ELECTRICAL POWER SYSTEMS

Scope

The various Codes applicable to the University's electrical power system are mainly based upon a model of a single utility service, connected to a single premise. The University's electrical system, however, consists of multiple utility services, a cogeneration facility, and a comprehensive primary distribution network connected to hundreds of premises. Thus applying the codes to the University's electrical system is not straightforward as it would be in other locations.

To meet the level of safety intended by the Codes, the design the University's electrical distribution systems is as described herein.

Electrical System Description

Utility Services

The Detroit Edison Company DTE provides the following primary and secondary services to the University:

1. Three 13.2 kV primary services, from DTE's University Substation, to the Central Power Plant (CPP) on Central Campus.
2. Two 13.8 kV primary services, from DTE's Academy Substation, to the University of Michigan Hospitals (UMH) main distribution substation in University Hospital. (A possible conversion to 13.2 kV is being investigated.)
3. Two 13.2 kV and two 4.8 kV primary services, from DTE's Campus Substation, to the North Campus Switching Station.
4. Eleven 13.2 kV and 4.8 kV primary services to individual buildings having service patterns where the primary demand rate is cost effective.
5. Over 250 secondary services of various voltages to individual buildings.

Cogeneration Facility

The University produces steam, and generates electricity, at the Central Power Plant, a cogeneration facility that contains the following:

1. Three steam turbine-driven 13.2 kV generators with a total capacity of 37.5 megawatts.
2. Two gas turbine-driven 13.2 kV generators with a total capacity of 7 megawatts.

Primary Distribution Network

The University distributes power to most of the buildings connected to its medium voltage distribution system through the following types of circuits and service points:

1. 13.2 kV and 2.4 kV primary feeders from the Central Power Plant to most buildings on the Central Campus and Athletic Campus.
2. 13.8 kV primary feeders from the University Hospital's Substation to most of the UMH buildings on the Medical Campus. (A possible conversion to 13.2 kV is being investigated.)
3. One 13.2kV emergency feeder from the Central Power Plant, through a 13.2-13.8-kV autotransformer, to select UMH loads. (May be eliminated if 13.8 to 13.2 conversion is warranted.)
4. 13.2 kV and 4.8 kV primary feeders from the North Campus Switching Station to most North Campus buildings.

Application of the Codes

General

1. New electrical systems shall comply with the NEC and other noted codes on the U of M web page.
2. Existing electrical systems under addition or renovation shall be upgraded to comply with the current codes.
3. Existing electrical systems serving an area, undergoing non-electrical renovation, in general, are not required to be upgraded to comply with the current codes. However:
    a. No work of any discipline shall degrade the existing electrical distribution system in any way.
    b. Upgrade the electrical distribution systems wherever possible and practical.
4. The University's electrical system is considered "reliable" as defined in NFPA 20 Appendix A.
5. As described in NEC Section 695-3(2), the Central Power Plant could be considered an "on-site power production facility" The University, however, prefers an on-site, natural-gas-fired generator to supply the emergency power loads in a facility.

Application of NFPA 70, the National Electrical Code

1. The service points at which the Detroit Edison utility services end and the University premises wiring begin, are defined as the connections of the secondary buses or terminals at the Detroit Edison owned step-down transformers, fused cut-out switches, or service drop conductors, to the University owned cables.
2. The "source ends" (Central Power Plant or switching station ends) of the University's primary distribution cables are feeders and shall comply with NEC Article 220, "Feeders".
3. The "load ends" (building ends) of the University primary distribution cables, however, shall be treated as the utility services to the building. Install service disconnecting means and comply with all of the requirements of NEC Article 230, "Services".

4. In a like manner, a secondary-voltage feeder (or feeders) from one building to another building shall be treated as the utility's service to the building. Install service disconnecting means and comply with all of the requirements of NEC Article 230, “Services”.
5. This service entrance shall fully comply with NEC Article 230, and all other applicable sections. These requirements include, but are not limited to the following:
    a. Conductors shall be maintained outside of the building or shall be enclosed in two inches of concrete until they enter the room containing the building service disconnecting means.
    b. Primary disconnect switches, unit substation transformers and pad-mount transformers shall be treated as utility owned equipment.
        - Access shall be restricted to qualified personnel only.
        - The transformer primary switches shall not be used as the building service disconnecting means.
    c. The line side terminals of the secondary main disconnecting device(s) shall be treated as the building service point.

Application of the National Electrical Safety Code

In addition to complying with the NEC, the Central Power Plant, switching stations, substation rooms, manholes and other areas containing primary equipment, main service switchgear, or cables shall comply with the National Electrical Safety Code.

Application of the International Building Code

1. In low-rise buildings, provide emergency power for egress lighting, emergency signs, and the fire alarm system.
    a. Provide a natural gas fueled engine-generator set whenever possible because the savings in maintenance costs will offset the higher initial cost. Connect the generator using one or more automatic transfer switches. These transfer switches shall be 'close-transition', soft-start, with full, isolated maintenance bypass systems included
    b. As an alternative to an engine-generator set, consider providing a fuel cell system.
    c. Provide a central battery/inverter system with the battery system being of the flooded-wet-cell, Plante-lead-alimony, type. Provide sufficient 'installation and working' clearances around the overall system, and installed needed ventilation. (Sealed valve regulated battery systems shall be used due to their high maintenance replacement costs.)
    d. When an engine-generator set cannot be provided, provide individual battery packs.
    e. Because the normal power source is sufficiently reliable, do not connect low-rise building fire pumps, elevators, or similar equipment to the engine-generator set.
2. In high rise buildings; provide emergency power for egress lighting, emergency signs, and the fire alarm system. Provide standby power for fire pumps, elevator(s), smoke exhaust systems, stairwell pressurization systems, and other standby systems as required by codes.

a. Provide a single natural gas fueled engine-generator set with one or multiple automatic transfer switches. These transfer switches shall be 'close-transition', soft-start, with full, isolated maintenance bypass systems included

   - Provide the fire pump automatic transfer switch as an integral part of the fire pump controller.
   - Provide the elevator system automatic transfer switches as part of the building's power distribution system, not integral to the elevator controllers.

b. Consider supplying more than one building from a single engine-generator set.

c. Consider installing the engine-generator set in an adjacent parking structure or lot to minimize noise and vibration.

3. Only as a temporary measure when an engine-generator set cannot be provided at the time of initial construction, provide two separate services to the building and provide multiple transfer switches.

   a. Obtain one service from the University electrical system and the other from Detroit Edison.

   b. Do not obtain both services from the University electrical system because both services will be connected together at times for system maintenance or load balance.

   c. Do not obtain either service from a 4.8kV or 2.4kV primary circuit because these circuits are being phased out.

   d. Do not obtain both services from Detroit Edison unless they originate at different Detroit Edison switching stations.

   e. The University's long-range goal is to provide emergency and standby power to every high-rise building from engine-generator sets. Design the electrical distribution system so that an engine-generator set can be connected in the future.

4. In low rise and high rise buildings with special needs, special power may be required by codes or may be requested by the Owner for hazardous labs, animal rooms, freezer farms, radio transmitters, telecom switching stations or other critical loads.

   a. When possible, provide the special power from the same natural gas fueled engine-generator set that supplies the emergency and standby power. Use a separate automatic transfer switch to feed the special loads.

   b. If no engine-generator set exists and special power is required within minutes of a loss of normal power, provide a dedicated natural gas fueled engine-generator set.

   c. If no engine-generator set exists and special power is required within a few hours of a loss of normal power, provide a University standard generator connection box for connecting a portable generator.

Electrical System Requirements

Distribution Network

The University's long-range goal is to convert the entire primary distribution network to 13.2kV.

1. Connect new unit substations to 13.2kV primary circuits, not to 4.8kV or 2.4kV circuits.

2. Coordinate with the Utilities and Plant Engineering Department to establish the specific circuits and connection points.

Unit Substations

Provide indoor unit substations consisting of primary load break switches, dry type transformers, and secondary switchgear distribution sections.

1. Provide double-ended substations with two main and one tie secondary circuit breakers Double-ended substations are typically only used for health care, and research buildings.

2. Provide single-ended substations with main secondary circuit breaker Single-ended substations are used for classroom, library, housing facility, and similar buildings. With single-ended substations provide a generator connection box on an exterior portion of building accessible to trucks. Also provide raceway and conductors from the generator connection box, to a separate circuit breaker in the substation dedicated for this generator connection.

3. Substations with a secondary voltage rating of 480/277-volts, three phase, 4-wire, are preferred.

4. Size substations only for the anticipated peak load plus spare capacity for future growth. Do not oversize the substations and thus increase initial costs and transformer losses.