COMMON WORK RESULTS FOR ELECTRICAL

Scope

Prepare the project's electrical design and associated contract documents in accordance with these Design Guidelines, in accordance with the scope of work defined in the Program Documents, and within the construction budget.

Related Sections

U-M Design Guideline Sections:
Special Instructions to Designers
Special Building Areas
Division 26 - Electrical Technical Sections
Electrical Trades Preferred Manufacturers List
Design Deliverables

U-M Master Specification Sections:
Division 01 - General Requirements
Division 26 - Electrical Master Specifications
Division 27 - Communications
Division 28 - Electronic Safety and Security

U-M Standard Details:
260000 Series - Electrical Standard Details

Reference Documents:
NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces

Design Requirements

Submit the documents specified in the Design Deliverables list for approval. Submit them at the end of the Schematic Design, Design Development and Construction Documents phases.

Design the power distribution system such that the arc flash hazard Personal Protective Equipment (PPE) required to examine, adjust, service or maintain equipment while energized is Category 4 or less at unit substations and switchboards, and Category 2 or less at panelboards and similar equipment.

Provide flexibility for future changes in the use of the space, and provide spare capacity for future load growth. Provide 20 percent spare capacity for load growth unless 20 percent spare capacity would require a significant power distribution system upgrade. In those special cases, provide as much spare capacity as the existing system can supply.

Field verify the existing installation and/or site. Do not rely solely on the existing drawings and/or site surveys. As a minimum, field verify the quantities, sizes, ages, conditions and spare capacities of the following:

- Power ducts, manholes, services to the building and unit substations.
- Panels, circuit breakers, disconnect switches, motor controls, raceways and wiring.
- Interior and exterior lighting, switches and receptacles.
- Grounding.
- Telecommunications ducts, manholes, rooms and services to the building.
- Fire alarm, security, card access control, audio/visual and other special systems.

Coordinate with the Design Manager to obtain recent historical information from the following U-M departments:

- Key plans and electrical risers from AEC.
- Electrical usage, primary system and unit substation information from the Plant Utilities and Plant Engineering (UPE) Department.
- Existing condition information from the Facility Condition Assessment Program, the Facility's Manager and the Plant Region maintenance personnel.
- Fire alarm and security system information including fire alarm drill results from the Plant Fire Protection Shop and the Department of Public Safety and Security.
- Card access control system information from the Plant Key Office.

Show all known below grade, below floor and in-floor utilities that will be impacted by the project's work.

Use existing spare circuit breakers or existing spaces whenever possible. If necessary, combine existing lightly loaded circuits to free existing circuit breakers for the new loads. Tap buses only with the approval of the Plant UPE Department. Coordinate with the Design Manager before adding a new unit substation.

Number electrical panels and devices in accordance with U-M Standard Detail 260500001.

Match the existing installation whenever possible and practical.

Locate equipment requiring routine maintenance so it is easily accessible.

- Installations shall not require the use of a lift or scaffolding, or the removal of other infrastructure, for routine maintenance.
- For rooftop equipment with control panels, motor starters, disconnects or motors mounted over 6 feet above roof level and requiring routine maintenance, arrange for the Architect to provide a permanent galvanized steel work platform and ladder.

Provide access panels (24 inches square minimum to access equipment out of arm's reach) for maintaining electrical equipment located behind walls or above permanent ceilings.

Ensure that no piping or ductwork is routed in the NEC-required dedicated spaces above or working spaces around electrical equipment. Provide drip pans for existing piping routed over electrical equipment.

Correct code violations and safety hazards to the greatest extent possible within the project boundary. If existing code violations or safety hazards are discovered that are not addressed in the Program Documents, notify the Project Manager.

Short Circuit, Protective Device Coordination and Arc Flash Hazard Studies

On projects providing a new or replacing an existing power distribution system, perform a preliminary power distribution system short circuit and protective device coordination study to establish the project's electrical equipment ratings.

- Include in the study the project scope plus existing electrical infrastructure affected by and coordinating with the project scope.
- Verify electrical equipment supplied by others such as inverters, chiller control panels and variable speed drives are adequately rated for the available short circuit current.
- Non-fusible disconnect switches are only rated 10kA symmetrical. Where the available short circuit current exceeds this amount, specify fused disconnect switches.
- When the power distribution system includes an interactive power source such as an engine-generator with closed transition or soft-loading automatic transfer switches, solar photovoltaic system, wind generator or fuel cells, perform the short circuit study twice. First, use only the fault contribution from the incoming utility power system or from the interactive source, whichever contribution is greater. Secondly, combine the fault contributions from the incoming utility power system and interactive source to get the worst case situation. Submit the results of both studies.
    - Use the first study to establish the electrical equipment ratings when the interactive power source will be paralleled only momentarily with the incoming utility power system, such as when the interactive source is an engine-generator with closed transition transfer switches.
    - Use the second study to establish the electrical equipment ratings when the interactive power source will be paralleled more than momentarily with the incoming utility power system.
- Submit the study for review at the end of Design Development.

Perform or arrange for a Registered Professional Engineer to perform a final power distribution system short circuit, protective device coordination and arc flash hazard study. The Electrical Contractor shall not perform or arrange for this study.

- Include in the final study the project scope plus existing electrical infrastructure affected by and coordinating with the project scope.
- Perform the final study in accordance with applicable ANSI/IEEE standards using computer software from SKM Power Tools. Perform the arc flash hazard study in accordance with NFPA 70E.
- The final study shall be performed by an Engineer with extensive experience in the performance of these studies. The study shall be signed and sealed by a Registered Professional Engineer in the State of Michigan. If performed by other than the Architect/Engineer, the Architect/Engineer shall review and approve the study.
- When the power distribution system includes an interactive power source, perform the final short circuit study twice as was done for the preliminary study. Submit the results of both studies.

    - Use the first study to establish the fuse sizes, protective device settings and arc flash hazard values when the interactive power source will be paralleled only momentarily with the incoming utility power system, such as when the interactive source is an engine-generator with closed transition transfer switches.
    - Use the second study to establish the fuse sizes, protective device settings and arc flash hazard values when the interactive power source will be paralleled more than momentarily with the incoming utility power system.
- The final study shall incorporate shop drawing information and protective device coordination time-current curves from the electrical equipment manufacturers, and actual cable sizes and lengths from the Electrical Contractor.
- Summarize the results of the final study in a report.
    - Identify electrical equipment that is inadequately rated or that does not coordinate with upstream equipment.
    - Specify fuse sizes and protective device settings in table format.
    - Specify automatic transfer switch voltage, current, time and control settings in table format.
    - Specify arc flash incident values, working distances, arc flash boundary distances and Personal Protection Equipment (PPE) levels in table format.
    - Provide phase and ground fault coordination time-current curves showing the selective coordination of the substation secondary main, tie and feeder breakers with downstream protective devices. Include transformer, large motor and feeder conductor damage curves.
- Submit the study and report to the Owner and Commissioning Authority for approval prior to equipment energization.
- Submit the report to the Electrical Contractor for their use in providing fuses and adjusting electrical equipment settings prior to equipment testing and energization. The independent electrical testing agency and Commissioning Authority will verify proper fuse sizes, protective device settings and automatic transfer switch settings.
- Submit the completed SKM Power Tools data files on a CD or DVD for use by the Owner during future system modifications.

Arc Flash Hazard Warning Labels

The Electrical Contractor shall provide generic arc flash hazard warning labels on equipment shown by the final report to have an arc flash incident energy level exceeding 1.2 calories/square centimeter and likely to require examination, adjustment, servicing or maintenance while energized. This includes but is not limited to automatic transfer switches, switchboards, panelboards, meter socket enclosures, transformers, storage batteries, battery chargers, inverters, control panels, variable speed drives, motor controllers, circuit breakers and disconnect switches. Two labels (line side and load side) are to be provided on fused disconnect switches and circuit breakers 800 amps and above, and on the primary and secondary sides of transformers.

- Contractor-provided labels are not required on primary switchgear or unit substations. U-M Plant Operations will provide device-specific labels on this equipment.

- Contractor-provided labels are not required on equipment that is factory labeled by its manufacturer.

Although portions may be energized early to provide temporary power for construction, the power distribution system will not be declared Substantially Complete and will not be accepted by the University until the study and labeling tasks have been completed.

Design Drawings

Prepare the following electrical drawings and specifications in accordance with the Design Deliverables list and as applicable to the project, for use during construction:

- Demolition plans and details.
- Underground duct bank and manhole plans, elevations, profiles and details.
- Primary and secondary feeder conduit routing drawings.
- Normal and emergency power plans, one-lines, risers and details.
- Schematic and wiring diagrams.
- Lighting plans and details.
- Telecommunications, fire alarm, clock, card access control, security, CCTV, audio/visual, sound reinforcement and other special systems plans, risers, schematics, and wiring diagrams.
- Grounding and lightning protection plans, risers and details.
- Substation, switchboard, panelboard, MCC and other applicable equipment schedules.
- Systems and equipment sequences of operation.

For new electrical drawings, use the symbols and abbreviations established by the applicable nationally recognized trade association. When revising existing drawings, use the existing symbols and name equipment using the existing convention. Provide a complete symbols legend.

When revising existing drawings, identify revisions. Circle and label revisions, or draw the revisions using a heavier line weight than used for the existing and background.

When a building feature, cable tray, conduit, or circuit continues on to another drawing, reference the continuation drawing at the point of continuation. Show reference column and row numbers for clarity.

On new building, building addition and total renovation projects, facilitate the use of aluminum cables in lieu of copper for feeder circuits No. 1 AWG and larger only. On partial renovation projects, match the existing cable type. Note that chiller manufacturers will not allow the use of aluminum cables to feed chiller VSDs or starters.

- Provide two cable and conduit sizing charts on the drawings, one for copper cables and one for aluminum cables.
- Include the aluminum cable technical and installation requirements contained in Master Specification 260513. Include Standard Detail 16120013 on the drawings.
- After completion of construction, verify the as-built drawings identify where aluminum conductor cables were installed.

Show the wire and conduit sizes for every feeder circuit on the riser and one-line diagrams.

Show wire and conduit sizes on the plan drawings for any circuit other than 20 amperes, single phase. Show multi-wire feeder and branch circuits requiring separate or oversized neutrals. A general note is adequate to define wire and conduit sizes for 20-ampere single phase circuits and to specify shared neutrals.

Show bus amperes, number of phases and wires, breaker/starter/fused switch/fuse sizes, and AIC ratings for all unit substations, switchboards, panels, MCC's, etc.

Specify the mounting heights of electrical devices. Indicate if the devices are flush or surface mounted. Indicate if raceways are exposed or concealed. Show 4" high minimum concrete housekeeping pads for floor-mounted equipment.

Show Contractor furnished electrical equipment and control wiring on the plan drawings. Include equipment required by the NEC such as motor disconnect switches if not provided by others, and include control wiring required for equipment operation if not provided by others. Do not rely solely on specification statements or general drawing notes to identify Contractor scope. Provide sufficient information so that quantities can be determined easily.

Specifications

Number specification sections in accordance with the CSI specification numbering system.

Use the U-M Master Specification sections applicable to the project. Turn on hidden text, follow the hidden text editor’s notes and edit the sections to make them project specific.

Eliminate from general specifications the requirements that do not apply to the project.

Shop Drawing Review

Review Contractor submitted shop drawings and product literature. Approve submittals that comply with the contract documents, and mark up or reject submittals that do not comply. Approved submittals shall include adequate information to prove that the proposed products comply fully with the contract documents. Each copy shall be marked to indicate the specific models, sizes, types and options being provided. Submittals not so marked shall be rejected.

Testing

Specify testing in accordance with Design Guideline 16950. Request approval before specifying testing beyond what is listed in Design Guideline 16950.

Commissioning

Insert Commissioning Master Specification 019100 or 019110 into the project specifications and edit it to make it project specific (unless an edited version will be provided by the U-M Commissioning Authority during CD design). Refer to this specification section rather than specifying commissioning requirements in the other specification sections.

Operation and Maintenance Manuals

Edit and insert Master Specification 017823 into the project specifications. Refer to this specification section rather than specifying O&M manual requirements in the other specification sections.

Review and approve Contractor submitted operation and maintenance manuals. These manuals shall be marked to indicate the specific models, sizes, types and options of the systems and equipment that will be provided. Manuals not so marked shall be rejected.

Training

Refer to Specification 017823 when specifying Owner training requirements. Training shall not take place until the Owner's Personnel have been given 2 weeks to review the approved Operation and Maintenance Manuals. The Contractor shall notify the Project Manager 3 working days in advance of training sessions.

Record Drawings

Review and approve Contractor submitted as-built information and provide the information to the University in accordance with SID-H, "Construction Documents". The drawings shall show the locations of equipment, light fixtures, switches, receptacles and junction boxes, riser information, the sizes of conduits and conductors, circuit numbers, and deviations from the design. Buried, embedded and concealed primary and feeder conduits shall be dimensioned from permanent building features.

Products

Specify products that conform to the applicable standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA).

Specify that products be listed or labeled by a Nationally Recognized Testing Laboratory. When components are combined to form a major assembly, the entire assembly shall be listed or labeled.

Specify multiple manufacturers from the Electrical Trades Preferred Manufacturers List when multiple manufacturers produce products meeting the project requirements.

Do not use the term "Or Equal" or any similar language to specify products or services.

Specify products that are known to have been used with success elsewhere. Do not specify newly developed or unproven products.

When designing new electrical systems, specify major power distribution equipment shall be from one manufacturer. When designing renovations, match the existing equipment where practical.

Specify that equipment and materials shall be provided from the manufacturers specified. Substitutions for specified products shall be acceptable only if proposed and approved in writing before the project is awarded.

During Contractor shop drawing submittal review, approve only those submittals which comply with the project specifications.

Execution

Ensure the following additional Contractor actions are specified in the contract documents.

Temporary Services

Temporary lighting and power shall be provided as specified in the project's Supplemental General Conditions.

Permanent electrical systems or equipment used during construction shall be replaced or cleaned and fully refurbished prior to acceptance by the University.

Electrical Coordination

The Contractor shall participate in the specified project scheduling and coordination drawing activities as specified in Division 1 of the project specifications.

The Contractor shall notify the Project Manager of power interruptions 3 working days in advance, and shall maintain power to loads outside of the work area.

The Contractor shall coordinate with the Plant Operations Call Center at (734) 647-2059:

- Before performing any work affecting primary power distribution circuits, unit substations or exterior lighting.
- Before performing any work affecting engine-generators or variable speed drives.
- Before performing any work affecting fire alarm, security or card access control systems.
- Before performing any work affecting telecommunications ducts, manholes or rooms.
- Before performing any work affecting roofs.

The Contractor shall notify OSEH at (734) 647-1143 before starting up engine-generators.

The Contractor shall coordinate work with the other trades to ensure the NEC-required dedicated spaces above and working spaces around electrical equipment is provided, and to ensure access to equipment requiring calibration or maintenance. Working space and access shall be sufficient for an adult to perform maintenance safely without straddling or removing obstructions. Work that encroaches on working space or that impedes maintenance shall be relocated at the Contractor's expense.

For deliveries of equipment to the Owner, the Project Manager shall be notified 3 working days in advance. Deliveries shall occur on normal workdays between 8:00 AM and 2:00 PM. Deliveries that arrive without adequate notice may be rejected.

Owner furnished equipment that is shipped to the project site shall be unloaded and stored by the Contractor. Owner furnished equipment that is stored in the Owner's warehouses shall picked up, transported, unloaded and stored by the Contractor at the project site.

Demolition

Equipment and materials designated for demolition shall be removed as follows:

- Power wiring: Remove back to the source or to the first junction box where the circuit continues on to remaining loads.
- Telecommunications wiring: Remove from conduits and J-hooks back to cable trays or to the outer walls of telecommunications rooms. U-M ITSComm personnel will remove abandoned wiring from cable trays and inside the telecommunications rooms.
- Conduits and boxes in walls and above permanent ceilings: Abandon in place. Install blank cover plates on boxes.
- Conduits through floors and walls, and boxes in floors: Remove completely. Patch and paint penetrations to match existing.
- Exposed and accessible conduits, wireways and boxes: Remove completely. Patch and paint surfaces to match existing, and plug unused panel and junction box holes.
- Lighting fixtures and electrical equipment: Remove and dispose of completely (unless designated for relocation).

Items designated for relocation shall cleaned and restored to a "like new" condition.

Lamp and Ballast Recycling

The Contractor shall recycle lamps and ballasts. Insert verbatim into the project specifications the recycling requirements contained in Master Specification 16010.

Quality Assurance

Electrical work shall be performed by licensed Journeyman or registered Apprentice Electricians. The number of Apprentices on a project shall not exceed the number of Journeymen. Electricians shall carry a copy of their license or registration while working on University projects.

The Contractor shall contact the Owner's Code Inspection Department at (734) 764-2457 before the start of the project to arrange for periodic inspections. Normal inspections will be performed at no cost to the Contractor, but the costs for repeat re-inspections of rejected work may be deducted from the Contractor's final payment.

Electrical systems, equipment and materials shall be tested by an independent testing agency prior to final acceptance of the work. Acceptance tests shall be performed in accordance with applicable codes, standards and manufacturers' instructions.

- Notify the Project Manager 3 working days in advance of tests. The Owner shall witness the tests unless the Project Manager waives witnessing in writing.

- Notify manufacturers sufficiently in advance of tests for which the manufacturers should be present.
- Provide written test reports, signed and dated, for all tests prior to acceptance of the electrical equipment by the Owner.

Warranty

Electrical work shall be guaranteed for a period of one year from the date of acceptance of the project by the University. A manufacturer's warranty beginning upon equipment receipt or startup shall be extended to one year from final project acceptance. A manufacturer's warranty in excess of one year shall remain in effect for its entire time period.