BASIS OF DESIGN

This section applies to the design of low-voltage switchboards.

Design Criteria

For service building switchboards, provide electronic trip units with long-time, short-time, and ground fault (LSG) protection (molded case circuit breakers). Instantaneous protection shall not be provided because it limits coordination with downstream molded case circuit breakers. Two and preferably three levels of ground fault protection are desired. Selectivity is critical to University of Cincinnati Construction Management (CM) to limit the extent of power outages.

Design Evaluation

The following information is required to evaluate the design:

- **Programming Phase**
  - Description of proprietary equipment required
  - Point of service location and building service category
  - Preliminary watt/square foot value for loads anticipated

- **Schematic Design Phase**
  - Space requirements for working clearances and equipment replacement routing
  - Description of power distribution and riser diagram layouts for project
  - Outline specifications

- **Design Development Phase**
  - Preliminary plans including elevations, layout, and footprint of equipment
  - Preliminary fault, load, and seismic calculations
  - Draft specifications

- **Construction Documents Phase**
  - Final plans including front view, section views, and attachments for proper seismic and fault bracing and mounting
  - Final detail drawings including shipping splits, assembly data, and wiring diagrams
  - Final fault, load, and seismic calculations
  - Final specifications
Submittals

- Catalog cuts including equipment ratings, dimensions, and installation instructions
- Listing by manufacturer standards

Products, Materials, and Equipment

Use National Electrical Manufacturers Association (NEMA) PB-2 and Underwriters Laboratories (UL) 891 design equipped with hinged and latched rear access panels and hinged front panel for breaker and metering compartments.

The main bus shall run continuously through the switchboard and shall include a fully rated neutral conductor, which shall be insulated from the switchboard frame and supported in the same manner as the phase conductors.

Use insulated and isolated silver-plated copper busing.

Provide copper ground through each vertical section.

Bus and connecting stabs for individual breakers shall be sized for the full capacity of the breaker frame size and not for the trip setting of the overcurrent devices. Provide protective shutters for the bus isolation when the breaker is removed. Provide fully rated vertical and horizontal bus sections.

Completely isolate the outgoing feeder cable terminal compartment from the main busing, using suitable insulating type barriers. Locate at the rear of the structure, vertically aligned, facing the rear of the section.

Provide terminal strips for remote control, metering, and status features in an accessible cubicle. Neatly dress all control wire (horizontally and vertically) in an enclosed channel (with removable cover) or surface-mounted raceway.

Main devices requiring energy for operation shall be supplied power from integral bus taps or stored mechanical energy devices.

Provide automatic “source select” scheme to ensure continuous control power to trip units and electronic meters. Provide terminals for access to the future secondary tie control power.

Provide mimic labeling on the front surface of the switchboard showing the busing arrangement. This labeling should reflect the equipment’s one-line diagram. Include transformer and breaker representations.

Provide flexible braided connectors to transformers.

Provide a breaker lifting device mounted on rails.

Spaces shall be totally equipped to accept future carriages and feeder breakers without any outages.
Required series rated equipment is not acceptable.

The metering used will be Square D power logic system or equal and must be compatible with the University metering system.

**Breakers**

Circuit breakers’ overcurrent protection shall be molded case type, UL listed for 100 percent continuous current rated, with full function trip.

Provide a breaker programmer test kit (one required per project).

Solid-state protective devices shall provide long-time, short-time, ground fault trip (LSG). Current sensing shall be true root mean square (rms) current. Manufacturer shall be Square D or approved equal. The unit shall also provide full trip function test, without tripping the breaker, with the breaker either in the energized or de-energized mode. The four-digit alphanumeric display shall indicate the following:

1. Cause of trip
2. Instantaneous value of maximum phase and ground currents
3. Approximate level of fault current that initiated an automatic trip
4. Cause of trip (LED shall remain illuminated if all power is lost to the breaker)

Main breakers shall have electrically operated closing features for remote and automatic operation.

Tie and feeder breakers shall be similar to main, without electrical operation.

**Main Breaker with Network Protection Relaying**

This device consists of a drawout power circuit breaker with an electrical motor-charged mechanism closed and tripped by network relays for reverse current or undervoltage. Amps interrupting capacity (AIC), frame, and trip settings shall be provided by the drawings and verified by the protective device study.

Relays shall, at a minimum, consist of the following:

- A master relay (a three-phase directional relay designed to provide highly sensitive directional tripping and to close the circuit breaker if the network voltage is favorable).
- A phasing relay, which permits breaker closing only when the phasing voltage lags the network voltage by up to 25 degrees or leads it by up to 100 degrees.

The network relays function to automatically close the breaker only when voltage conditions are such that the associated transformer will supply load to the secondary loop, and to automatically open the breaker when power flows from the secondary loop to the network transformer.
Current sensing shall be true rms current.

Load demand reclosure controls as found on public utility networks should not be used. Reclosure should be permitted when the network voltages are correct and in proper rotation. The recloser will limit the number of breaker closure attempts to three.

**Control Power**

For spot network and double-ended substations, provide relays and interlocking so that control power is available if one or more transformers is energized. Provide automatic "source select" scheme to ensure continuous control power to all breaker trip units, switchgear controls, and electronic metering. Control power shall be derived from connections ahead of the main breaker(s).

**Installation, Fabrication, and Construction**

Leveling rails are required for drawout equipment to ensure proper alignment.

Installation is not complete until all electrical and mechanical tests have been performed and passed.