

## CHAPTER 1

# ELECTRICAL POWER SYSTEM OVERCURRENTS

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### 1-1. Purpose

This manual establishes the criteria for design, coordination, and construction of power systems for military projects. A secondary purpose is to acquaint designers with the general applications, philosophies, and purposes for the selection, calibration, setting, and testing of protective devices.

### 1-2. Scope

This manual describes protection techniques for electrical power supply and distribution systems. Guidance is included for coordination techniques and selection of protective devices.

### 1-3. References

Appendix A contains a list of references used in this document.

### 1-4. Electrical power systems

Electric power systems consist of four major categories: generating stations, transmission lines, distribution lines, and utilization systems. The electric power system industry converts and transports energy for utilization by numerous industrial, commercial, and residential customers. One of the largest users of electric energy in the United States is the U.S. Government.

*a. Generation.* The majority of electrical power produced in the United States is generated by steam-turbine plants. Hydro-electric generation accounts for only a small percentage because most available water sources have already been placed into service. Gas-turbines are used primarily for peaking during short periods of high demand. Fuel for steam-turbine plants is, for the most part, coal or nuclear.

*b. Transmission lines.* The voltage rating of large generators employed at primary generating stations ranges from 13.8kV to 24kV. Generator voltage is stepped up to transmission voltage level using transformers. Transmission voltage levels in the United States range from 115kV to 765kV. Standard voltages are 115kV, 138kV, 230kV, 345kV, 500kV, and 765kV.

*c. Distribution lines.* Transmission line voltage is stepped down to lower levels at main substations. These lower voltage levels range from about

34.5kV to 138kV. Distribution substations further step the voltage down to distribution voltage level which is in the range of 5kV to 34.5kV. Popular standard voltages at the distribution level are 4.16kV, 12.47kV, 13.2kV, 13.8kV, and 34.5kV.

*d. Utilization.* Distribution transformers are used to step the distribution voltage down to utilization levels, usually at 600V. Standard utilization voltages include 480Y/277V, 460V, 208Y/120V, 240V, and 120V. Higher-level voltages, such as 6.9kV and 4.16kV, are popular standard voltages for supplying large industrial motor loads.

### 1-5. Design procedures

Utility features should be designed concurrently with the planning of the new installation. The selection and design of the power supply and distribution systems will depend on the availability, capacity, and reliability of the existing and new systems.

*a. Mission.* The plant and its mission must be given priority in establishing coordination requirements, and in selecting features such as dual feeders, or back-up power generation. Where several designs are feasible, the selection will be based on an economic study.

*b. New installations.* Assistance from local electric utility companies and cooperatives may be sought during preliminary design, but no commitment should be made to obligate the Government to procure electrical power or engage in contract negotiations. Contact with the local supplier should be limited to obtaining information on sources of electricity, their connection point location in regard to the site, conditions of service, utility capacity, and protective device ratings and settings. The electric supply and distribution systems should conform to prevailing practices of the utility service area insofar as they do not conflict with criteria in this manual.

*c. Existing installations.* Coordinate planning with the Directorate of Engineering and Housing, Base Civil Engineer, or official in charge to ensure that enough power will be available and that the design is compatible with the master plan for the installation. This may require anticipating what the master plan should be.