The following information shall be included in specifications prepared for use on all University of Cincinnati construction and renovation projects. This information is supplemental and not intended to be a complete specification.

**GENERAL STANDARDS**

**General Configuration and Requirements**

A. The building electrical power distribution systems shall be designed so that a high level of reliability and ease of operation is provided, as well as facilitating preventative maintenance while minimizing the impact to building operations during maintenance activities.

B. The exact nature and design of the distribution system varies with project size, building occupancy, level of risk and other factors, all of which must be considered when making a recommendation to the university. The design professional is responsible for assessing how these factors affect the needs of the university and determining what is an appropriate power system configuration, given these considerations.

C. Most buildings will have one (1) primary (12.47KV system operating voltage) service feeder sourced from a university substation, to be assigned to the project by the university. The design professional shall consult with the university to determine the tie-in sequence for the connections to the university service feeders, and this sequence shall be documented on the design professional's project drawings.

D. Buildings with main-tie-main configurations will operate in a double-ended, open tie breaker alignment for both the primary and secondary switchgear. All efforts should be made to achieve an equal balance of building loads on each primary feeder, and each secondary transformer. Redundant building equipment loads (fans, pumps, etc.) should be fed from opposite sides of tie breakers, and/or from different substations, so as to provide the greatest diversity of equipment power sources and reduction of impacts to building operations during electrical system disturbances.

E. Each substation transformer shall be individually protected by a protective relay or by an E-rated fuse.

F. Switchboard and switchgear enclosures shall be suitable for the environment.

G. A ground bus shall be run the full length of the switchgear/substation and shall be connected at both ends to the building ground loop.

H. The design professional shall prepare all calculations to verify the required ratings for the equipment, cables, etc.
I. The electrical power system as a whole shall be sized for present load along with future anticipated load plus 30% spare capacity. The exact requirements are to be defined in the project formation phase and shall be approved by the University Engineer.

J. All equipment shall be listed and labeled by UL.

**Mission Critical Considerations**

A. The electrical system shall be designed to meet all requirements of the applicable university design standards. This is considered by the University Engineer to be essential in order to meet mission critical goals. Options for value engineering of critical electrical system components, materials or configurations will not be considered; as such modifications could potentially increase the risk to the university. For example, it is considered essential that all conductor materials shall be copper, and the use aluminum should not be considered.

B. All new switchgear and substations shall be located above ground whenever possible to avoid flooding risk.

C. The design professional shall include a generator quick-connect switchboard or roll-up generator termination box, sized such that up to 500kVA of building load can be carried by a portable generator. The location of the generator connection point shall be chosen so that the need for routing temporary cables through the building is minimized or, preferably, eliminated. In no case shall temporary cables be routed through any public access pathways.

D. The building design shall document the rigging pathway for all major electrical equipment, including, but not limited to, transformers and switchgear. In no case shall the pathway be compromised in such a way that any methods other than normal rigging procedures would be required for equipment removal and replacement.

E. All generator fuel tanks shall be installed with an easily accessible fuel fill extension.

F. All devices and equipment required to support the operation of critical infrastructure should be connected to the appropriate branch of the emergency power system. This shall include, at a minimum, all lighting in switchgear rooms, basement sump pumps, storm water and sewage lift pumps and fuel pumps that supply or transfer fuel to the generator system.

G. The university follows best industry work methods as they pertain to the electrical power distribution system. For example, it is not considered a good work practice to apply multiple splices on the same phase conductor of a feeder in one manhole. The extra splice exposes the university to reduced electrical service reliability, which defeats the mission critical reliability goal.

**Metering**

A. Consult with university Utilities group for all required metering.
PRODUCT STANDARDS

Approved manufacturers for Low-Voltage electrical equipment, except VFD’s, are as follows:

A. Eaton Electrical Inc., Cutler-Hammer Business Unit

B. Square-D, a brand of Schneider Electric

C. Siemens Industry, Building Technology Division

Primary Switchgear

A. Primary Switchgear General Construction

1. The primary switchgear shall be metal-clad type as described in ANSI standards, unless other primary equipment types are specifically permitted by the University Engineer.

2. The switchgear shall be rated for 25,000 amperes symmetrical short circuit current (nominal 500 MVA class) at rated maximum voltage (15 kV class/95 kV BIL), in accordance with all applicable ANSI standards.

3. The switchgear shall be split into shipping groups/splits that are sized so that they can be maneuvered into the building to the electrical room, via available pathways (to be detailed on construction plans). If the rigging plan calls for the switchgear to be moved from its normal vertical position, this must be specified in the contract documents.

4. The switchgear shipping groups/splits shall be factory-assembled and all controls, interlocks and protective devices functionally tested.

5. The design shall be coordinated so that shipping groups/splits are easily reconnected at the site into a continuous line-up. Necessary connecting materials shall be furnished. All interconnecting wiring shall be clearly identified on manufacturer's drawings and shall be marked to identify the terminal block and terminal point to which it is to be terminated.

6. The switchgear assembly shall consist of one or more vertical sections, each of which shall have the following, as appropriate for the application:

   i. Main bus compartment.

   ii. Primary connection compartment housing cable / bus duct connections, current transformers and surge protection equipment.

   iii. Primary circuit breaker compartment.

   iv. Auxiliary compartment drawers housing voltage and/or control power transformers.
v. Low-voltage compartment housing relays, instruments and other low-voltage equipment, as indicated in the detailed specification.

vi. Vertical bus extended to upper and lower breaker positions.

7. Each main bus compartment shall contain fully rated copper bus bars silver-plated at electrical connection points, fully insulated epoxy powder coating, with joints covered with preformed PVC boots held together with nylon hardware for easy installation and removal during servicing. Taped joints are not permitted, except in unusual joint configurations and with specific approval from the University Engineer. Boots shall be provided for all cable connection lugs.

8. The ground bus shall be bare silver-plated copper, in minimum size of ¼ by 2 inches and shall extend the full length of switchgear.

9. Each circuit breaker compartment shall include:

   i. Vacuum circuit breaker with continuous 1200A current rating.

   ii. Protective relays.

   iii. Hinged front door, interlocked with the breaker to prevent racking unless the door is closed. The door may not be opened until the breaker is in the test or fully disconnected position.

   iv. Primary (line and load side) and secondary (control circuit) disconnecting devices.

   v. Secondary disconnects. The secondary connections shall engage automatically during the racking operation when the breaker is moved from the disconnect position to test position. Secondary disconnects using plug and socket arrangement with an umbilical cord are not permitted. No requirement for manual intervention to make the secondary connections shall be permitted.

   vi. Mechanical position (operate/test/disconnected) and status (open/closed) indicators shall be visible with the compartment door closed.

   vii. Circuit breaker position-actuated automatic shutters. Shutters shall be independently operated and shall have provisions for installation of padlocks on each shutter to prevent inadvertent opening when the breaker is removed from the compartment.

   viii. Safety interlocks. The racking mechanism of the circuit breaker shall be integral with the circuit breaker to minimize alignment problems and facilitate inspection and maintenance. Racking mechanisms installed directly in the switchgear structure or which permit exposure to primary conductors during maintenance are not acceptable.

   ix. Interlocks to prevent breakers of a lower-than-required continuous current rating from being inserted into the breaker cell.
x. Pistol-grip rotary control switch hard-wired to directly trip the breaker. Closing shall be supervised by the appropriate interlocks and the SEL 451 relay on all transfer scheme control modes.

xi. Ball type grounding studs shall be installed on each phase bus of the outgoing cable connection in a location that is readily accessible to maintenance personnel, so that safety ground cables can be connected during maintenance procedures.

10. Each auxiliary compartment shall include the following:
   
i. A separate compartment front panel for each drawout position.
   
   ii. Necessary terminal blocks, control wiring, fuses and buses.
   
   iii. VT, CPT or fuse rollouts, as needed.
   
   iv. All VT or CPT rollout assemblies shall include a secondary circuit breaker that is interlocked to prevent withdrawing the VT or CPT unit under load.

11. Control Wiring: Factory installed, complete with bundling, lacing, and protection.

12. Provide taped mimic bus on each switchgear section that indicates all breakers, buses, VTs, CPTs, CTs, surge arrestors, transformers, fuses, lugs, flex connections, etc.

13. All indicating lamps shall be LED type, push-to-test with replaceable LED lamps.

14. All current transformer (CT) circuits shall be wired using ring-tongue lugs.

15. Shorting terminal blocks shall be provided for all CT sets. As a minimum, one shorting terminal block shall be wired in the CT circuit ahead of all other devices connected to the CT's. If CT wiring leaves the switchgear enclosure, additional shorting terminal blocks shall be provided at that point also.

**Substation Transformers**

A. Type

  1. Transformers located in climate-conditioned electrical equipment rooms shall be of the cast-coil (cast primary and secondary windings) and 115 deg. C temperature rise.

  2. Primary surge protection shall be provided for all 12.47 kV primary windings.

B. Rating

  1. Primary voltage rating shall be 12.47 kV (delta), 95 kV BIL.

  2. Secondary voltage rating shall be 480Y/277V wye. 208Y/120V secondary voltage rating shall not be used unless specifically permitted otherwise by the University Engineer (for
example, in building service retrofits when required to comply with existing conditions). Secondary winding BIL rating shall be 30 kV.

3. Transformer impedance shall be 5.75%, based on the self-cooled kVA rating, unless permitted otherwise by the University Engineer.

4. Transformer capacity rating shall not exceed 1500 kVA (self-cooled rating), without specific permission from the University Engineer. The normal loading of the substation transformer shall not exceed the self-cooled rating of the transformer.

C. Cooling

1. Transformers shall be supplied with temperature controller and fans as original equipment. Transformers may be supplied without fans only with specific permission of the University Engineer. If the transformer is not to be equipped with forced-air cooling, the transformer, primary power source, and the associated secondary substations shall be fully outfitted for the future forced-air rating. All breakers, bus, etc. shall be sized to accommodate future forced-air capacity. Transformers equipped with future forced-air provisions shall include temperature indicator, control unit and alarm devices. The manufacturer shall furnish all documentation that is required to depict the installation of the future forced-cooling equipment and wiring.

D. Connections

1. Bus connections (in lieu of cable), with flexible braided connectors for vibration isolation, shall be provided to secondary side of the transformer in unit substation applications.

2. Transformers shall be equipped with primary and/or secondary air terminal chambers when required to accommodate cable connections. Air terminal chamber shall completely enclose the transformer bushings and cable terminators, allowing sufficient space for terminators such that terminator skirts are not deformed and cable bending radius limitations are accommodated.

3. When bus duct connections are required, the transformer shall be equipped with air terminal chambers that accommodate the bus duct termination and allow sufficient space for the required flexible cable (primary) or braided (secondary) connectors.

E. Loading

1. Transformers shall be sized so that the projected diversified demand building load (considering typical floor and lighting loads for the design occupancy, equipment loads with diversity factors, power factor, etc.) does not load the transformer beyond 70% of its self-cooled kVA rating.

2. Transformers used in diversified demand, double-ended substation configurations shall be sized to carry the projected normal (tie breaker open) load at 70% or less of the self-cooled kVA rating. Under single-ended conditions, the transformer shall be sized to carry the
projected single-ended diversified demand load at 70% or less of the maximum fan cooled rating.

F. Losses and Efficiency

1. Substation transformers shall comply with DOE-2016 energy requirements for transformer efficiency.

Secondary Switchgear and Distribution Equipment

A. The University Engineer will direct the professional on whether distribution circuit breakers should be metal-enclosed, group-mounted or metalclad drawout based on the building and application. In general, drawout switchgear is the preference for any building with 1000A or greater secondary ratings. Distribution panelboards or switchboards are acceptable for buildings with secondary ratings below 1000A.

B. Secondary Switchgear General Construction

1. In general, all secondary switching devices shall be circuit breaker type.

2. All mains and all ties shall be 100% ANSI-rated stored energy, drawout power air circuit breaker type.

3. All mains, all ties, and any feeders requiring electrical interlocks shall be equipped with electrically operated stored energy mechanisms.

4. Feeder breakers rated 1000 amperes or larger shall be either 100% ANSI-rated stored energy, drawout power air circuit breaker type or group-mounted, insulated-case type as appropriate for the application, with consideration for maintenance requirements and criticality of building occupancy. These breakers shall be equipped the electronic trip units and rating plugs.

5. Feeder breakers rated less than 1000 amperes shall be either ANSI-rated stored energy, drawout power air circuit breaker type or group-mounted, insulated-case type as appropriate for the application, with consideration for maintenance requirements and criticality of building occupancy. In general, breakers with 400 to 1000A trip settings shall be 100% rated, fixed insulated case ANSI type with electronic trip units and rating plugs. Breakers with trip settings lower than 400A shall be molded-case type.

6. SPD equipment shall be provided at the main 480-volt service switchboard or switchgear - both sides of tie breakers on double-ended configurations.

7. All removable cover panels for all switchgear and switchboards shall be bolted, hinged type, with lift-off hinges.
C. ANSI Switchgear – General Construction

1. Where ANSI-rated, stored-energy, drawout power air circuit breakers are provided, the switchgear shall meet the requirements of ANSI C37.20.1.

2. Shipping sections shall be configured so as to enable moving them into the electrical rooms.

3. The switchgear shipping groups shall be factory-assembled, and all controls, interlocks and protective devices shall be functionally tested.

4. The design shall be coordinated so that shipping groups are easily re-connected at the site into a continuous line-up. Necessary connecting materials shall be furnished. All interconnecting wiring shall be clearly identified on manufacturer's drawings and shall be marked to identify the terminal block and terminal point to which it is to be terminated.

5. Maintenance accessories similar to those required for metal-clad switchgear shall be provided, including, special tools, consumable spare parts, fuses, etc. Provide wall-mounted storage cabinet suitable for organized storage of maintenance accessories.

D. Switchboards – General Construction

1. Switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and UL 891 standards, with the required number of vertical sections bolted together to form one metal-enclosed, rigid switchboard.

2. The sides, top and rear shall be covered with removable screw-on code gauge steel plates.

3. Switchboard shall include all protective devices and equipment as listed on drawings with necessary interconnections, instrumentation and control wiring. Switchboards shall be the barriered, compartmentalized type.

4. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable identification.

5. Service entrance switchboards shall be suitable for use as service entrance equipment and shall be labeled in accordance with UL requirements.

**EXECUTION STANDARDS**

**Retrofits and Service Equipment Replacement Requirements**

A. Retrofit and Service Equipment Replacement projects present a unique set of challenges in light of the fact that these projects invariably take place in a building that will be occupied throughout the construction process.
B. The design professional shall determine the best combination of equipment configuration, equipment type, space utilization and construction phasing that fits the particular constraints and operational needs of the university.

C. The design professional shall determine the best available pathway for moving the new equipment into the building. This shall be documented in the contract documents.

Standard Building Service Configurations
A. The university has established standard configurations for building service:

1. Primary 15kV metalclad switchgear unit substation with secondary (480/277 or 208/120V) switchgear for building services greater than 1000 amps on the low-voltage side.

2. Secondary switchboard or distribution-rated panelboard for building services between 400 and 1000 amps.

3. Distribution panelboards for building services below 400 amps at the secondary voltage.

Relay and Circuit Breaker Protection and Coordination
A. The design professional shall provide an arc-flash and coordination study to determine relay and circuit breaker trip unit settings and plot time-current curves (TCC) to demonstrate that the overcurrent protective devices are selectively coordinated at all values of load current and fault current (phase and ground), in accordance with NEC requirements and IEEE standards, as well as generally accepted power system design practices.

B. Relay and circuit breaker trip settings shall provide proper protection of the power system equipment and cables. This shall be demonstrated by plotting equipment and cable damage curves on the TCC.

C. Relay and circuit breaker trip settings shall provide proper coordination with transformer magnetization and inrush currents so that nuisance tripping is avoided.

D. Primary phase and ground overcurrent protection settings shall coordinate with upstream university substation feeder circuit breaker overcurrent relays.

E. Along with TCC’s, the coordination study shall include a listing, in tabular form, of setting values for each circuit breaker or fuse. Actual currents and time delays shall be listed, as well as, relay parameter and time dial values. Corresponding CT primary and secondary values shall also be listed.

Requirements for Electrical Rooms and Spaces
A. The main power distribution equipment described herein shall be located in a dedicated electrical room designed to house such equipment.
B. The space must be adequately ventilated and positive-pressure outdoor ventilation should be utilized. Air conditioning should be used when use of outdoor is impractical or not possible. Where positive-pressure outdoor air is the cooling method, inline easily maintainable filters shall be provided at intake.

C. The switchgear shall be accessible from all sides. NEC working space requirements governing access to energized parts shall be met. Elsewhere, the minimum requirements of OSHA shall be met.

D. The room shall be located and spaces designed so that the largest piece of equipment can be replaced without major disturbances to the architectural elements of the building. The design professional is required to coordinate all requirements with the architect.

E. The preferred location for this room shall be the first floor of the building. Any location other than the first floor will require the specific approval of the University Engineer.

F. Walls, floors, and ceilings shall have a minimum one-hour fire rating; emergency lighting shall be provided in electrical rooms to allow service and operation by university personnel during power loss on building feeders.

G. Acoustical considerations shall be addressed when the electrical room is located adjacent to building program space.

H. Electrical rooms containing primary switchgear and main substations shall be protected by a dry-pipe, single-interlock, pre-action sprinkler system. The sprinkler system shall include a supplementary water flow switch with adjustable time delay.