POWER DISTRIBUTION SYSTEM DESIGN

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Goals of System Design

When considering the design of an electrical distribution system for a given customer and facility, the electrical engineer must consider alternate design approaches which best fit the following overall goals:

1. **Safety** – The number one goal is to design a power system which will not present any electrical hazard to the people who utilize the facility, who are responsible for electrical equipment maintenance and upkeep.

   The National Electric Code (N.E.C.) as well as local electrical codes provide **minimum** standards and requirements for electrical design and protection, wiring methods and materials. It is the responsibility of the design engineer to be familiar with the code requirements as well as the customer's facility, process, and operating procedures; to design a system which protects personnel.

2. **Minimum Initial Investment** – The owner's overall budget for first cost purchase and installation of the electrical distribution system and electrical utilization equipment will be a key factor in determining which of various alternate system designs are to be selected. When trying to minimize initial investment for electrical equipment, consideration should be given to the cost of installation, floor space requirements and possible extra cooling requirements as well as the initial purchase price.

3. **Reliability and Maximum Service Continuity** – The degree of service continuity and reliability needed will vary depending on the type and use of the facility as well as the loads or processes being supplied by the electrical distribution system

   Typically service continuity and reliability can be increased by:
   A) Supplying multiple utility power sources or services.
   B) Supplying multiple connection paths to the loads served.
   C) Providing alternate customer-owned power sources such as generators or batteries supplying uninterruptible power supplies.
   D) Selecting highest quality electrical equipment and conductors.
   E) Using the best installation methods.

4. **Maximum Flexibility and Expandability** – In many facilities electrical utilization loads are periodically relocated or changed requiring changes in the electrical distribution system. Consideration of the layout and design of the electrical distribution system to accommodate these changes must be included in the power system design. In addition, consideration must be given to future building expansion, and/or increased load requirements due to added utilization equipment.

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5. **Maximum Electrical Efficiency (Minimum Operating Costs)** – Electrical efficiency can generally be maximized by designing systems that minimize the losses in conductors, transformers and utilization equipment. Proper voltage level selection plays a key factor. Selecting equipment with lower operating losses, generally means higher first cost and increased floor space requirements; thus, there is a balance to be considered between the owner's utility energy change for the losses in the equipment versus the owner's first cost budget

6. **Minimum Maintenance Cost** – Usually the simpler the electrical system design and the simpler the electrical equipment, the less the associated maintenance costs and operator errors. As electrical systems and equipment become more complicated to provide greater service continuity or flexibility, the maintenance costs and chance for operator error increases. The systems should be designed with an alternate power circuit to take electrical equipment (requiring periodic maintenance) out of service without dropping essential loads.

7. **Maximum Power Quality** – The power input requirements of all utilization equipment has to be considered including the acceptable operating range of the equipment and the electrical distribution system has to be designed to meet these needs. Consideration to whether the loads are affected by harmonics (multiples of the basic 60 cycle per second sine wave) or generate harmonics must be taken into account.

The above goals are interrelated and in some ways contradictory. As more redundancy is added to the electrical system design with the best quality equipment to maximize service continuity, flexibility and expandability, and power quality, the more initial investment and maintenance are increased. Thus, the electrical engineer must weigh each factor based on the type of facility, the loads to be served, the owner's past experience and criteria.

Summary

It is expected that the engineer will never have complete information available when the system is designed. It is desirable that the engineer has as much definite information as possible concerning the function, requirements, and characteristics of the utilization devices. The engineer should know whether certain loads function separately or together as a unit, the magnitude of the demand of the loads viewed separately and as units, the rated voltage and frequency of the devices, their physical location with respect to each other and with respect to the source and the probability and possibility of the relocation of load devices and addition of loads in the future.

Often the key to the success of a power system design starts with a thorough understanding of the owner's needs. The owner will inherit the facility with the designed and installed power system. This understanding typically comes best from discussions with the owner and informing them of the different power distribution system arrangements and how each fit the facility budget, use and maintenance requirements.

Coupled with this information and a knowledge of the major types of electric power distribution systems equips the engineers to arrive at the best system design for the particular building.