

**SECTION 260500 - GENERAL REQUIREMENTS FOR ELECTRICAL**

- 1.0 ASHRAE 90.1 Compliance: University of Pennsylvania buildings shall comply with the Commercial Energy Efficiency Requirements of ASHRAE Standard 90.1-2016. The ASHRAE 90.1-2016 compliance paths shall be followed instead of the International Energy Conservation Code (IECC) requirements as permitted by 2018 IECC Section 401.2 Application.
- 2.0 In addition to the requirements previously presented herein, each specification shall contain the following general information:
- A. Codes, Laws, Ordinances, Regulations and Requirements:
1. State that all materials, equipment and workmanship must conform to all pertinent codes, laws, ordinances and regulations of all bodies having jurisdiction.
  2. Identify all references as necessary to invoke applicable electrical codes and standards, as well as building codes and any codes and standards that are not specifically electrical (ex. - building codes).
  3. State which codes and standards apply: ASTM, NEC, NFPA, UL, NETA, etc. by title and document number.
- B. Tests:
1. Define the Contractor's responsibility for execution, notification, documentation of results, and witnessing.
  2. Define, in detail, the factory and field tests required as part of the contract.
  3. As a minimum, factory acceptance tests shall be required for generators, transformers, UPS, switchgear/switchboards and paralleling switchgear. Consult the University for requirements for witnessed factory test requirements, which will require a minimum of two weeks' notice, when required.
  4. Field acceptance testing shall be completed in accordance with manufacturer's recommendation by a factory-authorized field services technician and International Electrical Testing Association Inc. (NETA) Acceptance Testing Specifications, by a NETA certified electrical testing firm that is retained by the contractor as an independent subcontractor. The testing subcontractor shall provide their report directly to the University and the design professional. Any non-conformance issues shall be resolved immediately, unless University operations require a delay to avoid conflicts.
  5. The electrical testing firm shall be required to perform an infrared thermographic inspection of all current carrying equipment and connections per NETA Standards, six months after beneficial occupancy (minimum 75% of available floor space is occupied unless directed otherwise by the University Engineering Department), and provide a report to the Owner. The inspector shall be Level III certified in infrared testing by the American Society of Nondestructive Testing (ASNT).
  6. Records of all torque wrench calibration and settings shall be provided
- 3.0 As a minimum, a start-up/energization plan shall be provided for new or modified electrical systems. When directed by the University Engineering Department (typically, larger projects) commissioning by an independent commissioning agent will be required for commissioning requirements.

## 4.0 Instructing Owner's Personnel:

- A. Require the contractor and each equipment manufacturer's technical agent to fully instruct the representatives of the University in all details of operation of the equipment installed under his contract. Training sessions should be scheduled with the appropriate University personnel (usually, Electrical Operators and Electricians - "ELOPs") and require a minimum of two weeks' notice.
- B. Each contractor shall be directed to provide three (3) copies of printed operating and maintenance instructions in separate hardback, three-ring loose-leaf binders and an electronic copy in Adobe or other acceptable format. The instructions shall be prepared by section and contain detail operating and maintenance data including wiring and piping diagrams. Each section shall be labeled and include detailed parts list data and the name, address and phone number of the nearest supply source. The manuals must provide all the information required to run the building and maintain systems and equipment efficiently.
- C. The manufacturer's standard specification sheets, if generalized in any way, will be clearly marked to show exactly which item has been supplied, what ratings are applicable, etc., and the job designation for that item will be noted on manufacturer's specification sheet which includes all details for this unit.
- D. If there are differences between pieces of equipment, then include a specification sheet for each, properly marked.
- E. Include control diagrams, single-line diagrams, interconnection (point to point) wiring diagrams, sequence of operations, and service instructions.
- F. Provide one section for preventive maintenance procedures (recommended materials and procedures, frequency, etc.).
- G. Include Contractor's phone numbers and any other references required to obtain warranty service.
- H. Training shall be conducted by the manufacturer's factory trained personnel who are knowledgeable of the specific project and actual operating conditions and requirements.
- I. Operator training shall be conducted before the equipment is placed into energized operation.
- J. The manufacturer shall produce a test procedure that covers all modes of operation and demonstrates all interlocks for the equipment provided.

## 5.0 Mechanical-Electrical Coordination:

- A. Include one or more articles that clearly define the extent of responsibility between the mechanical and electrical contractors regarding equipment, wiring or other features that involve the work of both trades.
- B. Require the contractors to provide coordination drawings that document coordination among all trades.
- C. Do not install equipment that must be accessed or serviced by trades other than electrical, in electrical rooms that are to be locked with an "ELEOP" key.

- D. Do not install equipment, piping, etc. that is foreign to electrical system above electrical equipment.

#### 6.0 Description of Work:

- A. Include a description of the scope of work highlighting all major systems, ratings, system boundaries and extents, equipment and material selections, etc.
- B. If the nature of the project requires a phased approach in order to keep systems running and buildings in operating condition, describe the required sequences of work.
- C. Any temporary power provisions must be clearly defined, including required equipment and materials, location of equipment, guarding of equipment (fences, etc.), tie-ins and shutdowns, sequencing, etc. Define the entire extent of the campus that is affected by temporary power provisions, such as buildings/building areas, exterior lighting, etc. Define the duration of required outages and scheduling restrictions.
- D. Define the required coordination between University operations, building owners and building occupants, for egress and access restrictions during the construction work, shutdowns, system availability, etc.
- E. Define all tie-ins to the University's campus substations and medium voltage distribution feeder circuits, including a plan that identifies the sequencing required to get the new work tied in, listing of existing buildings that are affected by outages and/or switching operations, duct banks, manholes, etc.
- F. Existing University electrical site maps and electrical site single line diagrams are to be updated to show all new building electrical tie-ins, as part of the project. Additionally, the composite campus site utility drawing showing chilled water, steam and electric must be updated. These drawings must be updated and submitted to the University prior to energizing electrical service to the building.

#### 7.0 Shop Drawings:

- A. Each shop drawing submitted shall be identified by the following:
  - B. Project Name
  - C. Specification Section
  - D. Drawing Numbers
  - E. Shop drawing data shall include but not be limited to:
    - 1. Manufacturer's catalog designation.
    - 2. Complete data and wiring diagrams.
    - 3. Dimensions, capacities, ratings, weights, materials, finishes, and storage conditions.
    - 4. Recommended installation procedures, performance, and conditions of performance, testing, and certifications if required.
- F. Each submittal shall be required to bear the review stamp of each contractor associated with the processing of the document. The processing of shop drawings shall follow contractual relationships between the Prime Contractor and all Subcontractors.

- G. Shop drawings which require coordination of two or more trades shall be required to bear the review stamp of the coordinating trades.
  - 1. All submittals depicting multiple options or configurations shall be marked to completely identify the specified options and/or configurations. This includes all electronic submittals, which shall be identical to all submitted paper copies.
  - 2. Coordination drawings shall meet the Division 1 requirements

#### 8.0 Record Drawings

- A. The project specifications must define the requirements for the as-built drawings. At a minimum, these drawings must identify locations and size of all major raceway systems (to include conduits 3" and larger, cable tray, etc.); locations of all devices; updated panelboard schedules, equipment locations; substitutions; depth of ductbanks, routing of duct banks. Also record on as-built drawings the dimensioned locations of other piping systems where they cross underground electrical duct banks.
- B. Provide digital pictures of duct bank crossings with other piping systems and at building entrances, prior to backfilling excavations.
- C. Require an electronic file of all project specific drawings in a version compatible with current University CAD software (AutoCAD, Revit and PDF formats, where applicable).

#### 9.0 Sleeves and Penetrations:

- A. The specifications and drawings must define and detail the installation of grouting and waterproofing of sleeves and fireproofing of rated wall penetrations, if necessary.
- B. Penetrations through below grade walls and foundation walls shall be sealed using grouted sleeves, with link seals to waterproof the sleeve to conduit annular space.
- C. Each fire-rated wall penetration shall be sealed with listed, fire-rated sealant and shall be located on as-built drawings and identified by the applicable UL directory file number.
- D. Sleeves installed in floors shall have a minimum 3" extension above the finished floor elevation.
- E. Access panels in walls and ceilings shall be provided where there are concealed items requiring access. Access panels shall match the fire rating of the wall or ceiling assembly in which they are located.
- F. Roof penetrations shall be supplied in accordance with the roofing system manufacturer's recommendations.

#### 10.0 Contract Drawings: The following applies to the preparation of drawings:

- A. All Division 26 drawings will be labeled according to the attached drawing numbering guide.
- B. Separate sheets must be used for plans, details, panelboard schedules, single line diagrams, and risers.
- C. Standard University details must be used where applicable.

## 11.0 Additional Design Considerations:

- A. Demolition work: Equipment to be removed, replaced, or made obsolete shall be demolished in its entirety back to source.
- B. All primary (high voltage) main breakers installed on the campus will be monitored (voltage [three phase L-L, L-G] amperes - each phase, kW, kVARS, kVA, kWH, kVARH, harmonics, relay status and breaker status) from the centrally located Operations Control Center.
  - 1. Refer to specification guideline 260913, Electrical Monitoring and Control, for monitoring and meter requirements.
  - 2. Meter data will be delivered to the building's SCADA node. All new building projects shall include the provision of a new SCADA node, utilizing exclusively, the services of the University's SCADA system provider. Renovation projects may, if allowed by the University Engineering Department, tie in to an existing SCADA node if one is present in the building. In general, meters and other devices are to interface with the SCADA node via Modbus TCP-IP. Refer to specification guideline 260913 for more information.
- C. Coordination of the design for the location of all floor and wall openings, lintels, equipment pads, etc. is the responsibility of design professional engaged to design the system which penetrates the floor, wall or roof.
- D. The following is a list of prohibited installations:
  - 1. Armored Cable. (Type AC)  
(type MC cable with insulated internal ground wire is acceptable.)
  - 2. Aluminum wires and cables.
  - 3. Aluminum bus duct.
  - 4. Aluminum windings in transformers and motors.
  - 5. Twin breaker units.
  - 6. Aluminum bus in panelboards or switchboards.
  - 7. Underslab/in-slab conduits.
  - 8. Direct burial of underground cable.
  - 9. Top entry in areas where water is present or could be present.
  - 10. Line side taps on panelboards
  - 11. Bottom entry in medium voltage switchgear
  - 12. Front access-only medium voltage switchgear
- E. All equipment must be installed on raised concrete housekeeping pads. Pads shall be a minimum of 4 inches high and shall extend a minimum of 4 inches beyond all sides of the equipment. Pads in front of switchgear or motor control centers containing draw-out units shall extend the full required working distance recommended by the manufacturer.
- F. The work sequence required to accommodate the University's operational or occupancy requirements must be described.
- G. Temporary work required to facilitate construction or University's occupancy requirements (i.e. continuity of electrical service) must be identified. Work and connections requiring interruption of services shall be identified and coordinated with Owner and performed only with prior written approval of Owner. Seven (7) days prior written notice of service interruption is required.

- H. The design professional shall demonstrate that electrical equipment is able to fit in space allotted with required NEC and OSHA clearances. Also demonstrate that equipment removal paths from the building are defined.
- I. The design professional shall familiarize themselves with the University's "Climate Action Plan" (latest version) which seeks to integrate sustainability into every aspect of the University including campus planning and design, and campus operations. To that end, equipment selections shall consider all practical options for reduction of losses, reduction of waste materials, and improved operating and maintenance efficiency. Refer to section 010020 for more detail on the University's Climate Action Plan.

#### 12.0 Power System Study:

- A. A power system coordination and short circuit study shall be performed. Provide a system time-current coordinated at all levels of overload and fault current. A complete short circuit protection and coordination study shall be prepared to denote actual items of equipment proposed to accomplish the required degree of coordination between protective devices from the external source feeding the building through all internal switchboards and panelboards. Study shall also evaluate withstand ratings of passive equipment such as bus duct, automatic transfer switches, contactors, and safety switches.
- B. The minimum interrupting rating of 15KV class switchgear shall be 20 kA (500 MVA).
- C. Design professional shall design the system for power factor correction to 95 percent. Capacitors should be placed locally at motors 20 HP and above, except for motors fed from VFDs. In addition, secondary automatic power factor correction capacitors shall be provided to further correct the power factor to 95 percent overall at the building low voltage substations.
- D. Provide an arc flash analysis that covers all electrical or electrified equipment supplied under the project. The arc flash analysis shall evaluate all operating scenarios present and report the worst case results obtained by the methodologies of both NFPA 70E and IEEE 1584. The most conservative results from these two methodologies shall be used as the basis for PPE recommendations.
- E. Refer to section 261000 for additional requirements for relay and circuit breaker coordination.

#### 13.0 Power Capacity Analysis:

- A. An electrical power capacity analysis shall be performed to confirm the ability of existing power systems to handle additional loads imposed by renovation projects and building expansion projects. For projects with demand loads of 100 KVA or more, the capacity analysis shall include local panelboards, affected power risers or feeders and the service feeder or transformer. For new buildings, a service capacity study shall be performed in conjunction with the University Engineering Department. A load study of the existing capacity shall be performed on all projects that intend to draw power from a campus substation.