

## **DIVISION 26 - ELECTRICAL**

### **26 00 00 ELECTRICAL**

#### **26 05 00 COMMON WORK RESULTS FOR ELECTRICAL**

##### **26 05 01 GENERAL REQUIREMENTS**

###### **26 05 01.01 ALL UNIVERSITY BUILDINGS**

1. Compliance with the following standards is required, as applicable to the work in each instance.
  - A. NEC 1996 (NFPA 70), National Electric Code
  - B. AWS American Welding Society, Standards for Welding
  - C. ANSI C2, National Electrical Safety Code
  - D. ANSI C73, Dimensions of Attachment Plugs & Receptacles
  - E. NECA Standards for Installation
  - F. NEMA Standards for Materials and Products
  - G. ASTM American Society for Testing Materials
  - H. ASA American Standards Association
  - I. NFPA, National Fire Protection Association
  - J. UL, Underwriters' Laboratories, Inc.
  - K. OSHA, Occupational Safety and Health Act
  - L. ADA, Americans with Disabilities Act
2. All work must comply with GVSU lockout / tag out procedures.
  - A. Contractors will be responsible for lockout/tag out of the nearest source of power supplying equipment to be repaired, replaced or removed.
  - B. Contractors will be responsible for the training of their employees in lockout procedures. They will also be responsible to supply their employee's with lockout equipment.
  - C. Prior to shutdown of any equipment and/or power, contractors will notify the Plant Customer Service (331-3000).
  - D. Any breaker, breaker panel, disconnects, switches, contractors, starter, controls and/or other electrical devices not locked out or tagged out, will be deemed in use.
  - E. All personnel involved in the repair, replacement, installation, or removal of equipment will use the lockout/tag out procedure. This includes but is not limited to the locking out of: electrical, steam, gas, hydraulic, pneumatic and stored energy.
4. It is generally desired that University buildings have a watertight pin and sleeve Hubbell HBL460MI12W 3P 4W un-fused circuit lock disconnect receptacle provided on the exterior of the building. Confirm need with the University on project by project basis.
5. Plan for locations of copiers, microwaves and vending machines. Provide separate 20-amp circuit for each device.
6. Provide minimum 20 amp dedicated circuits with isolated ground to all copy machines and with minimum 10 gauge copper wire.
7. Provide dedicated isolated ground 20A circuits with surge protected receptacles for all main computer hub network equipment and AV equipment.
8. Dedicated isolated-grounded circuits are not required for computer receptacles.
9. All surge protection shall be IT Protector or Owner approved equal.
10. Provide GFI type outlets at all counters.
11. Equipment, other than the transformer, main distribution panels or manual distribution switches shall not be installed in electrical vaults.

12. Provide exterior waterproof duplex receptacles near building entrances/exits. Verify other quantities and locations with University.
13. Provide one 120volt duplex receptacle in all building entrance vestibules.
14. Equipment in labs or shops to have Master Kill Switch. Also provide keyed switch to lockout power when no faculty are present to supervise activities.
15. Classroom lighting layout shall be in conformance with Standard Details #27.003 in Appendix C of this manual.
16. Install a set of contacts on lighting circuits (academic buildings only) that do not have occupancy sensors installed with initial construction. The purpose is to allow future flexibility to add sensors where desired at a future time.
17. Provide rough in for classroom and case room IT equipment. See Appendix C, Standard Details 27.001, 27.002, 27.004 and 27.005.
18. All electrical key switches shall be keyed alike.
19. All electrical panels with locks shall be keyed alike.
20. Firestopping: Provide U.L. listed firestopping assembly for all openings and sleeves through floors and firewalls. Sleeves provided for telephone, data, sound or other communication cables shall be firestopped after the respective contractor has finished their work. Only the following products, or University approved equals, shall be used:
  - A) STI SpecSeal SSP100 Putty.
  - B) STI SpecSeal SSB Pillows.
21. Wherever possible, electrical, telephone and data cabling are to be installed in concrete encased duct banks. Telephone and data are to be separated from electrical power.
22. All telecommunications cabling shall be kept in trays and /or conduits separate from primary or secondary power cabling. This includes any new telecommunications cabling installed in the existing utility tunnels. New cabling in tunnels shall be kept in separate trays or conduits and not laid together in trays containing primary or secondary power.
23. Provide adequate fluorescent lighting including emergency lighting to service all equipment in mechanical rooms. Provide GFI service outlet for supplemental lighting in mechanical spaces. Provide GFI outlet within 6 feet of Control Panels.
24. To meet ADA Requirements provide power at building entrances.
25. At the Allendale Campus all clock systems are tied to the existing Simplex System controlled at the Padnos Building. Standard Classroom clock is a Simplex #6310 9221 - Analog. Provide clocks in corridors and in classrooms. Preferred classroom location is opposite the teaching station. Review all clock locations with GVSU.
26. Provide outlets for several different furniture layouts in offices. Review with GVSU during Design Development. Solution may involve empty conduits.
27. Provide separate 20A circuits for vending machines, microwaves, and coffee makers.
28. There is a minimum of one welding outlet per mechanical room.
29. Provide a GFI receptacle at shelf height in custodial rooms.
30. Lighting controls used in public use areas be in compliance with ANSI/ASHRAE/IESNA 90.1- 2004.
31. Roadway and major walkway lights are to be connected to the campus control system. Concrete bases 30 inches above grade when located within paved areas; 12 inches above grade when located in lawn or landscaped areas and located a minimum of 5 feet off edge of paved surface to centerline of pole.
32. Metering: All service equipment shall have solid state metering on the secondary measuring KWH, demand, power factor and provide a signal compatible with GVSU CEMS. All electrical equipment rated 400 AMP and greater shall have solid state metering.
33. Light fixtures are to be located, where practical, so as not to require scaffolding for the replacement of lamps.

34. Oversize electrical panels by twenty percent. (Provide spare breakers, review with GVSU at Design Development). Twenty AMP minimum circuit size.
35. Fluorescent dimming ballasts may be used on a case by- case basis (Owner will have final say) in order to allow occupants to adjust the lighting to their individual needs and to promote the productivity, comfort and well-being of building occupants.
36. Lighting in all occupied rooms will be controlled by a wall switch located at ALL points of entry. If an occupied room is equipped with an automatic sensor, a wall switch will be used in addition at all points of entry.
37. Equipment in machine shops or work shops which has the potential to cause injury shall be wired to a service panel capable of disconnecting all machinery by means of a kill switch. Equipment shall be re-energized by use of a keyed switch.
38. Lighting Control:
  - A) All corridor and lobby lighting shall be controlled by EMS.
  - B) All entrances and areas receiving significant sunlight are controlled by photo-eye and EMS.
  - C) All conference rooms shall have motion sensors.
39. Daylighting Controls: Require automatic photocell based controls for shading systems and daylight harvesting systems.

#### **26 05 01.05 UNIVERSITY STUDENT HOUSING**

1. Switching for corridor lighting in Housing Units shall be placed in the Housing Staff Office(s) and labeled indicating area of control for each switch.
2. In Housing units provide separate 20-amp circuit for microwaves and refrigerators.
3. Consider security implications for lighting of housing developments. Review with GVSU public safety unit at design and development.
4. Exhaust Fans for Housing Unit bathrooms are to be separately switched, or switched with light fixture with "OFF" time delay.

#### **26 05 01.09 INSPECTIONS, ADJUSTMENTS AND BALANCING**

1. Provide Owner evidence that installation has been inspected and approved by authority with jurisdiction over electrical work involved.
2. Subsequent to the installation of the electrical power and distribution system and upon the beginning of operation, Contractor shall make all necessary adjustments to equipment installed or connected by him under this Contract so as to insure proper operation of the same. Contractor shall measure phase balance and make necessary adjustments to any portion of the electrical system that is substantially out of balance.

#### **26 05 01.13 RECORD DRAWINGS, GUARANTEES, WARRANTIES AND BONDS**

1. Provide written guarantee for all work performed under this Contract for a period of not less than one year from the date of project completion.
2. Contractor shall make all necessary alterations, repairs, adjustments, replacements during guarantee from date of acceptance of repair or replacement.
3. Provide manufacturer's warranty on all products provided.
4. The Contractor shall obtain and forward to GVSU statements concerning Guarantee and Indebtedness, and any other special warranties or requirements of the Contract Documents. All required material shall accompany Contractor's request for final payment, including all operation and maintenance data required by the Contract Documents.

**26 05 01.17 ITEMS DESIGNERS ARE TO AVOID**

1. UTH Lighting Excellence by Tridatum
2. Neon Lighting
3. Hex Head Screws
4. Eight foot fluorescent fixtures
5. 40R14NFL 120 volt incandescent lamps
6. Wall mounted parabolic with side ballast
7. Incandescent exterior lights at Housing Units
8. Incandescent lighting in Housing Units
9. Multiple lamp incandescent vanity fixture
10. Peerless circular fixture - wall mounted 90 degree lens
11. U Lamps

**26 05 19 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.**

1. Coordination: Coordinate layout and installation of cable with other installations.
  - A. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.
2. Manufacturers: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.
3. Examine raceways and building finishes receiving wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.
4. Remove existing wire from raceway before pulling in new wire and cable.
5. Conductor Splices: Keep to minimum.
  - A. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
  - B. Use splice and tap connectors that are compatible with conductor material.
  - C. Underground splices to use 3M or scotch kit.
6. Where 120 volt, 20 AMP branch circuit wiring from panelboard to first outlet exceeds 100 feet in length, increase wire size to 10 AWG.
7. Wire to wire connections in motor terminal housings will be made by means of wiring crimpable ring terminals bolted together or split bolts. Ring terminals or split bolts shall be rated for CU wire. The wrap shall consist of seamless rubber splitting tape as inner wrap and vinyl electrical tape as out wrap.
8. Where circuits are using a common neutral, the neutral is to be sized larger than its associated circuit conductors. ( in residential buildings using metallic cable or romex, use of common neutral is prohibited)
9. SJ and SJO cords require strain relief when hung from above.
10. Neutrals feeding panel boards are to be rated 200 percent of panel board ampacity. (EXCEPTION: Not required for residential buildings)
11. Use of AC cable to is prohibited.
12. MC cable is permitted only under the following conditions and requirements:
  - A. used for branch circuitry, but once exposed must terminate to junction box or EMT conduit within 6-feet unless otherwise approved by GVSU's Electrician.
  - B. may be used for light fixture connections not exceeding 6-feet in length.
  - C. may not be terminated into panels without GVSU approval.
13. Flexible conduits may not be run in excess of 6 feet without GVSU approval.
14. Testing: Upon installation of wires and cables and before electrical circuitry has been energized

15. Demonstrate product capability and compliance with requirements.
  - A. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
16. High Pot test required on primary feeders.
  - A. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

#### **26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

1. Conductor Materials: Copper.
2. Underground Conductors: Bare, stranded copper except as otherwise indicated.
3. Signal and Communications: For telephone, alarms, and communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.
4. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.
5. Ground Rods: Locate a minimum of one-rod length from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use 3/4-inch by 10-ft. ground rods except as otherwise indicated. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.
6. Bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, and electric heaters.
7. Exothermic Welded Connections: Use for connections to structural steel and for underground connections. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
8. Ground/resistance maximum values shall be as follows:
  - A. Equipment rated 500 kVA and less: 10 Ohms
  - B. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
  - C. Equipment rated over 1000 kVA: 3 Ohms
  - D. Unfenced substations and pad-mounted equipment: 5 Ohms
  - E. Manhole grounds: 10 Ohm.
9. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.
10. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit copy to Owner.

#### **26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

1. For telephone and data outlet boxes provide metal 4-inch square x 2-inch deep boxes with single gang plaster ring.
2. Floor Boxes: Cast metal, fully adjustable, rectangular.
3. Outdoors: Use the following wiring methods:
  - A. Exposed: Rigid or intermediate metal conduit.
  - B. Concealed: Rigid or intermediate metal conduit.
  - C. Underground, Single Run: Rigid nonmetallic conduit or schedule 80 PVC.

- D. Underground, Grouped: Rigid nonmetallic conduit or schedule 80 PVC.
- E. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquid tight flexible metal conduit.
- F. Boxes and Enclosures: NEMA Type 3R or Type 4.
- 4. Indoors: Use the following wiring methods:
  - A. Main Service Feeders: Rigid steel conduit.
  - B. Connection to Vibrating Equipment (including generators, dimmer racks, transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquid tight flexible metal conduit.
  - C. Damp or Wet Locations: Rigid steel conduit.
  - D. Exposed: Electrical metallic tubing.
  - E. Concealed: Electrical metallic tubing.
  - F. Concealed in Floor Slabs: Electrical non-metallic tubing or rigid non-metallic conduit.
  - G. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4, stainless steel.
  - H. Final connections to all electrical or mechanical equipment mounted on "floating floors" in Mechanical Rooms: Liquid-tight flexible metal conduit.
- 5. Conceal conduit and tubing, unless otherwise indicated, within walls, ceilings, and floors.
- 6. Conduit and tubing may be surface mounted in Mechanical Rooms.
- 7. Conduit and tubing running to surface mounted panelboards, automatic transfer switches, and transformers may be surface mounted.
- 8. Surface mounted conduit and tubing may be used where specifically approved by Architect/Engineer.
- 9. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- 10. Use insulating bushings to protect conductors.
- 11. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb (90 kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.
- 12. Telephone and Signal System Raceways 4-Inch Trade Size and Smaller: In addition to the above requirements, install in maximum lengths of 150 feet (45 m) and with a maximum of two 90-deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- 13. Equipment Grounding Conductor: Install a green equipment grounding conductor in all conduit including flexible conduit and non-metallic (PVC) conduit.
- 14. Surface Metal Raceway: Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.
- 15. All buried cable to be installed in conduit with a marker system. Install tracer wire and marker with all non-metallic cables.
- 16. Feeder neutrals are to be up-sized when multiple power feeders are using a common neutral.
- 17. All buried cable greater than 480 volts are to be encased in a concrete duct bank.

#### **26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS**

- 1. All devices to have circuits identified on back (inside) of device cover plate with permanent marker pen.
- 2. On all remodel jobs all legends are to be upgraded to show new circuitry and confirm existing circuitry.
- 3. GVSU Electrical Equipment Tags:
  - A. Equipment shall be identified using the equipment abbreviations below followed by a number consisting of three characters minimum. Where an abbreviation is not shown below for a specific item of equipment, the abbreviation shall consist of three characters minimum.

EQUIPMENT ABBREVIATIONS

PS	PRIMARY SWITCH	MCC	MOTOR CONTROL CENTER
TF	TRANSFORMER	GEN	GENERATOR
MDP	MAIN DISTRIBUTION PANEL	LP	LIGHTING PANEL (277/120)
SDP	SECONDARY DIST. PANEL	MS	MOTOR STARTER
BP	BREAKER PANEL (208/120)	RCS	REMOTE CONTROL SWITCH
PP	POWER PANEL (277/208/120)	TS	TRANSFER SWITCH

4. Identify high-voltage feeder conduits (over 600 V) by words "DANGER-HIGH VOLTAGE KEEP OUT" in black letters 2 inches high, stenciled at 10-foot intervals over painted orange background.
5. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits.
6. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located 12 inches directly above conduit. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
7. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<u>208/120 Volts</u>	<u>Phase</u>	<u>480/277 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Slate/Gray
Green	Ground	Green

8. Tag or label conductors as follows:
  - A. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
  - C. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
9. Install equipment/system circuit/device identification as follows:
  - A. Apply equipment identification labels of engraved plastic- laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
  - B. Refer to GVSU Electrical Tag list.
    - 1) Panelboards, electrical cabinets, and enclosures.
    - 2) Access doors and panels for concealed electrical items.

- 3) Electrical switchgear and switchboards.
  - 4) Electrical substations.
  - 5) Motor control centers.
  - 6) Motor starters.
  - 7) Pushbutton stations.
  - 8) Power transfer equipment.
  - 9) Contactors.
  - 10) Remote-controlled switches.
  - 11) Dimmers.
  - 12) Control devices.
  - 13) Transformers.
  - 14) Power generating units.
  - 15) Timers/Time Clocks.
10. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
11. Furnish and install a sign at the service entrance equipment indicating type and locations of on-site emergency power sources. Sign shall be 8 x 10-inch minimum size mounted on the face on the switchgear.

## **26 10 00 MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION**

### **26 12 00 MEDIUM-VOLTAGE TRANSFORMERS**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
  - A. General Electric Distribution and Control.
  - B. Siemens Energy & Automation, Inc.
  - C. Square D Co.; Schneider Electric
  - D. Cooper Industries
2. Warranty: All transformers shall have a warranty for a minimum of one (1) year from the date the transformer is first energized.
3. Windings: Two-winding type, designed for operation with high-voltage windings connected to a 3-phase, 4-wire, 60-Hz, grounded neutral distribution system.
4. Low-Sound Level Transformers: Units with a sound level rating a minimum of 3 dB less than NEMA TR 1 standard sound levels for the transformer type and rating.
5. Windings: Copper.
6. Dry type transformers shall comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications" and IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers."
  - A. Enclosure: Indoor, ventilated.
  - B. Cooling System: IEEE Standard C57.12.01, Class AA/FA.
  - C. Insulation Class: minimum 220 deg C.
  - D. Environmental Protection: Cast coil/vacuum pressure impregnation encapsulation with epoxy polyester resin (VPI).
  - E. Insulation Temperature Rise: 80 deg C maximum rise above 40 deg C.
  - F. Basic Impulse Insulation Level: 60 Kv
  - G. Full-Capacity Voltage Taps: Four nominal 2.5-percent taps, 2 above and 2 below rated high voltage.

- H. Impedance: 5.75 percent.
- I. Accessories: Provide the following accessory items:
  - 1) High-Voltage Surge Arresters: Distribution Class, low-spark-over metal-oxide varistor type complying with NEMA Standard LA 1, factory installed and connected to high-voltage terminals.
  - 2) High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.
- 7. Liquid-filled pad mounted transformers shall comply with IEEE C57.12.20, ANSI C57.12.13 and ANSI C57.12.26.
  - A. Insulating Liquid: Only edible seed-oil based products such as Envirotemp FR3, or University approved equal shall be used. Product shall be UL listed as NFPA 70 requirements for fire point of not less than 300 degrees C when tested according to ASTM D92. Liquid shall be biodegradable and nontoxic.
  - B. Basic Impulse Levels (BIL): 95 Kv
  - C. Full-Capacity Voltage Taps: Four 2.5-percent taps; 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with a position indicator and padlock hasp.
  - D. Surge Arresters: Distribution class, one for each primary phase. Comply with NEMA LA 1. Support from tank wall within high-voltage compartment. Location of arrester is to be on outside wall.
  - E. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts. Include the following:
  - F. Bushing-Well Inserts: One for each high-voltage bushing well.
  - G. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
  - H. Include the following accessories:
    - 1) Drain Valve: 1 inch (25 mm), with sampling device.
    - 2) Dial-type thermometer.
    - 3) Liquid-level gage.
    - 4) Pressure-vacuum gage.
    - 5) Pressure-Relief Device: Self-sealing with an indicator.
- 8. Factory Tests: Design and routine tests conform to the referenced standards.
- 9. Factory Sound-Level Tests: Conduct sound level tests on equipment for this Project where specifying sound levels below the standard ratings.
- 10. Identify transformers and install warning signs according to 26 05 53 "Identification for Electrical Systems."
- 11. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 12. In addition to any manufacturers standard testing procedures, the following tests, at a minimum, shall be performed on all transformers used on University projects:
  - A. Electrical tests, conducted in accordance with applicable ASTM standards, shall be performed for the following:
    - 1) Turn to turn ratio
    - 2) Megger
    - 3) Doble
    - 4) Power factor
    - 5) Excitation
    - 6) Impulse
  - B. Oil testing and analysis as follows:
    - 1) Shall be performed at the following internals:
      - a) Prior to shipping; Performed and paid for by manufacturer.

- b) Within seven (7) calendar days upon receipt of delivery for the transformer to the job site or contractor's warehouse, whichever is the designated initial point of delivery. Performed and paid for by Contractor.
- c) Thirty (30) calendar days after the transformer is energized and regardless of actual load placed upon transformer. Performed and paid for by Contractor.
- d) Six (6) months after transformer has been energized. Performed and paid for by Contractor.
- 2) Dissolved gas analysis (DGA) shall be performed in accordance with ASTM D3612.
  - a) Shall not have any one of the following individual combustible gases, and the total of all combustible gases that exceeds the following stated ASTM maximum levels, in parts per million (ppm):
    - i) Hydrogen - 150 ppm
    - ii) Methane - 150 ppm
    - iii) Ethane - 150 ppm
    - iv) Ethylene - 100 ppm
    - v) Acetylen - 2 ppm
    - vi) Carbon Monoxide - 750 ppm
    - vii) Total of all Combustible Gases - 750 ppm
- 3) Liquid Power Factor shall be performed in accordance with ASTM D924 and c provide the following test results:
  - a) Tested at 25° C shall be greater than 2.99 ppm
  - b) Tested at 100° C shall be greater than 2.99 ppm
- 4) Carl Fisher Moisture Test shall be performed in accordance with ASTM D1533 and provide the following test result:
  - a) Less than 29 ppm
- 5) Liquid Screen Test shall be performed in accordance with ASTM requirements and provide the following test results:
  - a) Acid; ASTM 974; Not greater than 7.05 ppm.
  - b) Interfacial tension (IFT); ASTM 971; Not greater than 32 ppm.
  - c) Dielectric; ASTM D877; Not greater than 30 ppm.
  - d) Specific Gravity; ASTM 1298; Between 0.83 and 0.89. Acceptable test result shall be within this range.
  - e) Color; ASTM 1298; 3.0 or less.
- C. Oil sampling, for the oil test described above, shall be obtained using the sampling method described in ASTM 3613. Retesting required as a result of the Contractor's failure to comply with ASTM 3613 shall be paid for by the Contractor.
- D. All required oil tests shall be performed by SD Meyers Transformer Consultants. Contact Glenn Abbott at 1-800-444-9580 extension 3226. Test from any other lab will not be considered valid and retest will be required.
- E. If any DGA test, performed at the required interval fails, additional testing will be performed as recommended by SD Meyers Transformer Consultants and all costs associated with retesting shall be paid for by the Contractor. If the recommendation of SD Meyers Transformer Consultants is to repair the transformer, it is at the sole discretion of the University to choose to repair or replace. All costs associated with the repair or replacement shall be paid for by the Contractor.
- F. If, at any of the above required test intervals, the test results indicate non-compliance with the stated requirements for the Liquid Power Factor test, the Carl Fisher Moisture test, the Liquid Screen test or the Color test the transformer shall be rejected and a new transformer provided. All costs associated with providing a new transformer shall be paid for by the Contractor.

- G. The project shall not be delayed as a result of the transformer failing to comply with any of the above stated requirements. The Contractor shall provide, if necessary to maintain the project's scheduled completion date, a temporary transformer(s) of KVA size and capacity that is not less the KVA specified for the new transformer. All cost associated with furnishing, installing and removing the temporary transformer(s) and any other required appurtenances and accessories shall be paid for by the Contractor.
13. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

## **26 13 00    MEDIUM-VOLTAGE SWITCHGEAR**

### **26 13 13    MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR**

1. Primary switches (12,470 v. and 7,200 v.), in a loop system, used only for the purpose of isolation, shall NOT be fused.
2. Where a feeder line (12,470 v.) serves a fused switch for the purpose of them re-feeding two or more additional feeder lines, the switch shall be capable of controlling each feeder individually. As an
3. example for two buildings there may be a single cabinet but two switches. If there is a failure in one line or switch, only one building is affected.
4. Any new switchgear required for new building construction, major renovations or replacement is to be UL listed.

## **26 20 00    LOW-VOLTAGE ELECTRICAL TRANSMISSION**

### **26 22 00    LOW-VOLTAGE TRANSFORMERS**

#### **26 22 13    LOW-VOLTAGE DISTRIBUTION TRANSFORMERS**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - A. Acme Electric Corp.
  - B. General Electric Co.
  - C. MagneTek.
  - D. Siemens
  - E. Square D Co.
2. Transformers: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.
3. Cores: Grain-oriented, non-aging silicon steel.
4. Coils: Continuous windings without splices except for taps.
5. Internal Coil Connections: Brazed or pressure type.
6. General-Purpose, Dry-Type Transformers:
  - A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications."
  - B. Transformers: Two-winding type, single phase or 3-phase units using 1 coil per phase in primary and secondary.
  - C. Windings: All copper.
  - D. Termination Plates: Tin Plated Copper.
7. Low Sound Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE Standard C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
8. Features and Ratings: As follows:
  - A. Enclosure: Indoor, ventilated.

9. Insulation Class: 185 deg C class for transformers 15 kVA or smaller; 220 deg C class for transformers larger than 15 kVA.
  - A. Insulation Temperature Rise: 80 deg C maximum rise above 40 deg C.
10. Taps: For transformers 3 kVA and larger, full capacity taps in high-voltage winding are as follows:
  - A. 15 kVA through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
11. Accessories: The following accessory items are required where indicated:
  - A. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.
12. Dry-Type Distribution Transformers For Non-Linear Loads
  - A. Provide transformers satisfying the above requirements and the following requirements. Transformers shall have a UL K-4 or UL K-13 rating as indicated on the plans. The K factor shall be based on the sum of fundamental and harmonic  $I_h$  (pu)  $^2h^2$  in accordance with ANSI/IEEE C57.110-1986. Manufacturers rating K factors by average temperature rise alone shall not be acceptable. The transformer secondary neutral terminal shall be sized for 200% of the secondary phase current.
13. Factory Tests: Design and routine tests conform to referenced standards.
14. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project where specified sound levels are below standard ratings.
15. Provide concrete housekeeping pads for all floor mounted transformers. Coordinate with Division 03310, Concrete Work.
16. Connect transformer units to conduit system using liquid-tight flexible conduit.
17. Arrange equipment to provide adequate spacing for access and for cooling air circulation.
18. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility.

## **26 24 00 SWITCHBOARDS AND PANELBOARDS**

### **26 24 16 PANEL BOARDS**

1. General use breaker panels may be installed in corridors. Review locations with GVSU. Installation should be as inconspicuous as possible. All panels are to be secured with locks. This requirement does not apply to Housing Units where panels are to be installed in separate electrical rooms.
2. When the project involves existing buildings, the Professional is to field investigate and verify existing circuit capacities.
3. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - A. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
  - B. General Electric Co.; Electrical Distribution & Control Div.
  - C. Siemens Energy & Automation, Inc.
  - D. Square D Co.
4. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise required to meet environmental conditions at installed location.
5. Bus: Hard drawn copper of 98 percent conductivity.
6. Main and Neutral Lugs: Setscrew, anti-turn solderless pressure type.
7. Equipment Ground Bus: Hard drawn copper of 98 percent conductivity. Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
8. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.
9. Special Features: Include the following features for panelboards.
  - A. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.

9. Feed-through Lugs: Sized to accommodate feeders indicated.
10. Neutrals shall be rated at 200 percent of panel ampacity.
11. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
12. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.
13. Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.
14. Circuit breaker interrupting rating shall be 22,000 RMS symmetrical amperes at 120/208/240 volts; 25,000 RMS symmetrical amperes at 277/480 volts unless noted otherwise on plans.
15. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
  - A. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
  - B. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
  - C. Single pole circuit breakers with handle ties shall not be used for multiple circuits.
  - D. Piggyback circuit breakers shall not be used.
16. Surge protection devices shall be supplied with service entrance equipment.
17. Surge protection devices shall be U.L listed and CSA certified as secondary surge arresters. They are to meet ANSI /IEEE C62-11-1987 Standards.
18. Mounting Heights: Top of enclosure 72 inches above finished floor, unless otherwise indicated.
19. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
20. Provide wiring and connection for Central Energy Management Systems (CEMS) from metering.
21. Termination at breaker panel shall be one wire per terminal.
22. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
  - A. Perform measurements during period of normal working load as advised by Owner.
  - B. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - C. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
  - D. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and re-check as required to meet this minimum requirement.
23. Testing Agency: Provide the services of a qualified independent testing agency to perform infrared scanning.
24. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts to make joints and connections accessible to a portable scanner.
  - A. Follow-up Infrared Scanning: Perform an additional follow-up infrared scanning of each panelboard 11 months after date of Substantial Completion.
  - B. Instrument: Use an approved infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
  - C. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- D. All scanning shall be performed in the presence of a University representative. Failure to comply will result in the Contractor performing a re-scan in the presence of a University representative.

**26 24 19 MOTOR CONTROL CENTERS**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - A. Allen-Bradley Co.
  - B. Eaton Corp./Cutler-Hammer/Westinghouse.
  - C. General Electric Co.
  - D. Siemens Energy & Automation, Inc.
  - E. Square D Co.
2. Wiring Classification: Class I, Type B, as defined in NEMA ICS 2.
3. Compartments: Modular, with individual doors with concealed hinges and quick-captive screw fasteners. For combination starter units provide interlocks so the disconnect means must be in the off position before door can be opened, and so door cannot be closed with the disconnect means in the on position, except by consciously operating a permissive release device.
4. Interchangeability: Construct compartments so it is possible to remove units without opening adjacent doors, disconnecting adjacent compartments, or disturbing the operation of other units in the control center. Units requiring the same size compartment shall be interchangeable, and compartments shall be constructed to permit ready rearrangement of units such as replacing 3 single units with a unit requiring 3 spaces without cutting or welding.
5. Buses shall meet the following criteria:
  - A. Material: Plated copper.
  - B. Neutral Buses (if indicated on plans): Full size.
  - C. Equipment Ground Bus: Noninsulated, horizontal copper bus 2-inches by 1/4-inch minimum.
    - 1) Horizontal Bus Arrangement: Extend main phase, neutral and ground buses with same capacity the entire length of the MCC, with provision for future extension at both A. Provide phase loss relay on all motor starters 10 HP and larger.
    - 2) Overcurrent Protective Devices: Provide types of devices with features, ratings, and circuit assignments indicated, as specified in Division 16 Section "Motor Controllers".
    - 3) Concrete pads shall be provided by the electrical contractor.
    - 4) Provide wiring and connections from metering to GVSU CEMS.
    - 5) Schedule with Owner visual and mechanical inspections and electrical tests with at least one week advance notice.

**26 27 00 LOW-VOLTAGE DISTRIBUTION EQUIPMENT**

**26 27 13 ELECTRICAL METERING**

1. Pulse output contacts wired to CEMS.
2. All electrical service entrance equipment supplying building power of 400 amps and greater shall have solid state metering.

**26 27 26 WIRING DEVICES**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - A. Wiring Devices:
    - 1) Arrow Hart Wiring Devices.
    - 2) GE Wiring Devices
    - 3) Hubbell Inc.

- 4) Leviton Mfg. Co., Inc.
- B. Wiring Devices for Hazardous (Classified) Locations:
  - 1) Crouse-Hinds Electrical Construction.
  - 2) Killark Electrical Mfg. Co.
  - 3) Pyle-National Co.
- C. Multi-Outlet Assemblies:
  - 1) Wiremold Co.
2. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices."
3. Enclosures: NEMA 1 equivalent, except as otherwise indicated.
4. Color: Ivory, unless approved otherwise, in writing, by the University. Receptacles connected to emergency power systems shall be red in color.
5. Simplex Receptacles, Straight-Blade: Except as otherwise indicated, comply with heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles", Federal Specification WC596-G, NEMA WD-1 and NEMA WD-6. Provide NRTL labeling of devices to verify these compliance's. NEMA 5-R configuration.
6. Duplex Receptacles, Straight-Blade: Except as otherwise indicated, comply with heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles", Federal Specification WC596-G,
7. NEMA WD-1 and NEMA WD-6. Provide NRTL labeling of devices to verify these compliance's. NEMA 5-20R configuration.
8. Residential, commercial, construction, trade, etc. grade receptacles are not acceptable.
9. Duplex Receptacles, Straight-Blade, Hospital Grade: Listed and labeled for compliance with Hospital Grade of UL Standard 498, "Electrical Attachment Plug and Receptacle, Federal Specification WC596-G, NEMA WD-1 and NEMA WD-6." NEMA 5-20R configuration.
  - A. Provide Hospital Grade Duplex receptacles in Corridors and other Rooms where indicated on plans.
10. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicted, and with the following additional requirements:
  - A. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a 2-3/4-inch (70-mm) deep outlet box without an adapter.
  - B. Isolated Ground Receptacles: Equipment grounding contacts are connected only to the green grounding screw terminal of the device and have inherent electrical isolation from the mounting strap. NEMA 5-20R configuration.
  - C. Devices: Listed and labeled as isolated ground receptacles.
  - D. Isolation Method: Integral to the receptacle construction and not dependent on removable parts.
  - E. Receptacles in Hazardous (Classified) Locations: Comply with NEMA Standard FB 11 "Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations" and UL
  - F. Standard 1010 "Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations."
  - G. Toggle Switches: Quiet-type a.c. switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches".
  - H. Toggle Switches in Hazardous (Classified) Locations: Comply with UL Standard 894, "Switches for Use in Hazardous (Classified) Locations."
  - I. Dimmer Switches: Modular full-wave solid-state units with integral, quiet on-off switches, and audible and electromagnetic noise filters.
    - 1) Wattage rating exceeds connected load by 30 percent minimum, except as otherwise indicated.
    - 2) Control: Continuously adjustable slide, toggle or rotary knob. Single-pole or 3-way switch to suit connections.
    - 3) Incandescent Lamp Dimmers: Modular dimmer switches for incandescent fixtures; switch poles and wattage as otherwise indicated, 120 V, 60 Hz with continuously adjustable rotary knob,

- toggle, or slide, single-pole with soft tap or other quiet switch. Equip with electromagnetic filter to eliminate noise, RF and TV interference, and 5-inch (127-mm) wire connecting leads.
11. Key Switches: Hubbell HBL1221L with Hubbell Key #HBL1209.
  12. Device Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:
    - A. Material for Finished Spaces: 0.04-inch-thick, type 302, satin-finished stainless steel, except as otherwise indicated.
    - B. Material for Finished Spaces: Smooth, flexible nylon plastic, except as otherwise indicated
  13. Wet Location Receptacle Covers: Receptacles located outdoors or those indicated as weatherproof shall be equipped with covers that maintain the NEMA 3R weatherproof integrity when attachment plug caps are inserted.
    - A. Cover shall be manufactured using flame resistant, self extinguishing, ultraviolet inhibiting, impact resistant polycarbonate resin.
  14. Floor Service Outlet Assemblies shall be as follows:
    - A. Types: Concealed service floor box, dual-service units suitable for the wiring method used.
    - B. Compartmentalization: Barrier separates power and signal compartments suitable for accommodating up to 4 standard wiring devices.
    - C. Housing Material: Stamped steel or P.V.C., suitable for concrete installation.
    - D. Power Receptacle(s): NEMA configuration 5-20R, except as otherwise indicated.
    - E. Signal Outlet: Blank cover with bushed cable opening, except as otherwise indicated.
    - F. Finish Trim and Door: Hinged nylon carpet/tile insert door-permitting passage of cords and cables while in the closed position. Trim color selected by Architect.
  15. Multi-Outlet Assemblies shall be as follows:
    - A. Comply with Standard UL 5, "Surface Metal Raceways and Fittings."
    - B. Components of Assemblies: Products of a single manufacturer designed to be used together to provide a complete matching assembly of raceways and receptacles.
    - C. Raceway Material: Metal, with manufacturer's standard corrosion-resistant finish.
    - D. Wire: No. 12 AWG.
  16. Install devices and assemblies plumb and secure with all four edges in continuous contact with the finished wall surfaces. Product caulking, as required, where edges are not making contact.
  17. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang device plates.
  18. Adjust locations of receptacles and telephone outlets to suit the indicated arrangement of partitions and furnishings.
  19. Provide permanent barriers for ganged switches on 277/480 volt lighting systems.
  20. Any receptacle located within 6 feet of a sink shall be GFI rated
  21. Comply with Division 16 Section "Electrical Identification."
    - A. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved on wall plate.
    - B. Receptacles: Identify the panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.
  21. Provide green grounding conductors in all branch circuits feeding duplex receptacles.

**26 28 00                    LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES**

**26 28 11                    DISCONNECTS**

1. Subject to compliance with requirements, provide enclosed switches by one of the following:
  - A. Fusible Switches:
    - 1) Bussmann Div. Cooper Industries, Inc.
    - 2) Westinghouse/Cutler-Hammer Products; Eaton Corp.
    - 3) Electrical Distribution and Control; General Electric Co.
    - 4) I.T.E.Siemen
    - 5) Square D Co.
2. Enclosed Non-fusible Switch: NEMA KS 1, Type HD, with handle, lockable with 2 padlocks.
3. Enclosed Fusible Switch, 800 Amperes and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
4. Enclosure: NEMA KS 1, Type 1, unless specified or required otherwise to meet environmental conditions of installed location.
5. Provide surface mounted (flush mounted in finished rooms) fuse switch units to be used for 125-volt circuits to small boilers, furnaces, and similar equipment. Locate box cover unit adjacent to equipment controlled unless shown otherwise on the plans. Provide box cover units manufactured by Bussmann, Series SSU/SSW/SSY/SCY.
6. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.5 for enclosed switches. Certify compliance with test parameters.

#### **26 28 13 FUSES**

1. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:
  - A. Bussmann Div., Cooper Industries, Inc.
  - B. Gould Shawmut.
  - C. Littelfuse, Inc.
2. Plug fuses shall be type UL 198F, Type S, dual element, time delay.
3. Cartridge fuses shall comply with the following:
  - A. NEMA FU 1 nonrenewable cartridge fuse, class as specified or indicated, current rating as indicated, voltage rating consistent with circuit voltage.
  - B. Main Service: Class L fast acting.
  - C. Main Feeders: Class J time delay.
  - D. Motor Branch Circuits: Class RK1 time delay.
  - E. Other Branch Circuits: Class RK5 non-time delay.

#### **26 29 00 LOW-VOLTAGE CONTOLLERS**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - A. Allen-Bradley Co.
  - B. Westinghouse/Cutler-Hammer, Eaton Corp.
  - C. General Electric Co.
  - D. I.T.E. Siemens
  - E. Square D Co.
2. Manual motor controllers shall be quick-make, quick-break toggle action.
3. Manual controllers are to be used only for single-phase motors.
4. Magnetic motor controllers shall provide full-voltage, non-reversing, across the line, magnetic controller, except where another type is indicated:
  - A. Control Circuit: 120 V. Provide control power transformer integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control.

- B. Devices, plus 100 percent spare capacity. Provide primary and secondary fuse protection on transformer.
- C. Combination Controller: Switch type; fused or non-fused as indicated; quick-make, quick-break switch; factory assembled with controller and arranged to disconnect it. For fused switches, provide rejection-type fuse clips and fuses rated as indicated. Interlock switch with unit cover or door.
  - 1) Where circuit breaker disconnects are indicated on drawings, units shall be NEMA AB1, motor-circuit protectors with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.
- D. Provide phase loss relay on all motor starters to 10 HP and larger.
- E. Green Pilot Light: Push-To-Test feature, long life lamps.
- F. Heavy Duty Hand-Off-Auto Switch: Door mounted.
- G. Auxiliary contacts: Two sets.
- H. Pushbutton Stations: Except as otherwise indicated, momentary-contact, start-stop units. Provide in covers of magnetic controllers for manually started motors where indicated, and connect start contact in parallel with sealing auxiliary contact for low-voltage protection.
- I. Hand-Off-Automatic Selector Switches: Except as otherwise indicated, install in covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment. Make control connections so only the manual and automatic control devices that have no safety functions will be bypassed when the switch is in the hand position. Connect motor-control circuit in both hand and automatic positions for safety type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors. Make control circuit connections to a hand-off-automatic switch or to more than one automatic control device in accordance with an indicated wiring diagram or one that is manufacturer approved.
- J. Install wiring in enclosures neatly bundled, trained, and supported.
- K. Provide a labeling system indicating all inter-locking control devices.
- L. Schedule with Owner visual and mechanical inspections and electrical tests with at least one week's advance notification.

## **26 30 00 FACILITY ELECTRICAL POWER GENERATING AND STORING EQUIPMENT**

### **26 36 00 TRANSFER SWITCHES**

- 1. Install manual transfer switch for emergency power service by generator on new building construction, or major renovations, that affect the primary service to the building.

## **26 50 00 LIGHTING**

### **26 51 00 INTERIOR LIGHTING**

#### **26 51 11 GENERAL**

- 1. The Architect/Engineer shall be responsible for insuring that the location of interior light fixtures, especially those located in high ceiling spaces or stairwells and stair cases, are readily, safely and easily accessible without use of specialized equipment in order to change lamps or clean lenses in light fixtures. Floor surfaces below shall be level and horizontal to allow safe positioning of ladder to access light fixture.
- 2. If equipment, such as a Genie Lift, is required the floor structure at the point of location, and access to that point, shall be designed taking into consideration the added equipment weight. Access routes shall be designed with adequate width to accommodate such equipment, including turning radii and not impeding safe means of egress.

3. Design interior lighting to insure that the angle of maximum candela from each interior luminaire as located in the building shall intersect opaque building interior surfaces and not exit out through the windows.

**OR**

Design non-emergency interior lighting to be automatically controlled to turn off during non-business hours. Require manual override capability for after hours use.

**26 51 13 INTERIOR LIGHTING FIXTURES, LAMPS, AND BALLASTS**

**1. GVSU APPROVED LAMP LIST \***

- A. T5
  - B. T50 (High Bay)
  - C. T8 Low Watt
  - D. BX for 2x2 Fluorescent lighting
  - E. Incandescent I.R. rated
  - F. P.S.M.N.
  - G. 3500K
  - H. 175 W MH
  - I. 400 W MH
  - J. 1000 W MH
  - K. 100 CL MH MED
  - L. LED
  - M. 50PAR20/30 degrees
  - N. 50MR16Q/11 degrees/NS
  - O. 65MR16Q/35 degrees/FL
  - P. 50MR16Q/40 degrees/FL
2. Lenses, Diffuses, Covers, and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass except as indicated.
    - A. Plastic: Highly resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
    - B. Lens Thickness: 0.125 inches, minimum.
    - C. Lens to be mechanically fastened to fixture.
3. FLUORESCENT FIXTURES
    - A. Electronic Ballasts: Solid-state, full-light-output, energy-saving type compatible with energy-saving lamps. Conform to FCC Regulations Part 15, Subpart J. for electromagnetic interference. Conform to IEEE C62.41, "Guide for Surge Voltages in Low-Voltage AC Power Circuits," Category A, for resistance to voltage surges for normal and common modes. It must have a 5-year warranty.
      - 1) Minimum Power Factor: 95 percent.
      - 2) Minimum Operating Frequency: 20,000 Hz.
      - 3) Total Harmonic Distortion: Less than 10 percent.
      - 4) Average Input: The following is the average required wattage when tested according to ANSI C82.2, "Fluorescent Lamp Ballasts, Methods of Measurement."
        - a) 58 or less watts when operating two F32T8 lamps.
        - b) 29 or less watts when operating one F32T8 lamp.
      - 5) Wiring configuration: Parallel
      - 6) Manufacturer's: Motorola, Universal, and Advance.
    - B. Provide fusing for all fluorescent ballasts.

- C. Unless otherwise provided by the fixture manufacturer, provide ballast disconnect for all fluorescent fixtures with tube (double ended) style bulbs. This disconnecting means has to break all supply conductors feeding the ballast including the neutral, but not the ground. Acceptable product is IDEAL PowerPlug or approved equal that meets NFPA NEC Code 410.73 (G).
- 4. HIGH INTENSITY DISCHARGE (HID) FIXTURES
  - A. Ballasts: Conform to UL 1029, "High-Intensity-Discharge Lamp Ballasts" and ANSI C82.4, "Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)."
  - B. Provide fusing for all H.I.D. ballasts.
- 5. TRACK LIGHTING SYSTEMS
  - A. Conform to UL 1574, "Track Lighting Systems." Provide components, including track, fittings, and fixtures from Halo manufacturing. Provide systems with remote transformers.
- 6. EXIT SIGNS
  - A. LED type exit signs are to conform to UL 924, "Emergency Lighting and Power Equipment," and the following:
  - B. Self-Powered Exit Signs (Battery Type): Integral automatic high/low trickle charger in a self-contained power pack.
  - C. Battery: Sealed, maintenance-free, nickel cadmium type with special project warranty.
  - D. Self-Powered Exit Signs (Luminous Source Type): Licensed for public use by the U.S. Nuclear Regulatory Commission. Signs have solid-state tritium gas energy source and provide legibility in total darkness at 100 feet after 10 years of service.
- 7. EMERGENCY LIGHTING UNITS
  - A. Battery: Sealed, maintenance-free, lead-acid type with 10-year nominal life minimum, and special project warranty.
- 8. EMERGENCY FLUORESCENT POWER SUPPLY
  - A. Internal Type: Self-contained, modular, battery-inverter unit factory-mounted within the fixture body.
    - 1) Test Switch and LED Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    - 2) Battery: Sealed, maintenance-free, nickel-cadmium type, with a minimum nominal 10-year life.
    - 3) Charger: Fully automatic, solid-state, constant-current type.
    - 4) Operation: Relay automatically turns 2 lamps on when supply circuit voltage drops to 80-percent of nominal or below. Relay disconnects lamp and battery automatically recharges when normal voltage is restored.
- 9. FLUORESCENT LAMPS
  - A. Conform to ANSI Standards, C78 series applicable to each type of lamp. Provide tri-phosphor fluorescent lamps, 3500EK color. Provide phosphor coated metal halide lamps for interior fixtures. Phosphor coated and fluorescent lamps shall be the product of a single manufacturer to reduce color deviations. Lamps shall be manufactured by General Electric, Osram Sylvania or Philips Lighting.
- 10. FINISH
  - A. Fixtures are NOT to have tamper proof screws.
  - B. Fixtures in areas subject to moisture and wash down should have an epoxy base paint.
- 11. Support for Recessed and Semi-recessed Fixtures: Install units may be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from fixture corners.
  - A. Fixtures Smaller Than Ceiling Grid: Install a minimum of four rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.

- B. Fixtures of Sizes Less Than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with manufacturer's standard support rails and secured to the ceiling tees.
  - C. Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corners.
12. Ballasts (including remote ballasts) are to be easily accessible.
  13. When installing new ballasts or fixtures the contractor is to label the date of installation.
  14. Fixtures are to be aligned and symmetrically installed.
  15. Inspect each installed fixture for damage. Replace damaged fixtures and components.
  16. Give advance notice of dates and times for field tests.
  17. Provide instruments to make and record test results.
  18. Tests: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following in tests of emergency lighting equipment.
    - A. Duration of supply.
    - B. Low battery voltage shutdown.
    - C. Normal transfer to battery source and retransfer to normal.
    - D. Low supply voltage transfer.
  19. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
  20. Clean fixtures upon completion of installation. Use methods and materials recommended by manufacturer.
  21. Adjust aimable fixtures to provide required light intensities.

## **26 56 00    EXTERIOR LIGHTING**

1. The Architect/Engineer and Contractor shall be responsible for insuring that lighting fixtures have the proper matched ballasts and lamps as required by the manufacturer. Failure to comply will result in replacement of ballasts and lamps, to conform to manufacturers requirements, at the expense of the Architect/Engineer and/or Contractor.
2. Exterior lamps shall be:
  - A. H.I.D. Metal Halide.
  - B. Fixtures shall be Cooper Lighting-Lumark; "Tribute" (TR).
  - C. Poles: Cooper Steel Square Straight (SSS) with dark bronze finish.
3. Minimum average maintained luminance levels for parking lots shall be 2 foot-candles.<sup>1</sup>
4. Lighting at crosswalks shall be 1,000 watts lamps.
5. Minimum average maintained luminance levels for roadways, excluding crosswalks, shall be 1 foot-candle.<sup>1</sup>
6. Minimum average maintained luminance levels for pedestrian sidewalks shall be 1 foot-candle measured 6 feet above walk surface.<sup>1</sup>
7. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to replace external parts of lighting fixtures exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies the Owner may have under the Contract Documents.
  - A. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.

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<sup>1</sup> Based upon American National Standard Practice for Roadway Lighting.

- B. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
- C. Special Warranty Period: 5 years from date of Substantial Completion.
- 8. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
- 9. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.
- 10. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast. Ballast assembly shall be modular style for quick removal and replacement.
- 11. Exposed Hardware Material: Stainless steel.
- 12. HID Ballasts: regulating high-power-factor type, unless otherwise indicated.
  - A. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer. Fusing to be in pole hand hole.
  - B. Operating Voltage: Match system voltage.
  - C. Single-Lamp Ballasts: Minimum starting temperature of minus 30 deg C.
  - D. Open circuit operation will not reduce average life.
  - E. Noise: Uniformly quiet operation, with a noise rating of B or better.
- 13. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mi./h (160 km/h) with a gust factor of 1.3
- 14. Exterior lighting is to be controlled by one of the following methods, to be agreed upon by GVSU Energy Engineer, GVSU Lighting Electrician and GVSU Project Manager. Each project will be evaluated on its own merit.
  - A. GVSU EMS
  - B. GVSU campus lighting control system
  - C. Photo eye (Tyco model #SST-PV-IES)
- 15. Ground fixtures and metal poles according to Division 16 Section "Grounding."
  - A. Poles: Install 8-foot (3-m) driven ground rod at each pole.
  - B. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor.
- 16. Design exterior lighting to only illuminate areas as required for safety and comfort. Do not exceed 80% of the lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments. At Owner's option, provide flagpole lighting which meets practices approved by a LEED rating system. Such practices include LEED Credit Interpretation Requests.
- 17. Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical foot-candles at boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site. For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.
- 18. Design exterior luminaires to allow no more than 5% of the total initial designed fixture lumens to be emitted at an angle of 90 degrees or higher from nadir (straight down). - Based on LZ3 - Medium (Commercial/Industrial, High-Density Residential) as defined in IESNA RP-33.

END OF SECTION