DIVISION 16 - ELECTRICAL

Section 16310 - Primary Switching Station
Introduction

The goal of the electrical department is to provide a looped power distribution system at both 4160 volts and 13.8 KV which can be upgraded in the future to 13.8 KV. Each basic loop is a 400 A loop with available capacity to be able to handle all of the load on the loop from either of two main disconnects at the main distribution system. At present the PMH switch is the point where each building is to be disconnected from the loop.

Where located as part of a new construction system the PMH switch is to be located at a point that is accessible as far as future connections and for future replacement if necessary. Where for redistribution to an existing system the switch is to be located at a point that is limited in access to the general public, and accessible for future connections.

The designer shall coordinate the medium voltage design with the University of Arizona, Electrical Engineer.

PMH switch should be mounted on a concrete pad with a minimum of 6' clearance in front of all doors, an accessible exit (when the doors are open), and minimum 3' of clearance on both sides for easy access to control switches. The concrete pad shall extend to a minimum of 3' in front of all doors. The concrete pad should contain a grounding ring composed of a 3/4" x 10' copperweld or copperclad ground rod on each corner, connected by minimum of 3/0 ground wire. This ground shall be connected to the ground pad of the PMH switch exothermically.

Specify stub-outs for all unused compartments.

Specify 24" bases under all switches.

Specify fuse sizes.

Part 1 - General

- Refer to Appendix Section 16310 and incorporate into project.

Part 2 - Products

- Refer to Appendix Section 16310 and incorporate into project.

Part 3 - Execution

- Refer to Appendix Section 16310 and incorporate into project.

End of Section 16310

Section 16310 PRIMARY SWITCH STATION

PART 1 GENERAL

1.01 Description of Work

A. The pad-mounted gear shall be in accordance with the one-line diagram, and shall conform to the following specification. This gear shall be type PMH-9 as manufactured by S&C Corporation or approved equal in Federal Pacific.

B. The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked.

C. NOTE: It is the intent of the University to use equipment rated for 13.8 KV ungrounded systems on 4160 volt at this time to allow for conversion to 13.8 KV ungrounded systems in the future.

1.02 Ratings

A. The ratings for the integrated pad-mounted gear shall be as designated below:

KV, Nominal 14.4	
KV, Maximum Design	17.0
KV, BIL	95
Main Bus Continuous, Amperes	600
Three Pole Interrupter Switches	
Continuous, Amperes (Source/Feeder)	600/600
Live Switching, Amperes (Source/Feeder)	600/600
Two-Time Duty-Cycle Fault-Closing Capability, Amperes Rms Asymmetrical	22,400
Fuses with Integral Load Interrupter	
Maximum, Amperes	200
Live Switching, Amperes	200
Two-Timing Duty-Cycle Fault-Closing Capability, Amperes Rms Asymmetrical	13,000
Short-Circuit Ratings	
Amperes, Rms Symmetrical at	12,500
Mva Three-Phase Symmetrical at Rated Nominal Voltage	310

B. The momentary and two time duty cycle fault closing ratings of switches and bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of the fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

1.03 Certification of Ratings

A. The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated pad-mounted gear assembly as rated.

B. The manufacturer shall furnish with the bid certification of ratings of the basic switch and fuse components and the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

1.04 Compliance with Standard and Codes

A. The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

1. Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970 which are in effect 30 days prior to the date of quotation or bid.

2. Article 710-21(e) Circuit Interrupting Devices (Load Interrupters) in the 1984 National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

3. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

1.05 Enclosure Design

A. To ensure a completely coordinated design, the pad-mounted gear assembly shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access and tamper resistance. Provide padlock and penta head fasteners, in addition to manufacturer's normal controls.

PART II PRODUCTS AND EXECUTION

2.01 Insulators

A. The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

1. Operating experience of at least 10 years under similar conditions.
2. Ablative action to ensure nontracking properties.
3. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.
4. Adequate strength for short-circuit stress established by test.
5. Conformance with applicable ANSI standards.
6. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.02 High-Voltage Bus

A. Bus and interconnections shall consist of copper bar.

B. Bus and interconnections shall withstand the stresses associated with short circuits up through the maximum rating of the pad-mounted gear, including proper allowance for transient conditions.

C. All current carrying parts shall be copper or bronze.

2.03 Ground-Connection Pads

A. A ground-connection pad shall be provided in each compartment of the padmounted gear.

B. The ground-connection pad shall be constructed of steel, 3/8" thick for use with 600 ampere main bus which shall be copper clad and welded to the enclosure, and shall have a short-circuit rating equal to that of the integrated assembly.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.04 Enclosure

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structuralframe-and-bolted-sheet) construction to maximum strength, minimize weight, and inhibit internal corrosion.

B. The basic material shall be 11-gauge hot-rolled, pickled, and oiled steel sheet.

C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth.

1. The gas-shielded short-circuiting transfer welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.
2. Any welds made by other than this method shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad. The flanges shall be formed from double-thickness folded edges for strength and rigidity, with the sheared edges folded back into the inside of the enclosure to minimize exposure to corrosive attack.

F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Roof edges shall be formed to create a mechanical maze with the top flanges of the enclosure which shall allow free-flow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

H. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to prevent condensation of moisture thereon.

I. Insulating interphase and end barriers of fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of power fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).

J. Models containing source switches rated 600 amperes continuous shall have full-length steel barriers separating adjoining compartments.

K. Lifting tabs shall be removable. Sockets for the lifting tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to prevent the tabs from scratching the enclosure finish. To help retard corrosion, this material shall be closed-cell neoprene to prevent moisture from being absorbed and held between the tabs and the enclosure.

L. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381 .G of the National Electrical Safety Code (ANSI Standard C2).

M. Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381.G of the National Electrical Safety Code (ANSI Standard C2).

N. A (steel-compartmented) base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 24 inches.

2.05 Doors

A. Doors shall be constructed of 11 gauge hot-rolled, pickled, and oiled steel sheet.

B. Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow free-flow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of three stainless steel hinges and hinge pins. The hinge pins shall be welded in place to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with a positive-action three-point latching system.

E. Each door (or set of double doors) shall be provided with a recessed stainless steel door handle. The door handle shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering. The handle shall be provided with a recessed penta head bolt for additional security.

F. Doors providing access to solid-material expulsion-type power fuses shall have provisions to store spare refill units.

G. Each door shall be provided with a galvanized-steel door holder located above the door opening. These holders shall be hidden from view when the door is closed, and it shall not be possible for the holders to swing inside the enclosure.

H. Doors shall automatically self lock open.

2.06 Ventilation System

A. Ventilation system shall be provided along the bottom and top at each side of the enclosure.

B. Each vent shall have an inside baffle to protect against insertion of foreign objects, or shall be so constructed as to prevent insertion of foreign objects.

2.07 Finish

A. During fabrication, the areas of structural parts which may later become inaccessible, such as folded edges and overlapping members, shall be given a phosphatizing bath and an iron-oxide zinc-chromate anti-corrosion primer to ensure that all surfaces are protected.

B. Any welds made by other than the gas-shielded short-circuiting transfer welding process shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

C. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the utilized structures.

D. All exterior seams shall be filled and sanded smooth for neat appearance.

E. To remove oils and dirt, and to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process before any protective coatings are applied.

F. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the ability of the finishing system to resist corrosion and protect the enclosure, representative test specimens shall satisfactorily pass the following tests:

1. 1000 hours of exposure to salt-spray testing per ASTM B 11 7-73 with loss of adhesion from bare metal not to extend more than 1/8" and underfilm corrosion not to extend more than 1/32" from the scribe.
2. 1000 hours of humidity testing per ASTM D 2247 with the formation of no more than #6 medium blisters as evaluated per ASTM D 714-56.
3. 500 hours of accelerated weather testing per ASTM G 53-77 with no more than 25% reduction of paint gloss.
4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of paint.
5. 160 inch-pound impact adhesion testing per ASTM D 2794-69 with no paint chipping or cracking.

6. Certified test abstracts substantiating such capabilities shall be furnished with the bid.

G. The finishing system shall be applied without sags or runs for a pleasing appearance.

H. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange and around the door hinges shall be coated with a wax-based anti-corrosion moisture barrier to give these areas added corrosion resistance. Weld studs within the enclosure that are not covered by nuts shall be coated with an oxide-inhibiting compound to help guard against corrosion starting on the exposed threads.

I. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

J. The finish shall be white. *Contractor shall sand finish with #220 grit dual action Sander Prime with duPont Vari Prime #815/8165 and apply 3 wet coats of duPont catalyzed #817 acrylic enamel.*

2.08 Corrosion

A. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either non-ferrous materials, or galvanized, or zinc-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

2.09 Tamper Resistance

A. In consideration of tamper resistance, the enclosure shall withstand a prying leverage of 75 foot-pounds applied to all joints, crevices, hinges, seams and locking means. All such openings shall prevent insertion of number 10 AWG hard-drawn copper wire after the prying leverage has been applied.

2.10 Interrupter Switches

A. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be furnished with the bid.

B. Interrupter switches shall be operated by means of an externally accessible 3/4 inch hex switch-operating hub. The switch-operating hub shall be located within a recessed pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4 inch deep-socket wrench or a 3/4 inch shallow-socket wrench with extension. The switch-operating hub pocket shall include a pad lockable access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch operating hub to prevent over travel and thereby guard against damage to the interrupter switch quick-make, quick-break mechanism.

C. Interrupter switches shall utilize a quick-made, quick-break mechanism installed by the switch manufacturer. The quick-make, quick-break mechanism shall be integrally mounted

on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch independent of the switch-operating hub speed. Switches shall be the air break type.

D. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the circuit when the interrupter switch is in the open position.

E. Interrupter switch contacts shall be of silver-to-silver construction for optimum current transfer, and shall be backed up by stainless steel springs to provide constant high contact pressure.

F. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

G. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

H. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.

I. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access door.

J. Key interlocks shall be provided between each fuse-compartment door and all switches to guard against opening fuse-compartment door(s) unless all switches are locked open.

K. Grounding studs shall be provided at all switch terminals. Grounding studs shall also be provided on the ground pad in each interrupter switch compartment and on terminals and ground pads in any cable-termination compartment. The momentary rating of the grounding studs shall equal or exceed the short-circuit ratings of the pad-mounting gear.

L. Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each switch compartment on units with more than one switch position.

2.11 Fuses

A. Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

1. Fusible elements shall be non-aging and non-damageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.

2. Fusible elements for refill units, rated 10 amperes or larger, shall be helically coiled to avoid mechanical damage due to stresses from surges.
3. Fusible elements shall be supported in air to allow cooling after current surges to help prevent damage.
4. Each refill unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.
5. Power fuses shall have melting time-current characteristics that are permanently accurate to within a total of 10% in terms of current. Time current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
6. Power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the power fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
7. All arcing accompanying power fuse operation shall be contained within the fuse, and all arc products and gases evolved during fuse operation shall be vented through an exhaust control device that shall effectively control fuse exhaust.
8. Power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
9. Fuses shall be S&C type SML-4Z units which accept type SM-4 refill units.

B. Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hook stick.

1. The integral load interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.
2. The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.
3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hook stick. No separate load-interrupting tool shall be required.
4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
7. The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
8. Integral load interrupters for power fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 1 3,000 amperes RMS asymmetrical at 14.4 KV or 25 KV. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), without a quick-make mechanism and when operated vigorously through its full travel with6ut hesitation at any point, with the integral load interrupter remaining operable

and able to carry and interrupt remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

C. Fuse terminal pads shall be provided with a two-position adapter. This adapter shall accommodate a variety of cable-terminating devices.

D. Grounding studs shall be provided at all fuse terminals. One grounding stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the grounding study shall equal or exceed the short-circuit ratings of the pad-mounted gear.

E. A full set of fuses, plus a full set of spare fuse refills, shall be provided for each fuse position as shown on the one line diagram.

2.12 Warning Signs

A. All external doors shall be provided with permanent "Caution - High Voltage -Keep out" signs.

B. The inside of each door shall be provided with "Danger - High Voltage -Qualified Persons Only" signs (Bilingual English, Spanish *and Japanese*).

C. The inside each door providing access to interrupter switches shall be provided with warning signs indicating that "Switch Blades May Be Energized In Any Position".

D. The inside of each door providing access to power fuses shall be provided with permanent warning signs indicating that "Fuses May Be Energized in Any Position".

E. All warning signs shall be provided in both English and Spanish.

2.13 Rating Nameplates and Connection Diagrams

A. The outside of each door (or set of double doors) shall be provided with nameplates indicating the manufacturer's name, catalog number, and model number.

B. The inside of each door (or set of double doors) shall be provided with nameplates indicating the following: voltage ratings (kv, nominal; kv, maximum design; and kv, BIL); main bus continuous rating (amperes); short-circuit ratings (amperes, RMS symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings (amperes, one-time/two-time duty-cycle fault-closing capability); and interrupter switch ratings (amperes, continuous; amperes, live switching - load splitting and load dropping; amperes, fault-closing, duty-cycle, two-time RMS symmetrical, RMS asymmetrical, and one-second symmetrical).

C. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of the front and rear doors (or set of double doors), and on the inside of each switch-operating-hub access cover.

2.14 Auxiliaries

A. Holders, and refill units for original installation, as well as one spare fuse unit or refill unit for each fuse mounting shall be furnished.

B. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

C. One bolted connector per phase accommodating NO.2 solid through 500 MCM stranded copper or aluminum conductor shall be furnished for all switch and fuse positions.

2.15 Three-Phase Fault Indicator

A. A three-phase fault indicator shall be provided and installed with three single phase sensors in each switch compartment on all units.

B. Fault indicators shall be provided at switching points on distribution circuits and unfused taps. A fault indicator shall be provided for each phase. Trip setting shall be as required for the given circuit. Reset shall be automatic and initiated by normal current. Fault indicators shall be type CR (10) manufactured by RTE Corporation, Waukesha, Wisconsin, or approved equal.

PART 3 INSTALLATION

3.00 Installation

A. The switch assembly shall be mounted securely on a concrete pad minimum of six inches in thickness, designed adequately for the weight of the switch. The pad shall extend a minimum of 3' from the front of each set of doors. The switch shall be securely anchored to the pad per the manufacturer's recommendations. A ground loop shall circle the switch and provisions for grounding the switch and landing any grounds or shields shall be provided for within the enclosure. During installation all internal shields shall be left inside of the switch and shall not be left out of the cabinet or subject to exposure to the elements. Any shield which has been damaged due to neglect or exposure to the elements shall be replaced to the satisfaction of the University of Arizona Electrical Engineer.

End of Appendix Section 16310