - b. EP2700 (1)
3. Distribution Panels 1000 amp and larger
 - a. EP2000 (2)
 - b. EP2700 (2)
4. Motor Control Centers 200 amp and smaller
 - a. EP2000 (1)
 - b. EP2700 (1)
5. Motor Control Centers 400 amp and larger
 - a. EP2000 (2)
 - b. EP2700 (2)
6. Sub-panels
 - a. Computer Room
 1. EP2000 (1)
 2. EP2700 (1)
 3. EP2750 (1)
 - b. Lab panels
 1. EP2000 (1)
 2. EP2750 (1)
 - c. Receptacle Panels
 1. EP2000 (1)
7. Lighting Panels
 - a. EP2000 (1)
 - b. EP2700 (1)

D. System Commissioning

A Power Quality Study will be completed to verify power quality standards have been met, and proper installation and operation of TVSS equipment

26 5100 INTERIOR LIGHTING

A. General:

1. All fluorescent lighting fixtures shall be served from 277/480 volt, 3-phase, 4-wire lighting distribution system, when possible.
2. Interior lighting shall comply with the latest edition of the Illuminating Engineering Society's lighting levels for each area.

3. Fluorescent lighting will be used for the majority of classrooms, office areas, corridors and storage area illumination.

B. Lamps:

1. Lamp types for a given application are to be thoroughly reviewed in the design of the overall project such that the number of different types is kept to a minimum for purposes of Owner inventory. Lamp types other than those listed below must be approved by the Director of Energy and Utilities or the Director of Plant Engineering and planning. The following are approved lamp types (equal to GE or Phillips):

Description	Sylvania Product
32W 4' T8	Sylvania F032/835/ECO
17W 2' T8	Sylvania F017/835/ECO
28W 4' T5	Sylvania FP28/835/ECO
14W 2' T5	Sylvania FP17/835/ECO
54W 4' T5 HO	Sylvania FP54/835/HO/ECO
26W T4 Triple tube	Sylvania CF26DT/E/IN/835
32W T4 Triple tube	Sylvania CF32DT/E/IN/835
42W T4 Triple tube	Sylvania CF42DT/E/IN/835

C. Ballasts:

1. Fluorescent ballast shall be electronic type programmed start with less than 10% total harmonic distortion, universal voltage and normal light output for all T4, T5 and T8 lamp installations.
2. Fluorescent ballasts with full five (5) year wrap-around warranty
3. Sound rating shall be A for classrooms and reading rooms.
4. Line fuse shall be included in the fixture for each ballast. Line fuses shall be selected, as required, for this application and wired in place by the fixture manufacturer
5. High intensity discharge fixture ballasts will be fused within the fixture.
6. Metal halide fixtures are to use pulse start ballast where available.

D. Interior Building Lighting:

1. Incandescent lighting will be kept to a minimum for purposes of energy conservation. All incandescent lighting should be dimmed 10% to increase lamp life. Incandescent lamps shall be 125-volt inside frosted
2. Fluorescent fixtures are preferred by the University. Commercial fluorescent 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 shall be powered by generator.

F. Emergency and Night Lights:

1. Emergency lighting will be provided per code and shall be powered by generator.
2. Emergency light fixtures shall not operate 24/7 unless designated as a night light. Emergency transfer devices shall be provided at all switched emergency lighting per code. Approved manufacturer's: Bodine, LVS, and UL Nine24.

- a. Emergency transfer devices to be located in nearest storage, electrical, mechanical or JC room. 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. Review locations with Owner.
 - 2. Residence halls to have corridor night lighting at 50%. Provide override switch in designated location.

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, ASHRAE requirements, and LEED requirements.
- 2. ASHRAE/IESNA Standard 90.1-2004 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 will be compact fluorescent suitable for minus twenty degrees. Recessed soffit or wall bracket type fixtures to be used where applicable. At least one fixture shall be powered on emergency generator. See attached light fixture schedule for approved light fixture types.

| E. Pole Mounted Site Lighting Fixtures:

- 1. CMU campus standard for walkway and parking lighting is Kim Lighting Archetype AR/SAR series. At least one fixture near emergency exit shall be powered on emergency generator. The location of fixtures shall be coordinated with the Director of Plant Engineering and Planning.
- 2. Standardization
 - a. Refer to "Site Lighting Details" Sheet E-1, E-2, E-3, E-4 at the following web address <http://fmgt.cmich.edu/standards.html>
 - b. Any deviations from the standard fixture will have to be specifically approved through the standards waiver process.
- 3. Lamp Type
 - a. CMU will standardize on the Pulse Start Metal Halide lamp type for the base but will also consider an induction type lamp. Both are a 'white light'.
 - b. Pulse start metal halide technology has recently evolved that provides significant advantage over traditional metal halide, such as increased light output per energy input, longer life, and less lumen depreciation. All three aspects rival high pressure sodium.

4. Light Levels
 - a. Various studies show that the eye perceives a 'white light' up to four times better than a light from a high pressure sodium (yellow cast) lamp.
 - b. CMU will reduce lighting design levels from typical national standards because of the exclusive use of metal halide.
5. City of Mt Pleasant Light Pollution Ordinance
 - a. CMU will meet the intent. Refer to the City of Mt. Pleasant Light Pollution Ordinance.
 - b. Exterior up lighting is prohibited
6. Control
 - a. CMU will only utilize photocell control.
7. Bollard Lighting
 - a. Is prohibited on the Campus of CMU.
8. SITE LIGHTING LEVELS:

	DESIGN LEVEL – AVG FC	RATIO	MAX FC	MIN FC
PARKING LOTS – MEDIUM (1)	0.4	20:1 MAX/MIN		0.1
PARKING LOTS – LOW (2)	0.3	20:1 MAX/MIN		0.075
WALKWAYS – HIGH	0.4	4:1 AVG/MIN		0.1
WALKWAYS – MEDIUM	0.3	4:1 AVG/MIN		0.1
ROADWAYS – HIGH (3)	0.4	10:1 MAX/MIN		
ROADWAYS – MEDIUM (4)	0.25	20:1 MAX/MIN		
BLDG ENTRANCES - ACTIVE	1.0	25' FROM DOOR OR UNDER CANOPY		
BLDG ENTRANCES - INACTIVE	0.4	10' FROM DOOR OR UNDER CANOPY		
BLDG FACADES (5)				

- F. All exterior area and security lighting shall be powered from one location within the building, preferably from the main electric room.
- G. Photo-electric control shall be provided for all exterior lighting. One control shall control all lights. A means shall also be provided in the control circuit to allow for the main campus Energy Management Control System (EMCS) to override the photoelectric control. The control circuit

shall have a hand-off-auto switch of reselecting the mode of control with the EMCS wire to the auto position.

- H. Temporary Construction Site Lighting: Specifications shall include temporary security lighting of the construction area. Temporary lighting fixtures shall have a metal halide lamp type and shall be shielded so that light does not spill off of the construction site.

END OF SECTION

DOCUMENT CONTROL PAGE:

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Date	Revision	Approved By:
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