PART 1 GENERAL

1.01 POLICY

A. The following standard applies to both retrofit and new work. This standard applies to the electric services for new buildings and upgrades to the electrical service equipment associated with existing buildings. This standard applies to buildings served by Cornell Utilities as well as buildings served by public utilities (i.e., NYSEG, National Grid, etc.).

B. This Standard pertains to primary switches, transformers, main secondary service equipment, and associated metering.

C. In an effort to provide safe and reliable electric distribution service to the Cornell campus, and to provide for a safe working environment, NFPA 70E - Standard for Electrical Safety Requirements for Employee Workplaces, shall be an integral part of any design strategy. Short circuit current, voltage, time curves, and working distance shall all be factors to limiting arc fault energies within levels set forth by this standard.

D. The arc flash hazard/risk levels as defined by NFPA 70E shall be no greater than:

1. Category 4 at the line side of the main secondary disconnect device.
2. Category 3 between the load side of the main secondary disconnect device and the line side of the secondary feeder breakers.
3. Category 2 at the load side of the secondary feeder breakers.
4. Category 1 at MCC’s and branch panelboards which only have access by qualified personnel.
5. Category 0 at any location accessible by unqualified personnel.
6. No device shall be greater than category 4 at any point in the system.

E. Definitions:

1. “Critical Use” – Facility where loss of power would result in immediate concern (i.e., health, life safety, loss of research).
2. “Non-Critical Use” - Facility where loss of power would not result in immediate concern (i.e., classroom or office building).
3. “Qualified personnel” – as defined by NFPA 70 (NEC).
4. One-Line Diagram – drawing consisting of, at minimum, equipment location/room number, equipment voltage/short circuit ratings, conduit and conductor sizes, device overcurrent protection rating(s), bonding and grounding location(s), specific equipment identification labels.
5. Electric Service Gear – circuit breaker enclosures UL listed as service equipment, including switchgear, switchboards, panelboards, and enclosed circuit breakers that are designed, listed, and intended to be used as electric service equipment.

6. Low voltage circuit breakers – for the purpose of this standard, this term includes low voltage power circuit breakers (LVPCB), insulated case circuit breakers (ICCB), and molded case circuit breakers (MCCB).

1.02 SYSTEM DESCRIPTION

A. New electric services are recommended to be connected to the campus 13.2kV distribution system.

B. Existing buildings connected to the campus 2.4kV distribution system undergoing a service upgrade are recommended to be converted to the 13.2kV distribution system.

C. As a general practice, buildings with demand loads exceeding 300 kVA are recommended to have a main secondary voltage of 480Y/277V. This is a rule of thumb and will vary depending on the type of equipment installed in the building. The optimal service voltage for the building shall be evaluated by the Engineer of Record.

1. Mechanical equipment and lighting panels should be 480Y/277V.
2. Distribution step down transformers should provide 208Y/120V to panels serving convenience power and receptacle loads.

D. Buildings with demand loads of 300KVA or less may have a main secondary voltage of 208Y/120V. This is a rule of thumb and will vary depending on the type of equipment installed in the building. The optimal service voltage for the building shall be evaluated by the Engineer of Record.

1.03 QUALITY ASSURANCE

A. Current with the date of submittal, the NFPA, NEC, and UL codes, standards, and guidelines shall be applied herein.

B. The Engineer of Record shall provide the following information for review:

1. “Basis of Design” statement describing the system objectives and measures to limit arc fault levels and protect from short circuit interruption.
2. Building load calculations with connected and demand loads, including a percent breakdown of the lighting, mechanical, and plug loads at the design development level.
3. Building power distribution one-line diagram.
4. Computer generated fault study conforming to IEEE 1584 Standard (indicating both short circuit and arc flash levels) and a device coordination study. Existing arc flash hazard and short circuit data may be used if available; otherwise, include this assessment in the design development. Following this, the Engineer shall provide the circuit breaker settings in the specification and be responsible for compliance of this specification.

C. Information provided by Owner:

1. System voltage and characteristics.
2. Available short circuit fault current at connection point to the Cornell medium voltage distribution system.
3. Medium voltage fuse data and relay settings immediately upstream from the new service being designed.

D. Reviews and Approvals: Depending on the scope and location of a project, review and approval may be required from multiple Cornell departments. This includes, but is not limited to:

1. Facilities Engineering (FE), Electrical Section
2. Energy & Sustainability, Utilities & Infrastructure Operations
3. Facilities Management (FM), Maintenance Management

PART 2 SYSTEM REQUIREMENTS

2.01 MANUFACTURERS

A. Square D, GE, and Eaton shall be standard for all secondary distribution equipment. Siemens equipment will not be allowed.

B. The Engineer of Record shall perform a coordination, arc flash study, and circuit breaker trip settings recommendation using a professional engineer. The Engineer of Record shall provide the arc-flash hazard data to Cornell in printed spreadsheet format. If the equipment submitted is different than specified by the Engineer of Record, a new coordination and arc flash study and circuit breaker trip settings recommendation shall be prepared by the Contractor using a professional engineer. This report shall be submitted for review and approval by the Engineer of Record prior to the release of equipment for manufacture.

2.02 ELECTRIC SERVICE ENTRANCE ROOM

A. All new gear should be located in one room. If a medium voltage network switch is required, it should be separated by a full height chain link fence and a padlockable personnel access gate sized to allow for equipment removal. Access to the network switch shall be by the Cornell FM Electric Shop Line Crew only.
B. The primary switch, transformer, and secondary switchgear should be close-coupled in one line-up and be installed on a 4-inch concrete housekeeping pad. For rear access type switchgear, provide minimum 24” clearance between distribution equipment and any adjacent wall for access and maintenance. Provide a minimum 12” clearance between dry-type transformers and a wall for proper ventilation of the transformer.

C. Primary electric service entrance room shall have a minimum 2-hour fire rating.

D. No sprinklers or dry chemical for fire protection shall be installed in the primary electric service entrance room unless specifically required by Code. Provide fire alarm smoke detection and visual notification devices as required per NFPA 72.

E. Provide minimum horizontal illumination level of 50 foot-candles in front of all electrical equipment (measured at the floor). All room lighting shall be fed from an emergency generator source, if available. Supplemental emergency lighting shall be provided via battery powered wall packs. The wall packs shall be charged via an emergency generator source, if available. Provide occupancy sensor(s) with an overriding (bypass) wall switch to control room lighting.

F. Provide an Ethernet source in the electric service room.

G. Safety grounding shall consist of, but not be limited to, a fully exposed ground ring around the interior space of the room. Visibly bond all equipment, room door frame(s), etc. to the ground ring.

H. A double door for access will be required for new installations. Crash bars shall be installed on the interior side of all access doors. Doors shall swing in the outward direction for egress.

I. The design development process shall minimize the risk of water entering the switchgear room (i.e., no mechanical water system shall be located over the electric gear, the room shall have proper drainage, consider conduit routing from primary electric manhole, etc.).

J. The electric room shall have proper ventilation, thermostatically controlled, to remove excess heat.

2.03 MEDIUM VOLTAGE NETWORK SWITCH

A. This type of switch will be required to allow for two sources of 15kV power to serve new buildings. Reference Medium Voltage Distribution Standard 337500 for additional information.

B. Ratings: 15kV, 600 amp, SF6 insulated, 25KA one second symmetrical withstand.
C. Acceptable Manufacturers:
   1. G&W, SF6 insulated, RAM series (non-fused) or VPNI (vacuum interrupter) series, depending on primary protection scheme.
   2. S&C, air insulated PME series (non-fused) or SF6 insulated Vista series (vacuum interrupter) depending on primary protection scheme.

D. A vacuum interrupter shall be located in the medium voltage network switch for transformer protection when determined through an arc flash analysis to be the optimal method to reduce arc flash hazards to acceptable levels or where a primary switch can’t be fitted into the electric room.

E. The Engineer of Record will be responsible for determining if a fused-way or fault interrupter-way will be required for the application.

F. The specific style of switch will need to be determined based on discussions with Facilities Engineering and Energy & Sustainability Departments. At a minimum, the switch will require two switched-ways for the incoming and outgoing loop feeders, one switched-way for the building load, and at least one spare switched-way.

G. Distribution switchgear is not permitted to be located in manholes. Rooms containing distribution switches shall have emergency lighting and power.

2.04 PRIMARY SWITCH

A. A primary switch will be required for every installation. The primary switch shall be fused when no vacuum interrupter is provided in the medium voltage network switch, or non-fused when a vacuum interrupter is provided in the medium voltage network switch.

B. Switch manufacturer and style:
   2. Outdoor: Integral to outdoor compartmental type transformer.

C. Fuse manufacturer: S&C, SM5, standard speed, power fuse only. An S&C SM4 fuse is not acceptable due to the lower interrupting rating.

D. The SM-5 fuse will be the smallest size that meets the following criteria:
   1. The transformer inrush will not intrude into the fuse melt curve with a cold fuse.
   2. The fuses will be sized such that the continuous hot fuse rating (S&C technical application manual) is under the forced air (if applicable) full load amperage of the transformer.
3. The fuse should coordinate with the main and feeder breakers. Loss of coordination between the primary fuse and main secondary breaker is allowable if a drop in fuse size results in a significant drop on arc flash energy, or a change in the flash hazard classification.

4. Loss of coordination with the main breaker, especially the short time element, is not a significant concern. Loss of coordination with a feeder breaker will not be allowed.

5. Upsizing to the next higher fuse size requires clear documentation of the coordination issues and arc flash impact, or a proven situation of regularly blowing fuses. If a fuse is resized, the arc flash hazard categories as listed in paragraph 1.01.D above still need to be met.

6. Fuses larger than 80E (>2000kVA transformer) at 13.2kV are not allowed due to the greater than one second clearing time at 400A (13.2kV high impedance ground fault).

7. Services with transformers 1500kVA or larger, using fuses for primary protection, shall also have secondary loss of phase protection or blown fuse protection tripping the secondary main breaker.

2.05 SERVICE ENTRANCE TRANSFORMERS

A. For large research and “critical use” facilities, a double-ended service entrance is recommended to minimize power disruptions.

B. Maximum transformer size at 480V:

1. 1500 kVA with fan cooling.
2. 2000 kVA will require special permission from owner and will still need to meet arc flash hazard classifications listed in paragraph 1.01.D.
3. The transformer shall be sized to carry both buses of a double-ended switchgear from a single transformer with fans on and loads of both buses from both transformers (with bus tie open) with fans off.

C. Maximum transformer size at 208V shall be 500 kVA, provided maximum arc flash level requirements in 1.01D can be met.

D. A vacuum interrupter for transformer protection shall be required when determined through an arc flash analysis to be the optimal method to reduce arc flash hazards to acceptable levels. Vacuum interrupters shall be located in the medium voltage network switch vice the primary switch. Vacuum interrupters may also be built into an outdoor pad mounted transformer.

E. Construction type:

1. Indoor: Vacuum Pressure Impregnated (VPI), pad-mount, dry type.
2. Outdoor: Compartmental type, pad-mount, FR3 or E200 fluid filled, dead front.
F. Bonding between the electrical system neutral and ground shall be performed at the service entrance transformer neutral (Xo) connection for indoor transformers. For services with outdoor transformers, the bonding between the electric system neutral and ground shall be performed in both the outdoor transformer as well as in the main electric service gear, per NEC 250.24(A) (2).

2.06 SERVICE ENTRANCE METERING

A. Primary metering is not allowed for electric services fed from the campus medium voltage electrical system.

B. Revenue grade metering: CT’s shall be provided for every service entrance greater than 200 amps and shall be located within the secondary switchgear, downstream from the main secondary device (cold sequence). All CT’s shall conform to the ANSI Standard accuracy class for metering service of 0.3 or better.

C. Meter Device types:
   1. Allen Bradley (Rockwell Automation), Powermonitor 5000, 1404-M6, with Ethernet communications and Powermonitor II display module. Device shall be located in the electric switchgear line-up. Ethernet connected for remote monitoring via the campus system.
   2. GE, KV series, S-Base, form 9S, Fitzall. Device shall be mounted in an accessible location 48-65” AFF with a meter box as manufactured by Hialeah, part no. “4-MS-G13T20SHO-M,” remotely from the electric switchgear line-up. Meter shall have a KYZ output sized for one (1) pulse per kilowatt hour.

D. Communication:
   1. Provide shorting blocks and cabling between CT’s and meter. Provide raceway (i.e. ¾” EMT) with pullstring between main electric service room and CIT telecommunications closet. Ethernet cabling, terminations, and face plate typically provided by CIT.

E. Application:
   1. Coordinate specific meter requirements with FE and Energy & Sustainability departments during design development phase.

2.07 SECONDARY SERVICE GEAR/DISTRIBUTION EQUIPMENT

A. General:
1. Secondary service gear/distribution equipment shall be coordinated with the primary switch and service entrance transformer(s) to limit the arc flash hazard to levels as specified in Part 1.01 D above and 2.07.D.3 below.

2. Main Disconnect device shall be a circuit breaker with solid-state trip device.

B. “Critical Use” Facility

1. Low voltage draw-out style, compartmentalized individually mounted power breakers are recommended for the main and all feeder devices.

2. Provide electronic trip units on the main and feeder breakers.

3. Provide full-function long time (L), short time (S), and instantaneous (I) trip functions.

4. Instantaneous trip setting shall be capable of being turned off.

5. Instantaneous (I) trip function shall be turned off on the main device, provided maximum permissible arc flash levels outlined in this standard can be met.

6. Provide ground fault (G) trip function only when required by the National Electrical Code or when the Engineer of Record documents the specific technical reasons why a ground fault trip unit is necessary for the electric service.

7. If ground fault trip function is provided on the main device, it must also be provided on all of the feeder devices.

8. Ground fault trip settings shall include multiple selectable i²t on (in) and off (out) settings.

9. All electronic trip circuit breakers shall have local ammeter displays.

10. Manufacturer: Square D, Eaton, or GE. Siemens distribution equipment will not be allowed.

C. “Non-Critical Use” Facility:

1. Low voltage molded case or insulated case group mounted circuit breakers may be utilized for the main and all feeder devices.

2. Provide full-function electronic trip units on the main and feeder breakers as needed to achieve coordination and minimize arc flash hazard levels.

3. Provide full function long time (L), short time (S), and instantaneous (I) trip functions.

4. Instantaneous trip setting shall be capable of being turned off.

5. Instantaneous (I) trip function shall be turned off on the main device, provided maximum permissible arc flash levels outlined in this standard can be met.

6. Provide ground fault (G) trip function only when required by the National Electrical Code or when the Engineer of Record documents the specific technical reasons why a ground fault trip unit is necessary for the electric service.

7. If ground fault trip is provided on the main device, it must also be provided on all of the feeder devices.
8. Ground fault trip settings shall include multiple selectable \( i^2t \) on (in) and off (out) settings.
9. All electronic trip circuit breakers shall have local ammeter displays.
10. Manufacturer: Square D, Eaton or GE. Siemens distribution equipment will not be allowed.

D. Electric Service Gear Hardware Requirements:

1. All main low voltage secondary circuit breakers shall be equipped with shunt trip devices for load shedding purposes.
2. No closed source transitions are allowed. Sources must be interlocked.
3. Non-compartmentalized group mounted low voltage breakers (where main and feeder breakers are group mounted together) may be used when the arc flash level on the line side of the main secondary breaker is hazard category 3 or less.
4. If the arc flash level on the line side of the main secondary breaker is calculated to be hazard category 4, then the main breaker must be separated from the feeder breakers (separate breaker compartment or separate enclosure) in order to achieve an arc flash hazard category of 3 or less on the line side of the feeder breakers and 2 or less on the load side of the feeder breakers.
5. Provide factory installed quartz windows for infrared thermography for rear access switchgear with draw-out breakers.
6. Status of transformer temperature and cooling fans should be monitored by the building automation system.
7. Circuit breaker status and amps should be monitored by the building automation system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Prior to installation, equipment shall be properly stored and protected to prevent damage. Install equipment per manufacturer’s recommendations.

B. The electric service entrance room must be fully enclosed prior to a request for energization of equipment by Cornell staff:

1. Electric service entrance room must be fully enclosed and water tight.
2. Equipment and area must be clean.
3. Manufacturer’s representative of installed equipment must provide written approval that all equipment was installed properly and is functioning correctly.
4. Electric inspection permit must be provided by the appropriate third party.

C. In cases where a Contractor must work on medium voltage systems, the following shall apply:
1. Operation of switching equipment: Contractors shall not operate medium voltage circuit breakers, distribution switches, and other switching equipment except to de-energize a circuit in the event of an emergency. Cornell linemen will perform all live switching operations.

2. Work on New Systems: Contractors may perform all necessary work on new systems installed by the Contractor, without the necessity for supervision or assistance of Cornell personnel. The Contractor is expected to follow standard de-energizing, lock out / tag out, testing, and grounding procedures before handling any medium voltage equipment. Any connection to existing equipment shall require the Contractor and Cornell personnel to adhere to the following procedure. Once a system has been energized and put into service, it is considered to be “existing equipment.”

3. Work on Existing Systems: Any time a Contractor must make a connection to, or work on an existing system, the following procedures shall be used to ensure the safety of all personnel involved:
   
   a. Cornell linemen will operate all switching equipment as required to de-energize a circuit in preparation for work. A representative of the Contractor shall be present during all switching, and both the Contractor’s electrician and a Cornell lineman shall install locks on all switches as required to prevent accidental switch operation. Each switch shall be tagged to inform others of the work being done. Manhole switches are never operated with personnel in the manhole. Cornell linemen have and use remote switching devices.

   b. Cornell linemen will test a circuit to ensure that it is “dead” before any contact is made with the circuit. After testing, grounds will be installed by Cornell linemen to ensure the circuit is dead and cannot become energized. The Contractor may also install grounding equipment.

   c. A Contractor shall not work on any existing cable without first having a Cornell lineman verify that the correct cable has been selected and the cable is de-energized. Cornell linemen will make the first cut into any existing cable system prior to Contractor splicing or terminating. This is to ensure that the Contractor does not select and cut into an energized cable. Cornell linemen will perform the switching, locking, tagging, and testing procedure before cutting into the cable and grounding each phase. The Contractor may then proceed with work.

D. Primary equipment will only be energized after inspection by the Cornell FM Electric Shop, City or Town of Ithaca Electrical Inspector, and a representative from the Cornell Energy & Sustainability Department.

3.02 TESTING AND COMMISSIONING

A. The Contractor shall perform initial system breaker settings in compliance with the equipment coordination study.
B. A third party commissioning agent shall verify the actual field electrical settings to be in accordance with the approved settings.

3.03 ARC FLASH LABELING

A. The Engineer of Record shall provide and apply the arc flash hazard labels to the equipment. If the equipment submitted is different than specified by the Engineer of Record, the Contractor shall be responsible for providing and applying the arc flash labels to the equipment.