pipelines, overhead conveyors, other parts of the structure, and other installations is disclosed in studying the models A vertical distance of at least 7 ft generally is specified between passageways and stairways and overhead structures to provide ample clearance Overhead cranes and conveyors require at least 24 in of vertical and horizontal clearance

Trucks and other vehicles require enough room for movement without endangering men and equipment and need space to back and turn near machines Aisles should be wide enough to permit trucks to pass without colliding For one-way traffic, aisles should be not less than 3 ft wider than the widest vehicles Aisles for two-way traffic should be not less than 3 ft wider than twice the width of the widest vehicle These minimum widths are exceeded considerably in some new buildings where, because of anticipated heavy traffic, aisles from 12 to 20 ft wide have been specified

Safe layout of aisles requires that there be no blind corners and that adequate radius be provided to allow for vehicle turns A 6-ft radius is large enough for small industrial trucks

Aisles should be clearly defined with approved markings of either traffic paint or striping material Follow American National Standard Z53 1, *Safety Color Code for Marking Physical Hazards* See the recommendations on pages 385–386 Plastic buttons that are glued or fastened with metal fasteners to the floor are used by many because of their durability

Parking areas for both hand and power trucks should be designated Large plants often provide garages with room for both storage and maintenance See Chapter 27, "Powered Industrial Trucks," in this Manual

If building plans include ramps for use by both pedestrians and trucks, a 3-ft wide section should be reserved as a walkway Sharp turns into aisles at the top and bottom of ramps are hazardous and should be avoided Provide an abrasive coating where slippery floor conditions may exist

Electrical equipment

Complete metal-enclosed unit substations have been developed for industrial plants and are grounded Such rooms, however, are not proof against the hazards of oil-filled transformers This equipment may give off flammable gases under certain conditions, which may form an explosive mixture with the atmosphere in the room Nonflammable transformers should be installed in confined areas and near flammable materials

Short circuit protective devices should be large enough to carry the load and should be rated to open without any danger from the maximum short circuit current Circuit breakers, fuses, and safety switches that fail under short circuit current may explode and cause serious damage and injuries

The potential of every grounding system should be measured with a meter to determine whether or not the system is capable of conducting the necessary amount of return

When direct current voltage is supplied from batteries, isolate the battery room from the work area Battery room should be well ventilated, no smoking should be permitted.

In an up-to-date industrial electrical system, sections may be de-energized for maintenance and other work without shutting down the entire system In addition, all electrical installations should conform to the NFPA *National Electrical Code* as well as local ordinances Also see Chapter 41, "Electrical Hazards," in this Manual

Major switching apparatus should have metal enclosures connected to the grounding system, and cable circuits likewise should be enclosed in rigid conduit or interlocked armor cable Metal-enclosed plug-in bus-ways should provide an easy method of connecting and disconnecting machine tools

Ungrounded portable electric tools and equipment constitute a common source of fatalities in industry The hazard can be largely eliminated if plans include a three-wire system, of which one is a ground wire, and if the equipment is provided with three-conductor cables

(For additional information, see Chapter 41, "Electrical Hazards.")

Ventilating, heating, and air conditioning

Ventilating, heating, and air conditioning are needed both for personal comfort and very often to meet process conditions Personal comfort is very important because it affects