

# WVU DESIGN GUIDELINES & CONSTRUCTION STANDARDS

## DIVISION 26 – ELECTRICAL

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### SECTION 260505 – POWER STUDIES

#### PART 1 - GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by WVU Facilities Management.
- 1.2 WVU acts as its own utility for electric distribution on the Law Center, Downtown, and Evansdale Campus in Morgantown. All service shall be provided from WVU's 4160-volt and 23,000-volt distribution networks.
- 1.3 WVU has contracted a Power Study Consultant to maintain their Main Distribution System Study, (MDSS). It includes a load flow, arc flash, coordination, and short circuit studies for the Evansdale, Downtown, and the Law School Campus. This study will go from WVU's 23kv substation to the first breaker inside the building on the secondary side of the transformer. This study will be updated as facilities are added or deleted from the system.
- 1.4 Where projects are located outside WVU's utility distribution system it shall be the A/E's responsibility to coordinate with local utility providers to obtain information regarding the utility's power quality and requirements for connection to the local utility provider's distribution system. For this application the A/E shall incorporate the specifications necessary in the project manual to require the electrical contractor to obtain the services of an approved Power Study Consultant to perform a load flow, arc flash, coordination and short circuit studies as noted in this and other sections of the WVU Design Guidelines and Construction Standards.

#### PART 2 - PRODUCTS

- 2.1 Coordination Study Requirements
  - A. Provide each study with the following items as a minimum:
    1. Provide coordination plots which graphically indicate the coordination proposed for the several systems. Provide plots centered on full scale log-log forms.
    2. Provide coordination plots with complete titles, representative one-line diagrams and legends, associated power company's relay or system characteristics, motor controller fuses and relays, significant motor starting characteristics, complete parameters for power, network and substation transformers, complete operating bands for low voltage switchboard circuit breaker trip devices, fuses, if applicable, and the associated system load protective devices.
    3. Provide coordination plots which define the types of protective devices selected, together with the proposed coil taps, time dial settings and pick-up settings required.
    4. The long time region of the coordination plots shall indicate a complete tap scale for each medium voltage relay and full load current transformer parameters and designate the pick-ups required for the low voltage circuit breakers.
    5. The short time region shall indicate medium voltage relay instantaneous elements, the magnetizing inrush, and American National Standards Institute (ANSI) withstand transformer parameters, the low voltage circuit breaker, short time and instantaneous trip devices, fuse manufacturing tolerance bands, including the low voltage network protector fuses, when applicable, and significant symmetrical fault currents.

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### 2.2 Short Circuit and Protective Device Study

- A. The short circuit study shall be performed with the aid of a SKM Systems Analysis Power Tools for Windows (PTW) software program or approved equal and shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.
- C. Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breakers trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristic of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150,400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significantly symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

### 2.3 Arc-Flash Hazard Study

- A. A detailed arc-flash hazard study shall be performed in accordance with the latest versions of all appropriate and applicable codes and standards including, but not limited to, NFPA 70E and IEEE Std. 1584.
- B. The scope of this evaluation is the system as defined by the short-circuit study but is limited to all system voltages of 250V and up as well as 208V and 240V systems fed from 125kVA transformers and larger.
- C. The study work shall be performed by the equipment manufacturer's engineers involved in the analysis of power systems for a period of at least five years.
- D. The arc-flash hazard study shall be conducted by the same personnel performing the project's short-circuit and coordination studies, the output data of which shall form the input basis for the arc-flash hazard calculations and analysis. Equipment layouts and configurations shall be obtained from the manufacturer's final submittals and project layout drawings.

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- E. The results of this study shall include the calculated arc-flash boundary and incident energy (in cal/cm<sup>2</sup>) at key points throughout the scope of the system defined for the short-circuit and coordination studies. The study report shall also provide a detailed verbal discussion and explanation of the tabulated outputs, and an executive summary of these results.

### PART 3 - EXECUTION

#### 3.1 Project Specific Power Studies

- A. During the conceptual phase of a potential project (by Schematic Design), the Architect/Engineer shall provide WVU with the estimated connected load for the project. The A/E shall update this information as required at each design submittal phase of the project. WVU will forward this information to the Power Study Consultant to determine if adequate capacity exists within WVU's system.
  - 1. When a potential project may exceed the capacity of WVU's distribution system or the primary utility feed into WVU's system, the A/E shall coordinate directly with the utility provider and the Power Study Consultant to determine what, if any, upgrades are required and provide WVU with an estimate of the potential costs for the upgrades.
- B. WVU shall contract the Power Study Consultant to determine the point of connection to the main distribution system and the available fault current at that location.
  - 1. Projects requiring connection to local utility distribution systems, the A/E shall coordinate directly with the utility provider to determine the point of connection and the available fault current at that location.
- C. The Architectural/Engineering design firm shall use the Power Study Consultant's information while conducting their design work. At the 90% design point, the A/E firm shall supply project drawings to the Power Study Consultant to review their equipment selection.
- D. During the construction phase and after equipment has been ordered, the Power Study Consultant will provide breaker settings at the first protective device to the contractor.
- E. During construction, the contractor shall coordinate with the Primary equipment manufacturers or with one of the approved Power Study Consultants to conduct a coordination study, short circuit, load flow, and arc flash study to support the selection of instrument transformer ratios, protective relay characteristics and settings, fuse ratings, low-voltage circuit breaker ratings, characteristics, and settings. The studies shall demonstrate that the protective devices as selected and set will ensure that the minimum unfaulted load is interrupted when protective devices isolate a fault or overload anywhere in the system while satisfactory protection is provided for equipment against overloads, and short circuits are interrupted as rapidly as possible. Technical characteristic, manuals, time characteristic curves, etc. for each protective device along with the calculations used in preparing the study shall be provided to the University.
- F. Two weeks prior to energizing a project, WVU needs to be notified so the Power Study Consultant can revise the distribution system relay setpoints.

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- G. After the project has been completed, the Power Study Consultant shall update the MDSS. Funds for this work shall come from the project.
- H. The A/E firm shall include in the project specifications the requirements for the contractor to provide Arc-Flash labeling consistent with these guidelines.
- I. The A/E firm shall include requirements in the project specifications for the Power Study Consultant to provide minimum (4) hours arc flash hazard training certified for continuing education credits (CEU's) by the IACET.

### PART 4 – SUBMITTAL REQUIREMENTS

#### 4.1 General Requirements

- A. Studies to be submitted in 8-1/2" x 11", 3-ring binder format with tabbed dividers, clearly identified in the table of contents. All line diagrams and drawings are to be included in binders in secure drawing pockets.
- B. (5) copies of studies shall be submitted to the WVU Project Manager.
- C. The study shall include each medium and low voltage distribution system.
- D. The study shall reference the industry testing standards used as a basis for the study, including the identification and a description of the standard.

#### 4.2 Content

- A. The study shall include the utility company's system and relay characteristics as they are related to the point of connection.
- B. Include calculations, impedance diagrams, conclusions and recommendations.
- C. Include a Ground Fault Study for each medium voltage switchgear, controller, low voltage switch, switchboard, MCC, distribution panel, branch circuit panel and other significant pieces of equipment.
- D. Include a One Line Diagram showing all electrical equipment and wiring included as part of the project scope. Clearly identify the schematic wiring of the electrical distribution system. Include as part of the one line diagram the following:
  - 1. Calculated fault impedance, X/R ratios and short circuit values at each 480V switch bus, busway, on each transformer at 480V and 230V power panel, short circuit value for each branch panel.
  - 2. Breaker and Fuse ratings.
  - 3. Transformer KVA and voltage ratings, percent impedance, X/R ratios and wiring connections.
  - 4. Identify each bus and include voltage.
  - 5. Conduit material, feeder sizes, lengths and X/R ratios.

END OF SECTION 260505