SECTION 26 00 10- ELECTRICAL DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY:

A. This section details the general design requirements for electrical systems, for both new and retrofit applications.

B. RELATED SECTIONS:

1. Section 01 13 01 - Design Guidelines for Sustainability
2. Section 01 17 71 – Project Turnover Requirements
3. Section 01 17 73 – Operations & Maintenance Manuals
4. Section 01 70 10 – MEPS Identification & Labeling
5. Section 01 78 25 – Facilities Visual Aids Documentation
6. Section 01 81 10 - Building Service Equipment Accessibility Requirements
7. Section 01 81 11 – Confined Spaces
8. Section 01 93 10 – Equipment-Specific Energy Control Measures
9. Section 26 09 02 - Campus Central Metering System Design Criteria

1.2 BACKGROUND:

A. Brown University maintains its own campus electrical distribution system which serves the majority of the buildings and facilities on the main campus. Electricity is distributed on the campus at two operating voltages: 11.2 KV and 4.16 KV. Both distribution systems are configured as three phase, three wire, grounded wye. Rhode Island Energy, the local utility company, feeders supply the University electrical distribution system at 11.2 kilovolts (kV). Electricity is in turn distributed to facilities throughout the campus via local distribution substations and underground electrical ductbanks and circuits. Building distribution transformers step the distribution voltage down to a utilization voltage of 120/208 volts, three phase four wire and/or 480/277 volts three phase four wire.

B. Brown University facilities located in the downtown area (Jewelry District) are directly served by Rhode Island Energy. Buildings in this area are fed from the “downtown network”, which is an underground network distribution system operating at 11.2 KV. Buildings are served either from outdoor padmount style transformers or indoor electrical vaults which directly feed the building secondary services at a utilization voltage of 120/208 volts, three phase four wire and/or 480/277 volts three phase four wire.

1.3 DESIGN SUBMITTAL REQUIREMENTS:

A. Electrical system designs shall include the following:

B. Conceptual/schematic design: A design narrative including the basis of design with description of each system and the proposed utility or building connections, shall be provided. Systems shall include: normal power distribution, emergency/standby/legally required distribution systems, emergency lighting, lighting systems and controls.

C. By second submittal, or design development phase, whichever is earlier:
   1. Basis of design, including the following:
      a. Preliminary design studies.

b. Description of each system including: one-line diagrams of each proposed system(s).
c. Sequences of operation for all new or modified existing power distribution, lighting systems and controls.

2. Deviations from Brown standards.

D. By third submittal, final review set, or construction documents, whichever is earlier:
1. Deviations from previous submittals
2. Deviations from Brown standards
3. Preliminary design development information with updates for final design incorporated.
4. Final design studies.
5. Accessibility drawing(s) detailing accessibility for equipment rigging/ installation as well as access to equipment for routine operation, service and maintenance.
6. Electrical testing requirements identified for construction phase.

1.4 PRELIMINARY DESIGN STUDIES:

A. For all projects, the engineer of record shall perform the following basic studies and investigations in the course of the design. Existing system information required for these studies shall be provided by Brown as required.
1. Preliminary electrical fault current availability (short circuit analysis) to determine the worst-case fault current at each major equipment location. This study is required for proper selection and verification of powered mechanical equipment and electrical distribution equipment fault current withstand and interrupting ratings, and protective device sizing.
2. Load calculations and building power requirements for sizing of electrical distribution equipment, transformers and feeders.
3. Emergency and legally required standby power requirements and equipment sizing.
4. For modifications to existing building electrical systems, and loads being added to the campus electrical distribution systems, verify existing system capacities and loads. Perform an analysis to evaluate the impact of new loads on existing building and/or campus distribution systems.
5. Voltage drop (on long, low-voltage circuit runs).

1.5 FINAL DESIGN ARC FLASH, OVERCURRENT DEVICE AND HARMONIC COORDINATION STUDIES:

A. For all new construction, complete building renovations, larger and /or more specialized electrical system design projects, and when so directed, perform the following final electrical system design studies:

1. Short circuit and overcurrent device coordination study: perform studies in accordance with IEEE “Red Book” standard 141 for all service and distribution equipment. Overcurrent device coordination study shall include time-current plots for phase and ground overcurrent coordination. Provide settings for all adjustable-trip electrical circuit protective devices, such as circuit breakers, relays and voltage sensors; provide settings for all automatic transfer switches, standby power systems, variable speed drives, chillers and large powered mechanical equipment.

2. Arc-flash protection studies, and the provision and installation of specific equipment Arc-flash labeling for determination of the level of incident energy available and required personnel hazard protection, per IEEE 1584 and NFPA 70E requirements.

   The project team shall determine the level of incident energy at each high voltage switch, transformer, switchboard, panelboard, motor control center (MCC), variable-speed drive, motor starter, service switch, automatic transfer switch, and electrically-fed equipment (such as boilers chillers and equipment control panels) requiring analysis, down to loads operating at larger than 50-amps, three phase, and distribution transformers larger than 75 KVA.

3. Power system harmonic analysis study: required for all applications involving loads with high concentrations of harmonic content, such as server racks, data processing equipment and variable speed drives for motors over 25 HP. Analysis shall include proposed mitigation measures to maintain total harmonic distortion at the building service within the requirements of IEEE 519, and the proper selection of equipment required to withstand anticipated harmonic distortion levels, ie. K-rated transformers.

B. Studies shall include all electrical systems originating from the project primary service, through the service transformer(s) and distribution system down to the representative branch circuit level; include feeders and connections for major mechanical and other powered equipment. Where existing facilities are to be reconnected to new project distribution systems, include existing facility distribution systems in the studies.

C. The electrical systems analysis shall be performed using the SKM Power*Tools Electrical Engineering Software (Dapper, Captor & Arc-Flash).

D. Study reports shall be prepared by an independent firm not affiliated with the electrical equipment manufacturer, stamped by a registered professional electrical engineer and reviewed by the project engineer of record.

E. Provide the following study deliverables. Include one hard (paper) copy and a PDF electronic file.

1. Introduction/purpose

2. Short circuit analysis and overcurrent device coordination study with an interpretation and evaluation of the study results, along with any required recommendations. Include:
   a. Tabular data tables of available fault current ratings and equipment AIC ratings for each point or bus in the electrical system.
   b. Tabular listing of the settings required for all adjustable trip and electronic trip protective devices (with a minimum of adjustable long time pickup).
   c. For devices that have (as a minimum) long time pickup, plot time current curves for the device to downstream devices. Where identical conditions exist, provide a typical plot. Include separate plots for phase and ground settings.

3. Arc-flash study with an interpretation and evaluation of the study results, along with any required recommendations. Include:
   a. Input report, listing source fault current, bus identification data, over-current protective device (OCPD), transformer, motor and feeder data used in the study.
   b. Arc-flash results in tabular form.
   c. Labels indicating the arc-flash information for each panel or switchgear assembly.

4. Harmonic analysis study (when required or directed) with an interpretation and evaluation of the study results, along with any required recommendations. Include:
   a. Input report, listing source impedances, fault current, bus identification data, transformer, motor,

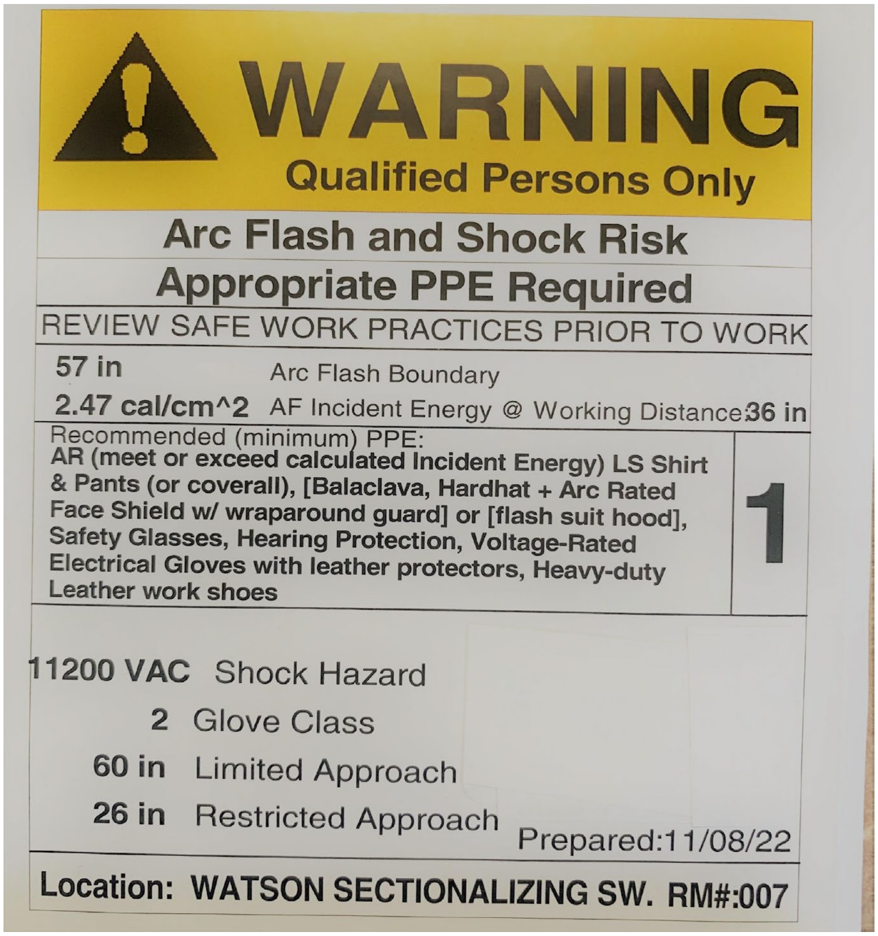
feeder and harmonic load data used in the study.
b. Where emergency or standby generators are utilized, model the loads connected to both normal and generator power sources.
c. Harmonic voltage and current results in tabular form.

5. Indicate problems discovered while performing the studies. Examples include:
   a. Recommendations to mitigate arc flash hazards above category 2.
   b. Identification of circuit protective devices with insufficient interrupting ratings.
   c. Identification of protective devices that are not property coordinated.
   d. Identification of locations that have excessive harmonic content.

6. Computer-based one-line diagram information to be developed for the study shall include:
   a. Electrical device (transformer, switchboard, panelboard, etc.)
   b. Voltages at each point
   c. Short circuit available at each point
   d. Horsepower ratings of each motor over 25 HP
   e. Brown standard names of all panels and equipment
   f. Incident energy level
   g. Table of calculated Arc flash data
   h. Coordination curves
   i. Harmonic (voltage and current) values at each point (where required)
   j. Any other pertinent data

7. Electronic program files: provide unlocked, editable electronic copies of all program input files, one-line files and output data files for each analysis, including but not limited to the following:
   a. Source fault current
   b. Bus identification data
   c. Over-current protective device (OCPD) data
   d. Transformer data
   e. Motor data
   f. Feeder data
   g. Short circuit data at each bus in tabular form
   h. Arc-Flash results in tabular form
   i. Label print files indicating the Arc-Flash information for each panel or switchgear assembly.
   j. One-line CADD drawing files.
   k. Harmonic device data.

F. Arc flash labels: create and install thermal-transfer style adhesive labels for the equipment.
a. Labels shall include site specific PPE requirements, the name of the equipment, and the room number where the equipment is installed.
b. The “site-specific level of PPE” on the labels is allowed using the “incident energy analysis” method, section 130.5(D)(3)(c). The number will be on the label in addition to the Incident Energy.
c. Brown will determine its “site specific levels” for PPE to be included on the card.



Sample Arc Flash Label

1.6 **GENERAL ELECTRICAL REQUIREMENTS:**

A. A detailed sequence of operation for emergency/standby power systems and automatic source transfer systems shall be included on the plans, including any automatic load shed schemes to prevent overload conditions.

B. A detailed lighting control system sequence of operations shall be included on the project plans.

C. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for their intended use. Where built-up electrical systems, such as equipment control panels, are installed, they shall be listed as an assembly.

D. Buildings located in areas served by the Brown University campus distribution grid shall be powered from the grid, except as directed.

E. It is Brown University's intent to coordinate and limit the loads added onto the campus distribution systems based on the size of the new loads and their location on the campus. In general, new building loads of 150 KVA and below shall be served from the 4.16 KV distribution system where it is readily available. Loads larger than 150 KVA shall be served from the 11.2 KV distribution system.

F. In general, building loads on the 4.16 KV distribution systems are configured as a radial primary connection; building loads on the 11.2 KV distribution system are configured as a loop-primary connection system. Actual distribution system connection locations and service voltages shall be coordinated with the Brown University FM Operations and Engineering staff.

G. Buildings less than 25,000 gross sq. ft. and connected loads less than 250 kW may have a main secondary voltage of 208Y/120V.

H. Buildings with areas exceeding 25,000 gross sq. ft., or connected loads exceeding 150 kW are recommended to have a main secondary voltage of 480Y/277V, and 120/208V for user and small power loads.
   1. Mechanical equipment and lighting panels should be 480Y/277V.
   2. Distribution step down transformers shall provide 208Y/120V to panels serving convenience power and receptacle loads.

1.7 RELIABILITY AND REDUNDANCY CONSIDERATIONS FOR FACILITIES:

A. For certain critical facilities, redundancy of electrical supplies shall be provided where program needs require electrical power to be available in the event of a component failure or to allow for routine preventive maintenance procedures on the building distribution systems.

B. Redundant supplies may be achieved by one or more of the following depending upon the type of facility. System redundancy needs shall be as directed by Brown University project manager in coordination with FM Operations and Engineering staff.
   1. Double-ended switchgear/building service transformers, in a “main-tie-main” configuration, and connected to the primary distribution system in a “loop-fed” primary configuration. The switchgear/building service transformers shall be sized such that the overall building demand load may be carried on only one side of the switchgear.
   2. Installation of permanent provisions at building exterior wall for ready connection of a roll-up generator to the building main switchboard.

1.8 EMERGENCY AND STANDBY POWER CONSIDERATIONS:

A. In general, many campus facilities (such as offices, small classrooms, academic, and support facilities) typically only require emergency power for life safety needs (egress lighting, exit signage and fire alarm systems). Other facilities, typically those containing research and other important campus functions, or buildings having large Life Safety loads such as electric-powered fire pumps, smoke control systems, etc. will require a standby generator, as their program or research needs require electrical power to be continuously available in the event of a utility outage or building outage.

B. Connections of equipment to emergency and/or standby generator power shall be as directed by Brown University project manager in coordination with FM Operations and Engineering staff and shall be specified in design documents at all project stages. Where projects require connections to an existing generator, analysis shall be made on the existing generator system to verify adequate spare capacity is available to accommodate the added load(s). This may require load bank testing of the generator to verify full-load Kw output.

C. Certain buildings may require provisions for the ready connection of a portable, roll-up generator to provide for the ongoing operation of the building power distribution system in the event of a failure in the normal utility power source. These applications shall include the following:
   1. "Tri-Star"- brand portable generator connection box (or equal), located on the building exterior. Connection box provided as a NEMA 3R enclosure, with Cam-Lok cable connectors, capacity as required, and phase rotation meter.
   2. Wired connection from connection box to dedicated circuit breaker, key-interlocked to building main service circuit breaker, to prevent simultaneous closure of both devices.

1.9 ELECTRICAL SPACE PLANNING GUIDES:

A. The following requirements are to be used for electrical space planning considerations at the conceptual design level. Refinements and modifications will be considered upon evaluation of the specific requirements in the building:
   1. Medium-voltage campus distribution and switchgear equipment, where located in a common main electric room, shall be isolated from routinely accessed low-voltage local distribution panels by a full height chain link fence and a lockable personnel access gate.
   2. Centrally locate and "stack" local electrical rooms wherever possible so that feeder conduits and bus ducts are run as straight and short as possible.
   3. Electrical rooms shall not share space with storage, telecommunications, custodial supplies, major mechanical systems and piping.
   4. Where possible, locate electric rooms away from outside walls, elevator shafts, stairwells, HVAC duct chases and other major utility corridors so that branch circuits can fan out in all directions.
   5. Locate electrical rooms where they are not susceptible to flooding from heavy rains, broken pipes, stopped drains, or surface drainage.
   6. Locate branch circuit distribution panels serving general building loads in dedicated closets or rooms; do not locate panels in public corridors. Distribution panels serving multiple branch circuit loads within a room, such as within research labs, may be located within the rooms.
   7. Preference is to serve building loads from distribution panels located on each floor.

1.10 ELECTRICAL RISER DIAGRAMS:

A. All system designs shall include detailed building riser and one-line system diagrams showing all major distribution system components, meters, controls and interfaces with other building and campus utility systems.

B. For renovation projects, existing building riser diagrams shall be provided with updates to clearly indicate locations of all new system tie-ins being added, or components to be removed.

C. Provide riser diagrams for each building electrical system. Include the following for each system riser diagram as applicable:
   1. Diagrams shall be generally geographic in nature. For example, a building with main switchgear in the basement, and distribution panels throughout the building: the switchgear would be at the bottom of the riser diagram, each of the major distribution panels and feeders would be shown diagrammatically correct to the general wiring configuration throughout the building, and inclusive of the room numbers where it is located.

2. Diagrams shall indicate all the major equipment loads and equipment served, as well as the design ratings of key components in each system. Equipment shall be referenced by its specific common name identification, and include its nominal equipment ratings (or capacities), relevant feeder sizes and interrelationships with other building systems and utilities.
3. Diagrams shall include room numbers for the location of the equipment as well as room numbers of the spaces being served by the specific system.
4. Indicate relevant incoming utility capacities (i.e.: voltage, ampacity, KVA and fault current ratings).
5. Show all major system and feeder disconnect switch ratings and specific overcurrent protection settings.
6. Orientation of high voltage switchgear switch ways on the project drawings shall match the left-to-right orientation of the switches as viewed when looking at the front of the equipment.

1.11 **ELECTRIC ROOM DETAILED DESIGN GUIDES:**

A. Refer to Section 01 81 10 - Building Service Equipment Accessibility Requirements for additional requirements.

B. Floor mounted electrical equipment shall be installed on concrete housekeeping pads.

C. Electric rooms containing medium-voltage distribution equipment shall include a Safety grounding ring comprised of either a continuous ground bar or multiple interconnected ground busses, with all equipment connected to at least two ground points. Visibly bond all equipment, room door frame(s), etc. to the ground ring. Refer to Section 26 05 26 – Grounding and Bonding for additional electric room details.

1.12 **ELECTRIC METERING:**

A. All buildings connected to the campus electrical distribution systems shall be separately metered and connected into the campus central metering system. Academic and research buildings located in the Jewelry District shall be separately metered and connected into the campus central metering system.

B. Refer to Section 26 09 01 – Campus Central Metering System Design Criteria for additional details on electrical metering.

1.13 **EQUIPMENT MANUFACTURERS:**

A. Square D, Siemens or Eaton, the allowed master electrical equipment manufacturers, shall be standard for all distribution equipment unless a specific or additional manufacturer(s) is identified in detailed electrical standards.

B. All new installations requiring switchboards, switchgear, panelboards, disconnect switches, and other power related components shall all be from the same manufacturer. New equipment installed within existing facilities shall be of the same manufacturer as already installed within the facility.

C. Older installations with obsolete manufacturers: coordinate with Brown project manager.

1.14 **NAMING CONVENTIONS AND EQUIPMENT LISTS:**

A. Development of equipment lists and operating and maintenance procedures shall be as indicated in section 01 17 71 – Contract Record Documents and Turnover Requirements.

B. Signage: provide appropriate door and room signage per ANSI and NFPA requirements.

C. Campus distribution equipment. all medium voltage electrical equipment shall be identified and labeled with color-coded plastic tags. Coordinate wording and tag color-coding with FM-Operations and Engineering staff.

D. Electrical Equipment Naming Legend

(1) -(2) -(3) -(4)

(1) = Type of Equipment (Normal Power or Emergency Power Equipment):

Normal Power Equipment:

- MSB Main Switchboard
- SWBD Switchboard
- DP Distribution Panel
- PP Power Panel
- LP Lighting Panel
- MP Mechanical Panel
- RP Receptacle Panel
- CP Cleanroom Panel
- FP Fire Panel
- TP Theatrical Panel

Emergency Power Equipment:

- ESWBD Emergency Switchboard
- EDP Emergency (Life Safety) Distribution Panel
- EMP Emergency (Life Safety) Mechanical Panel
- ERP Emergency (Life Safety) Receptacle/ Small Power Panelboard
- ELP Emergency (Life Safety) Lighting Panel
- LRDP Legally Required Distribution Panel
- LRRP Legally Required Receptacle/ Small Power Panelboard
- LRLP Legally Required Lighting Panel
- LRMP Legally Required Mechanical Panel
- SDP Standby Distribution Panel
- SPP Standby Power Panel
- SMP Standby Mechanical Panel
- SRP Standby Receptacle/ Small Power Panelboard
- SLP Standby Lighting Panel

(2) = Operating Voltage:

- 1 120/208 volts or 120/240 volts
- 2 240 volts
- 4 480/277 volts

(3) = Floor Level

- B Basement sublevel B
- A Basement sublevel A

- 1 Ground Floor Level
- 2 Second Floor Level

(4) = Panel Identifier (for small facilities, use room # for large facilities)

- 1 First panel in floor sequence
- 2 Second panel in floor sequence
- 3 Third panel in floor sequence

1.15 **DETAILED ELECTRICAL DESIGN REQUIREMENTS:**

A. Modifications to the campus medium-voltage distributions system(s) shall be reviewed with Brown FM-Operations and Engineering staff for specific requirements. Examples include key interlocks on switchgear, minimum equipment AIC ratings, feeder switching protocols, provisions for line and load-side circuit phasing, metering and equipment status monitoring, cable tagging and switchgear identification.

B. For buildings that are fed with medium voltage feeders, building service transformers and low-voltage distribution switchboards and panels:

1. Install key interlocks on the low voltage main overcurrent device and the upstream medium voltage switch, keyed such that the low voltage device must be open to open up the upstream device. Provide a spare key and turn over to the Brown electrical department.

2. Provide all building medium voltage switches and circuit breakers with auxiliary switch position status indicators; wire the position indicators into the Campus metering system for remote position status and alarm monitoring.

C. Electrically powered steam boilers, water heaters and central heating equipment with immersion-type heating elements shall be provided with ground fault protection on the feeders and branch circuits serving this type of equipment.

D. Hermetic refrigerant motors and compressors shall be provided with ground fault protection on the feeders and branch circuits serving this type of equipment, where the unit-mounted controls do not have ground fault protection installed within them.

1.16 **ACCEPTANCE TESTING:**

A. The engineer of record shall determine the particular field and factory acceptance testing requirements for each project in coordination with FM Operations and Engineering staff.

B. Refer to section 26 08 01 for additional electrical testing requirements.

C. Field acceptance testing for electrical distribution equipment and equipment feeders shall be completed in accordance with International Electrical Testing Association Inc. (NETA) Acceptance Testing Specifications.

D. All adjustable-trip electrical protective devices, including relays, circuit breakers and automatic transfer switches shall be set and calibrated per coordination study recommendations.

E. Perform an infrared thermographic inspection of all distribution equipment and feeder connections per NETA Standards, six months after beneficial occupancy. Submit reports identifying the inspection, summary of issues found and what corrective measures were taken.

F. Metering systems and equipment shall be commissioned to verify proper setup, calibration and recording of data into the campus metering system.

END OF SECTION