MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes medium voltage metal-enclosed SF6 gas insulated interrupter switch with electronic fuse emulation relay protection all in a NEMA 3R pad mounted enclosure with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points.

2. Relays.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches and fuse emulating relays.

2. Time-current characteristic curves for overcurrent protective devices, including fuse emulating relay devices.

3. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: For each type of switchgear and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

a. Tabulation of installed devices with features and ratings.
b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
d. Floor plan drawing showing locations for anchor bolts.
e. Current ratings of buses.
f. Short-time and short-circuit ratings of switchgear assembly.
g. Nameplate legends.

2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

a. Power, signal, and control wiring.
b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
c. Schematic control diagrams.
d. Diagrams showing connections of component devices and equipment.
e. Schematic diagrams showing connections to remote devices.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 140°F and not below -40°F

2. Altitude of 1000 above sea level.

3. Switches will be mounted outdoors on the Eastern Michigan University campus, Ypsilanti, Michigan on a concrete pad.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Touchup Paint: One container of paint matching enclosure finish, each 1.0 pint.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.3.

B. Ratings: Suitable for application in 15kV, 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 15 kV.

2.3 METAL-ENCLOSED INTERRUPTER SWITCHGEAR

A. Manufacturers:

1. G&W Electric, RPFI

B. Comply with IEEE C37.20.3 and ANSI C37.72.

C. Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.

D. Ratings: Comply with standard ratings designated in IEEE C37.20.3 for maximum-rated voltage specified.

1. Each switch cabinet shall contain one switch and vacuum bottle contactor with electronic fuse emulation relay.

E. Interrupter Switches: Stationary, gang operated, internally mounted operating mechanism capable of providing quick-make, quick-break operation in either switching direction independent of switch handle speed. The integrated switchgear assembly shall be suitable for application at load interrupting, fault closing and momentary ratings of integrated switchgear assembly.

1. Rating: 600A continuous duty and load break.

2. Basic impulse level (BIL), 110kV.

3. Momentary current rating: 20,000 asymmetrical Amperes.

4. Duty-Cycle, Fault Closing: 20,000 asymmetrical Amperes.

5. One second current: 12,000 symmetrical Amperes.

6. Switch Action: Totally enclosed SF6 gas insulated.

7. Switch totally enclosed in welded stainless steel tank resulting in a dead front connection. Insulating gas shall be SF6

8. Components shall be internally connected by copper conductors capable of handling momentary and continuous current duty.

9. Switch contacts shall be plated, high-conductivity copper alloy in a tulip-bayonet design.

10. Arcing tips shall be copper/tungsten alloy.

F. Vacuum Interrupters

1. The vacuum interrupter shall consist of vacuum bottles and a spring-assisted operating mechanism. The mechanism used shall be used for three phase operation only. The mechanism shall consist of three vacuum bottles mechanically linked to a single spring-assisted operating mechanism.

1. The vacuum interrupter operating mechanism shall consist of the support assembly, linkage, spring latch mechanism, and solenoid utilized for electronic tripping. Maximum interrupting time shall be three cycles (50 msec). The movable contact shaft shall be flagged to indicate the contact position, open or closed. This contact position indicator shall be fully visible through viewing windows supplied in the switch tank.

2. Each tap phase shall be equipped with an individual 600A vacuum interrupter fully enclosed in an SF6 insulated switch tank. Electrical opening shall be by a solenoid that is activated from sources external to the switch tank. Closing (reset) of the vacuum interrupter shall be mechanical with the use of an external operating handle. The mechanical linkage assembly shall provide for a "trip-free" operation which allows the vacuum interrupter to interrupt independent of the operating lever.

1. Rating: 600A continuous duty and load break.

2. Basic impulse level (BIL), 95kV.

3. Interrupting rating: 12,000 symmetrical Amperes.

4. One minute withstand: 35kV.

G. Window: Permit viewing contact positions upon opening front door.

H. Include provisions for mounting and provide fault indicator fish eyes in the skid riser below the enclosure doors.

2.4 FABRICATION

A. Outdoor Enclosure: Galvanized steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating for concrete pad mounting.

1. Each compartment shall have the following features:

a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
c. Louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.
d. Hinged front door with locking provisions.
e. Front accessible dead front connections and controls.
f. Power for heaters to be provided by control power transformer.

B. Finish: Manufacturer's standard finish over rust-inhibiting primer on phosphatizing-treated metal surfaces. Color as required by Eastern Michigan University.

C. Bus Transition Unit: Arranged to suit bus and adjacent units.

D. Incoming-Line Unit: Arranged to suit incoming line.

E. Outgoing Feeder Units: Arranged to suit distribution feeders.

F. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

G. Cable connection points to the primary select switch shall all be 600-amp, dead break bushing for incoming cables and 600-amp deep well load break bushings. Bushings shall be welded, not gasketed. Provide elbow type, dead front cable terminations compatible with the specified medium Voltage cables and the bushings provided with the medium Voltage switch.

2.5 COMPONENTS

A. Main Bus: Copper, silver plated at connection points and electrically isolated from the adjacent switch.

B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches; full length of switchgear.

C. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

D. Relays:

1. An electronic assembly shall be provided to sense load and fault current on each phase of the load tap circuits. The electronic control shall be powered from the current transformers mounted inside the SF6 insulated switch tank. No external power source shall be required for overcurrent protection. The electronic control shall monitor the current on the individual phases of the load tap circuits using input from the internal current transformers. Electronic trip capability shall be selectable for each phase. Temperature range shall be -30°c to +50°c.
3. Minimum trip selection shall be accomplished with selector knobs inside the electronic enclosure. Trip time current characteristics (tcc) shall be field selectable using a dip switch. Maximum time for power up and ready-to-trip when closing on a circuit shall be ten percent of the trip time or 1/2 cycle, whichever is greater. Trip selection may be made with the load taps energized. The electronic controller shall be preset for three phase trip.

E. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with NEMA LA 1.

1. Install in cable termination compartments on the line and load side of the switch, in each phase of circuit.

2. Coordinate rating with circuit voltage. Circuit feeding the switches is rated 4800/2770V three phase.

F. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.

2. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

G. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2. Conductors sized according to NFPA 70 for duty required.

2.6 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Electrical Identification." Identify units, devices, controls, and wiring.

2.7 SOURCE QUALITY CONTROL

A. Before shipment of equipment, perform the following tests and prepare test reports:

1. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.

2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as switch trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchgear and anchor to concrete bases according to utility, manufacturer’s written instructions, seismic codes at project, N.E.C.A. 430-2006 and requirements in Division 26 section “Hangers and Supports for Electrical Systems.”

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Diagram and Instructions:

1. Include in the Operation and Maintenance Manuals:

a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

3.4 CONNECTIONS

A. Cable terminations at switchgear are specified above and are to be compatible with the medium voltage cables specified in Division 26 Section "Medium-Voltage Cables."

B. Where internal power connections require the use of cable,

1. The cable shall be unshielded 15kV rated,

2. The terminations shall use long barrel two hole compression lugs insulated to match appropriate voltage.

C. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Sections "Conductors and Cables" and "Medium-Voltage Cables."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.

2. Report results in writing.

C. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”

1. Visual and Mechanical Inspection

a. Inspect for physical, electrical and mechanical condition.
b. Compare equipment nameplate information with construction document one line diagram and report discrepancies.
c. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
d. Inspect all ~~bus~~ connections for high resistance by infrared survey after equipment has been energized.
e. Inspect accessible insulators for evidence of physical damage or contaminated surfaces.
f. Verify proper ground connection to ground mat.
g. Lubrication

1) Verify appropriate contact lubricant on moving current carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.

h. Exercise all active components.
i. Inspect all mechanical indicating devices for proper operation.
j. Verify that current and potential transformer ratios correspond to Drawings.

2. Electrical Tests

   a. Perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.
   b. Perform an over-potential test on each bus section, each phase-to-ground, for one (1) minute at values manufacturer's recommended potential.
   c. Perform phasing check on double-ended switchgear to ensure proper bus phasing from each source.
   d. Determine accuracy of volt and amp readings for all meters and verify multipliers
   e. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
   f. Perform secondary voltage energization test on all control power circuits and potential circuits. Check voltage levels at each point on terminal boards and at each terminal on devices.
   g. Perform current injection tests on the entire current circuit in each section of switchgear.

      1) Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.
      2) Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.
      3) Test current at each device.

   h. Control Power Transformers - Dry Type

      1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
      2) Verify proper primary and secondary fuse ratings.
      3) Verify proper interlock function and contact operation.
      4) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices.
      5) Verify proper secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

   i. Perform tests on all instrument transformers as required elsewhere in this Specification.
   j. Potential Transformer Circuits

      1) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check for proper potential at all devices.
      2) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

D. Test Values

1. Insulation resistance test to be performed in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.1. Values of insulation resistance less than manufacturer's minimum should be investigated.

2. Over-potential test voltages shall be applied in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.2. Test results are evaluated on a go, no-go basis by

slowly raising the test voltage to the required value. The final test voltage shall be applied for one (1) minute.

E. Report test results in writing.

F. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

~~A.~~ Set field-adjustable, protective-relay trip characteristics to trip after upstream device in circuit and to maintain cable short circuit protection.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 1 Section "Demonstration and Training."

SECONDARY/LOW VOLTAGE ELECTRICAL DISTRIBUTION
MARCH 17, 2008

1. Magnetic Interference and Mitigation:
    a. Magnetic interference can pose major problems in the design and operation of electrical and electronic equipment, instruments, control systems, data processing equipment and communication networks. This equipment frequently indicates aberrations whose sources may not be readily recognized, but which are due to magnetic interference. In general, such interference is classified as internal and external.
        i. Internal interference, created by operation of components within the system itself, can usually be eliminated or nullified by shielding the individual components and confirming the magnetic force they create.
        ii. External interference is frequently caused by nearby or adjacent equipment such as transformers, medium voltage busway, or switching equipment, which generate magnetic “spikes” affecting apparatus which is not physically attached to the source of interference.
    b. Special Protective and Preventive Materials: In addition to developing a basic protection design in preventing the penetration of magnetic interference, when it is required by this Standard to Design and specify EMF mitigation plans or strategies that will prevent and solve the magnetic interference problems as described in Section 26 10 00.1.a. The expectation of this standard is to reduce EMF to below one (1) milligauss, even in the most complex field environment.
    c. Special EMF Shielding Material: There are two means of EMF shielding that may be used to achieve effective prevention of magnetic interference or eliminate the existing problems. See Sections 26 10 00.1.b and 26 10 00.1.d.
        i. In fields of low intensity, use CO-NETIC AA perfection sheet because of its high initial permeability and corresponding high attenuation characteristics. In fields with high intensity, use NETIC S3-6 sheet because of its high magnetic

saturation characteristics. CO-NETIC AA Perfection Annealed Sheet are available in standard gauge .014" through .062" thick, in flat sheet sizes up to 30" x 59" or full sheet of .015" thick and 36" by 120".

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

iii. Fasteners: NETIC/CO-NETIC AA sheets shall be mounted to walls by non-magnetic fasteners to penetrate the shielding sheets. Hole in the NETIC/CONETIC AA alloy sheets for fasteners shall be drilled with standard metal drills (cobalt steel drill bits). Special fastening application (masonry, concrete, etc.) shall be consistent with EMF shield manufacturer's recommended attachment procedures and EMU Building Design Standard requirements.

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

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

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

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

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

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

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

2. Transformers (Under 600 Volts):

a. General purpose distributing transformers shall be single phase and three phase dry type, which are generally used with primaries connected to secondary distribution circuits. They shall be designed for the voltage of 120, 208, 240, 480, and 600 with ratings ranging from 500VA to 5000KVA and frequency of 60 Hz.

b. The transformers shall be designed for continuous operation at the rated KVA for 24 hours a day, 365 days a year operation with a nominal life expectancy and greater overload capabilities in accordance with the latest ANSI-C57. The temperature rise of these energy efficient transformers shall be 80 degrees C temperature rise and shall be insulated with a UL recognized 220 degree C insulation system. Transformers shall have K factor rating as recommended by ANSI/IEEE C57.110-1986, where required (i.e. computer center, lab, etc.). It shall have a 30 percent overload capability. Because of the growth of computer lab in all building and use of wireless computers throughout the University campus all general purpose transformers in renovations and new construction shall be K-rated transformers.

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

d. Coil and Core Assemblies:

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

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

   iii. Enclosure shall be ventilated, heavy gauge sheet steel, primed and finished in gray baked enamel. The core and coil assembly of the transformers shall be impregnated with non-hygroscopic, thermosetting varnish and cure to minimize hot spots and seal out moisture. The core of the transformer shall be grounded to the enclosure.

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

   v. Provide minimum clear working space of 3-1/2 feet about transformers operating at 600 volts, nominal, or less to permit ready and safe operation adjustment, repair and maintenance.

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

f. Proper ventilation and cooling shall be provided at locations where transformers are installed to prevent temperature in the room to rise above 75 degrees F.

LOW VOLTAGE SWITCHGEAR-SERVICE ENTRANCE
MARCH 17, 2008

1. Protective Devices: Main breakers and feeder breakers or switches shall be equipped with ground fault protection as required by applicable codes. In critical applications provide coordinated ground fault protection on feeder breakers. Provide settings and coordination information with the service manuals.
   a. All circuit breakers with solid state trip units shall comply with the following standards:
      i. ANSI/IEEE C37.90.1 – Surge Withstand Capability (SWC).
      ii. ANSI/IEEE C37.90.2 – Withstand capability of relay systems to radiated electromagnetic interference from transceivers.
2. The maximum operating force required to open or close a switch or breaker shall not be greater than 75 pounds on the operating handle.
3. Vacuum breakers or vacuum switches may be used with the approval of the University Engineer's Office.
   a. All switches shall be top or horizontal fed to the breakers.
4. Indicator lamps shall be LED or transformer type utilizing low voltage lamps.

METERING
MARCH 17, 2008

1. Metering System: A meter with system display is required for each building, transformer, or service. Approved and acceptable meters and manufacturers for EMU facilities are:
    a. Power Management Ltd. shall be PML 7200 or PML 7700 with enhanced package #1, RS-485 and 480 volt power supply, if required.
    b.
    c. Each individual KWH meter specified must have communications and impulse capability.
    d. If complete meter setup cannot be done from the front panel, any required software, cables, and keys shall be provided to the Facilities Operations and Development Electric Utilities Shop.
    e. The height shall be five feet (5'-0") from the finished floor or four and a half feet (4-1/2') from the switch pad to the center of the meter.
    f. Provide four (4) current transformers and circuit monitor that indicate true RMS current for phase and neutral.
    g. The monitor shall provide the following information:
        i. Voltage: phase to neutral and phase-to-phase ABC.
        ii. Amps: present reading and 15-minute maximum demand ABCN
        iii. Kilowatt maximum demand based on 15-minute intervals.
        iv. Power factor, kilo VAR, kilo VAR, hour KVA.
2. A 6-pole GE PK-2 panel-mounted test plug installed flush on switchgear for portable test metering by University Maintenance Personnel. Specify that three (3) left poles be factory wired to the phase current transformer secondaries; wire the right hand pole no. 6 to the phase to neutral potential source. Current transformer poles shall have shorting auxiliary contacts.
    a. If the meter used for KWHR reading does not have a meter serial number on the front of the display, then an engraved name plate shall be installed below the meter with the meter serial number engraved on its.
    b. Avoid metering schemes that are only capable of measuring partial loads connected to the distribution system or electrical apparatus being monitored. Specify that the current transformers and the meter shall be installed to measure electrical load from the distribution system including fire pumps. The fire pumps shall be connected ahead of the main overcurrent protective

SERVICE DISCONNECT
MARCH 17, 2008

1. Secondary main disconnects shall be equipped with electronic trip devices.
    a. The analysis diagram fault currents shall be shown on a symmetrical basis; and for calculation purposes, the transformer primary available fault supply shall be determined from the University Fault Current Study.
2. Fuses may be used in primary voltage services, secondary voltage main switchgear, distribution panel boards, and motor controls.
    a. UL classification fuses shall be used as required for time delay and current limitation requirements of the application.
    b. Class I fuse is prohibited.
    c. Fuses for feeders and branch circuits up to 600 ampere shall be UL Class RK1 or RK5 with 200,000 AIC.
    d. Fuses for secondary service mains and feeders over 600 ampere shall be UL Class L with 200,000 AIC.

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

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

END OF SECTION