mal operating conditions The amount of depreciation depends upon (*a*) the decrease of light output of the lamps with age, (*b*) the design of the luminaires with reference to the rate at which dirt accumulates, and (*c*) the severity of dirt conditions in the area If maintenance is not well performed or is performed infrequently, the light at the working surfaces is likely to be below 50 percent of the initial value Because it is essential to the efficient operation of an industrial lighting system, frequent maintenance is more economical than allowing the lighting system to operate at low efficiency

#### Electrical distribution systems

Efficient utilization of lighting equipment depends on the distribution system that carries the necessary electrical energy The term "distribution system" includes the methods and materials used for getting the energy from the main supply source in any given building or area to the light source that converts the electrical energy to light In many cases this includes distribution transformers, feeders, panelboards, overcurrent protection and branch circuits In "total energy" systems, it includes generation of the power itself

In most communities, installations of electrical distribution systems within a building or plant are governed by electrical installation codes that are given the force of law by local or state ordinances While not uniform everywhere, these codes have much in common since they are usually based on the *National Electrical Code* (NEC), a standard compiled by the National Fire Protection Association and approved by the American National Standards Institute as Standard C1 (Construction and alteration of power supply transmission and distribution lines and equipment is covered in subpart V of OSHA Safety and Health Regulations for Construction, Part 1926 )

The essential function of the code is to provide reasonable safety to persons and property The NEC covers the general lighting loads by broad occupancies, it does not give a breakdown for specific uses of space The NEC requirements should be considered as minimum safety requirements, not as design criteria

The system should be designed to provide economical distribution of electrical energy Every conductor of electricity resists the free flow of energy, thus causing energy losses Large conductor sizes are the best protection against losses, therefore a careful balance between energy loss and installation cost must be considered Satisfactory voltage conditions must be maintained, since all electrical devices are designed for specific operating voltages Failure to supply the specified voltage may seriously affect the efficient performance of the lighting system Both resistance and reactance cause a reduction of the voltage delivered to any utilization point and must be considered in computing voltage drop NEC recommends a maximum of one percent voltage drop in feeders and two percent voltage drop in branch circuits

Distribution systems should be of sufficient capacity to take care of reasonable and anticipated increases in future loads Local codes and ordinances, in general, consider wiring only from a safety standpoint, with no thought for adequacy of lighting

The electrical engineer is best qualified to handle details of electrical distribution system design and should be consulted to make sure the system meets both capacity and safety requirements

#### Light sources

Light sources having widespread application in industry may be classified under the general headings of incandescent, fluorescent, and mercury lamps These groups of lamps differ considerably in physical dimensions, electrical characteristics, and operating performance Some have certain applications for which they are better suited than any other type, however, in many cases two or more sources are qualified to fulfill a particular lighting requirement

**Incandescent lamps.** An incandescent lamp produces light when a wire or filament is heated to incandescence by the flow of electric current Initial efficacy of typical incandescent lamps (for sizes 25 to 1000 watts) ranges from approximately 10 to 23 lumens per watt, depending on size and design Incandescent lamps for industry are commonly designed for approximately 1000 hours of life Longer-life lamps are available in some cases, but only