UNIT SUBSTATIONS

Scope

Unit substations shall be 500 kVA minimum, 1500 kVA maximum unless approved otherwise by the University. For the required configuration of University substations see Standard Electrical Detail 16313001 for single-ended substations and Standard Electrical Detail 16313002 for double-ended substations,

A system fault contribution of 750 mVA shall be used when determining the required interrupting rating for unit substation equipment.

In general, size a unit substation so that the transformer's AA rating (or the combined transformer AA ratings in a double-ended unit substation) equals roughly 150 percent of the projected peak demand.

Rooms or vaults for indoor unit substations shall be adequately ventilated for equipment cooling, and adequately sound-proofed to significantly reduce the transmission of sound to adjacent areas.

All bus bars shall be copper. All bus connections shall have at least two bolts

All medium voltage insulators shall be porcelain or cyclophatic epoxy

Provide rear access to all unit substations.

Provide drip shields for unit substations installed in areas with fire protection sprinkler systems.

Feeder breakers shall be 800-ampere minimum.

All incoming cable connectors shall be compression type, with NEMA standard lugs and bolt spacing. Two-bolt or 4-bolt connectors are required for each connection.

Incoming Line Section Requirements

Provide incoming line sections with two loop switches for the two incoming lines, and a fused load interrupter transformer primary switch. The transformer primary switch shall be key-interlocked with its associated secondary main breaker so that the secondary main breaker closes after and must be opened before the transformer primary switch.

Provide space for distribution class surge suppressors on each incoming primary line.

Primary switches shall be metal enclosed and rated as follows:
Voltage: 15 kV.

Continuous current: 600 amperes.

Momentary short circuit and fault closing current: 61,000 amperes

Basic Impulse Level: 95 kV

Primary switches shall be two position, of the quick make/quick break type and shall be bottom hinged. Switch mechanisms shall be direct coupled. Chain or cable drives are not acceptable. **Exception:** Powercon chain driven switches, if supplied as a complete unit (switch, operator, enclosure) by Powercon.

The phase bus bars shall be routed across the top of the switch compartments to eliminate unnecessary transition sections.

All primary cable connections shall be provided with NEMA 2-hole, solderless cable lugs. Allow space in the loop-switch cubicles for stress cones for top or bottom cable entry.

Provide a copper ground bus bar that is connected to the transformer and secondary switchgear section ground bus bars.

**Transformer Requirements**

Provide only dry type transformers, unless an alternate for a given project is specifically approved by the University.

Transformers (dry type) shall have a 220°C insulation system, and shall be designed for a maximum temperature rise at full load of 115°C above a 40°C ambient.

The transformer coils shall be rigidly clamped to the core. The coil and core assembly shall mechanically and electrically isolated from the transformer frame and enclosure.

Transformers shall have primaries rated 95 kV BIL and secondaries rated 10 kV BIL.

Transformers shall either be equipped with forced air cooling fans and controls, or equipped with needed support equipment and accessories to support future forced air rating fans. The transformers FA ratings shall equal 133 percent times of their AA ratings. Control power transformers supplied with the transformers shall power the fans.

Transformers shall be equipped with temperature switches that start the fans on high (FA operating) temperature and close a dry contact on high-high (alarm) temperature.

The temperature monitor shall be mounted on a hinged front plate of a flush mounted box. The electrical connections shall be accessible and the monitor shall be removable without de-energizing the transformer.

Wiring to the temperature monitor shall be routed and supported independently of the transformer enclosure so that enclosure panels can be removed without affecting the wiring.
The temperature monitor shall include three hot spot temperature sensors, one for each transformer phase.

The temperature monitor shall start the fans at a temperature of 100 degrees C. It shall initiate an audible alarm, close an “alarm” contact, and illuminate a red alarm LED at 135 degrees C. It shall close a breaker “trip” contact and illuminate a second red alarm LED at 175 degrees C. The temperature set points shall be adjustable. The contacts shall be Form C and wired out to a terminal strip inside the box.

The temperature monitor shall include an LED or LCD display to allow reading of the hot spot temperature in each phase, and the highest temperature seen on each phase since the last reset. A reset button shall be provided to reset the maximum readings.

The temperature monitor shall include LED’s indicating "power on" and "fans running".

The temperature monitor shall include an RS422 data port for future connection to a remote monitor.

A Hand-Auto control switch shall be connected in parallel with the temperature monitor fan control contacts.

Full capacity, 2.5 percent taps shall be provided on the primary winding, three below, and one above the rated voltage tap (five total taps).

Transformers for the North Campus, initially served at 4800-volts, shall be equipped with dual wound primaries; 13.2 kV and 4.8 kV. The 13.2-kV primary shall be equipped with taps as noted above.

**Secondary Switchgear Section Requirements**

Provide secondary main breakers in all unit substations. Secondary main, tie breakers, and feeder breakers shall be:

1. Individually mounted, draw out, metal-clad, mechanically operated, stored energy type, quick-make and quick-break air circuit breakers.
   A. Unless noted otherwise, the breakers shall be manually 'charged'.
   B. Electrically operated (electrically charged) breakers shall be supplied where called for on the drawings. Each electrically operated breaker shall be powered by a dedicated, charging motor.
2. Breakers shall be equipped with removable arcing contacts and operation counters.
3. Breakers shall be rated for 100 percent continuous duty, with frame and trip (sensor) ratings as shown on the drawings. Sensor size (and design application) will typically be 75%, or more, of the frame size
4. Breakers shall be capable of being manually racked into three positions; “connected”, “test” and “disconnected”. The breaker frames shall be grounded in all positions.
5. The compartment front doors shall be closable in all breaker positions and shall permit breaker operation with door open or closed. The doors shall be capable of being opened without tripping breakers in the “connected” position.
6. A breaker shall be tripped open and the stored energy in the breaker mechanism shall be discharged as the breaker is moved from one position to another.
7. Breaker compartments shall be deadfront. Shutters shall close automatically as a breaker is racked out of the 'connected' position. Control contacts shall be 'made' when breaker is in test or connected positions.
8. Breakers shall have a minimum of two spare “Form C”, isolated contacts brought out to an accessible terminal strip in the compartment. The contacts shall be rated 120 volts, 10 amperes, 60 Hz.
9. Each breaker shall be equipped with three-phase and one neutral current sensor, and a microprocessor-based trip unit.
10. Where shown on the drawings, breakers shall be equipped with a flux transfer shunt-trip. The flux transfer shunt trip wiring shall be terminated on an accessible terminal strip in the compartment.
11. Breakers shall be capable of being padlocked in the “open” position.
12. A Kirk Key interlock shall be provided to prevent the operation of the fused primary switch unless the main breaker is open.

Each breaker shall be equipped with RMS sensing trip units as noted below.

1. Solid-state trip units shall be true RMS sensing, with trip ratings adjustable by removable rating plugs. The trip units shall be magnitude and time adjustable, and shall include a local indication of the cause of a trip. The trip units shall be rated as shown on the drawings.

2. The trip units shall coordinate with the primary fuses, main breaker and largest downstream feeder breakers.

3. The trip units shall allow adjustment without breaker trips and routine testing without removing the breakers from service.

4. The trip units (sensors) shall be rated for 100 percent continuous duty.

5. Trip units shall provide the following ranges and functions as a minimum. See drawings for specific requirements that vary from this configuration:
   
   A. Long time (L) current settings of at least 50-100 percent of the current sensor rating, divided into seven or more steps, and time delays of at least 2-22 seconds, at 600 percent of the long time current setting, divided into seven or more steps.
   
   B. Short time (S) current settings of at least 250-1000 percent of the long time current setting, divided into seven or more steps, and time delays of at least .1-.5 seconds, divided into seven or more steps, to include "flat response" and "I^2T response" characteristics.
C. Instantaneous (I) settings of at least 200-1000 percent of current sensor rating. The instantaneous setting shall be applied on the feeder circuit breakers only, not on the main breaker.

D. Ground fault (G) current settings of 25-100% of current sensor rating, with a 1200 ampere maximum, divided in seven or more steps, with ground fault time delay settings of at least .1-.5 seconds, divided into five or more steps, to include "flat response" and "I²T response" characteristics.

6. Power for operating the solid state trip unit shall be obtained from within the circuit breaker assembly itself, or it shall be provided by a separate control circuit connected to the secondary bus ahead of the main breaker. The solid state trip units shall have non-volatile memory to maintain all settings, trip indications and fault data during a power outage. Batteries to maintain the memory are not acceptable.

The A/E shall design the overcurrent protective system so it can be set in a 'selective' manner, to minimize the disruption from any given fault, to as small an area as possible. The A/E shall also prepare, and/or approve the settings for the overcurrent protective system to insure proper selectivity and coordination. The contractor shall provide test reports showing that the overcurrent system has been set and tested, before the system is commissioned.

In double-ended unit substations, the two main breakers typically are interlocked with the tie breaker so that all three breakers can not be closed at the same time. The throw-over is normally done manually, unless noted otherwise.

Provide ground fault protection on all breakers rated 1200 amps or more. Avoid providing unnecessary ground fault protection that may cause nuisance outages.

Bus bars shall be braced for the calculated short circuit current.

Provide a voltmeter with selector switch, and an ammeter with selector switch. Selector switches shall have also off position.

Provide a Power Measurement Limited (PML) 7330 ION three phase power, energy, demand, and harmonics meter for each transformer secondary. The PML meter shall be panel mounted with an FT (Flexi-Test) case at 60 inches above the finished floor. The meter shall be provided with an Ethernet port.

**Installation Requirements**

Instruct the Contractor to perform testing and do settings in accordance with manufacturer instructions and Section 16950, and to provide the University Project Coordinator with a test report. University will supply circuit breaker settings, and primary fuse sizes.