

NFPA
803

FIRE PROTECTION FOR NUCLEAR POWER PLANTS 1978



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NATIONAL FIRE PROTECTION ASSOCIATION

470 Atlantic Avenue, Boston, MA 02210

3M-7-78-FP
Printed in U.S.A.

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Standard for
Fire Protection for Nuclear Power Plants

NFPA 803 — 1978

1978 Edition of NFPA 803

This document was prepared by the Committee on Atomic Energy and this present edition was adopted by the Association on May 18, 1978 at its Annual Meeting in Anaheim, California. It was released by the Standards Council for publication on June 6, 1978.

Origin and Development of NFPA 803

The Committee on Atomic Energy was organized in 1953 for the purpose of providing guidance on practices necessary for fire safety in facilities handling radioactive materials. A Recommended Fire Protection Practice for Nuclear Reactors, NFPA 802, was developed and officially adopted in 1960. Following a serious fire in 1975 at the Brown's Ferry Plant of the TVA, the Nuclear Regulatory Commission expressed the need for a fire protection standard specifically covering nuclear power plants. The Committee started work on the preparation of this document early in 1976, and this standard is the result of their efforts.

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Standard for
Fire Protection for Nuclear Power Plants

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NOTICE

An asterisk (*) preceding the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

For information on referenced publications see Appendix C.

Chapter 1 Introduction

1-1 Scope. This standard covers the protection of nuclear power plants from the consequences of fire, including safety to life of on-site personnel, protection of property, and continuity of production. Nuclear safety is provided for in other documents such as NRC regulatory guides or position papers or pending ANSI standards.

1-2 Purpose. This standard is prepared for the use and guidance of those charged with the design, construction, operation, and protection of nuclear power plants. This standard covers those requirements essential to assure that the consequences of fire will have minimum impact on the safety of construction and operating personnel, the physical integrity of plant components, and the continuity of plant operations. Additional emphasis is on requirements dictated by the need to protect the lives of constructors and operators from the consequences of fire and to conform to best fire protection engineering practice.

1-3 Definitions.

Class A Interior Finishes means any material classified with a flame spread rating 0-25 (see *NFPA 101, Life Safety Code, Section 6-2*.)

Combustible means any material which, in the form in which it is used and under the conditions anticipated, will ignite and burn.

Combustible Liquid means a liquid having a flash point at or above 100°F (37.8°C). (See NFPA 30.)

Fire Area means that portion of a building or plant that is separated from other areas by fire barriers.

Fire Barrier means those components of construction (walls, floors or floor/ceiling assemblies and their supports, including beams, joists, columns, penetration seals or closures, fire doors, and fire dampers) that are rated by approval laboratories in hours of resistance to fire and are used to prevent the spread of fire.

Fire Door means a door assembly rated in accordance with NFPA 252, *Standard Method of Fire Test of Door Assemblies* and installed in accordance with NFPA 80, *Fire Doors and Windows*.

Fire Loading means the amount of combustibles present in a given situation, expressed in Btu's per square foot.

Fire Prevention means measures directed towards avoiding the inception of fire.

Fire Protection means methods of providing for fire control or fire extinguishment.

Fire Protection Manager means the person directly responsible for fire prevention and fire protection at the plant.

Fire Rated Penetration means an opening in a fire barrier for the passage of pipe, cable, duct, etc., which has been sealed so as not to reduce the integrity of the fire barrier.

Fire Resistance Rating means the time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

Fire Zone means subdivisions of fire areas in which fire detection and/or suppression systems provide alarm information indicating the location of fire at a central fire control center.

Flame Spread Rating is a relative measurement of the surface burning characteristic of building materials when tested in accordance with NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials*.

Flammable Liquid means any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi (276 kPa) absolute pressure at 100°F (37.8°C).

Limited Combustible means a building construction material which, in the form in which it is used, has a potential heat value not exceeding 3500 Btu per pound (8141 kJ/kg), and either has a structural base of noncombustible material with a surfacing not exceeding a thickness of $\frac{1}{8}$ inch (3.2 mm) which has a flame spread rating not greater than 50, or other material having neither a flame spread rating greater than 25 nor evidence of continued progressive combustion, even on surfaces exposed by cutting through the material on any plane. (See *NFPA 220*.)

Noncombustible Material means a material which, in the form in which it is used and under the conditions anticipated, will not ignite, support combustion, burn, or release flammable vapors when subjected to fire or heat. Materials reported as noncombustible, when tested in accordance with ASTM E136-1973, *Standard Method of Test for Noncombustibility of Elementary Materials*, shall be considered noncombustible materials.

1-4 Introduction and Special Problems Relating to the Protection of Nuclear Electric Generating Stations.

1-4.1 General Introduction. Fire protection is both an art and a science. Perfection and practice in the art is the objective, with fire prevention being the ultimate goal. Fire prevention in the absolute sense is only possible where there is no combustible material to fuel a fire. The presence of combustible material creates a fire potential, no matter how slight. Thus, fire prevention must, as a first priority, consider the presence of any combustible material as a variance.

The total elimination of combustible material is seldom possible; therefore, fire protection requires additional measures to limit the consequences of fire.

A defense-in-depth philosophy of fire prevention, control, and extinguishment shall be adopted and implemented to minimize and mitigate the effects of fire, and reduce hazards to personnel and property damage to acceptable minimums.

A well-balanced fire protection program includes prevention, detection, extinguishment of fires, safety to life, and preservation of property. The protection of the environment and of the public against nuclear hazards takes priority over that of the plant itself, and is addressed by the appropriate regulatory agencies. However, the size of nuclear power plants makes the economic impact of a forced outage such that protection measures must be extended to include provisions to assure their continued operation.

1-4.2 Special Considerations in Fire Protection Encountered at Nuclear Power Plants. Consideration of the need for nuclear safety results in several areas of fire protection emphasis unique to the nuclear electric generating station, for example:

- (a) Reactor Shutdown Systems.
- (b) Cooling System Integrity.
- (c) Filtering System Integrity.
- (d) Ventilating System Integrity.

NOTE: See Appendix B.

1-4.3 Defense-in-depth.

1-4.3.1 Nuclear power plants use the concept of defense-in-depth to achieve the high degree of safety required in the nuclear safety systems of the plant. This concept shall be extended to fire protection for the remaining areas of the plant.

1-4.3.2 With respect to the fire protection program the defense-in-depth principle is aimed at achieving an adequate balance in:

- (a) Preventing fires from starting.
- (b) Detecting fires quickly and suppressing those fires that occur, thereby limiting damage.
- (c) Designing the plant to limit the consequences of fire.

NOTE: No one of these echelons can be perfect or complete by itself. Strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others.

1-4.4 Fire Protection Management Program. The fire protection program for a nuclear power plant shall cover design features, personnel, procedures, plans and equipment. Senior management participation in this program shall begin with early design concepts and plant layout and continue through plant operation. In order to effectively develop and conduct this program, a fire protection manager shall be appointed at the conceptual stage of the project. He shall be selected on the basis of education, experience and advancement as an industrial fire protection engineer. He shall establish liaison with all internal departments, with all authorities having jurisdiction, and with the public fire department.

***1-4.5 Liquid Metal-cooled Reactors.** The evolution of the liquid metal-cooled reactor for use in nuclear power plants will require special attention because of the nature of the metal coolants involved (sodium and sodium potassium alloy). Special consideration shall be given to the storage, handling, and use of these reactive metals in the plant. In particular, special attention shall be given to the origin, characteristics, methods of detection, methods of extinguishment and control, and hazards to personnel of these reactive metal fires. In addition, special consideration shall be given to the unique problem of post-fire cleanup and disposal of these metals and their combustion and/or decomposition products.

1-5 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). One unit (litre), outside of but recognized by SI, is commonly used in international fire protection. If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

Chapter 2 Functional Subdivision of the Plant Layout

2-1 Safety to the lives of on-site personnel, protection of property, and continuity of power production as affected by the possibility of fires shall be given appropriate consideration in the general arrangement of the nuclear power plant. For the purposes of fire hazard analysis the plant component facilities shall be divided into primary facilities, secondary facilities, and support facilities as follows:

NOTE: The nuclear power plant will generally consist of the following functional facilities which would be expected to vary in their physical relationship to each other from plant to plant.

(a) Typical Primary Facilities.

Reactor Building. Houses the reactor within a containment structure and its integral or free standing shield.

Reactor Auxiliary Building. Contains reactor auxiliary and emergency core cooling system (ECCS) equipment.

Control Building. Houses the main and auxiliary control panels, emergency switchgear, and batteries.

Turbine Building. Houses the turbine generator and turbine generator auxiliaries.

Steam Generator Building (LMFBR). Houses the steam generator.

Intake Pumping Station. Houses the condenser circulating water makeup pumps, the raw service water and fire protection pumps, and all necessary valves and strainers for these systems.

Electrical Switchyard. Encompasses the electrical transmission system coming into the site and leaving the site.

Emergency Power Generation Facility. That facility designed to provide on-site emergency power in the event of an off-site power failure.

Emergency Service Water Pumping Station. Houses the emergency service water pumps, and all necessary valves, strainers, and electrical switchgear for these systems

Condenser Circulating Water Pumping Station. Houses the condenser circulating water pumps, pump isolation valves, pump suction and discharge conduits, and associated electrical equipment.

Electrical Control and Communications Building. Houses the switchyard relays, terminal communications equipment, and may act as a control center for the switchyard up until the time the main control room becomes operational.

Main Heat Rejection System. Includes cooling towers and facilities associated with spray ponds and canals.

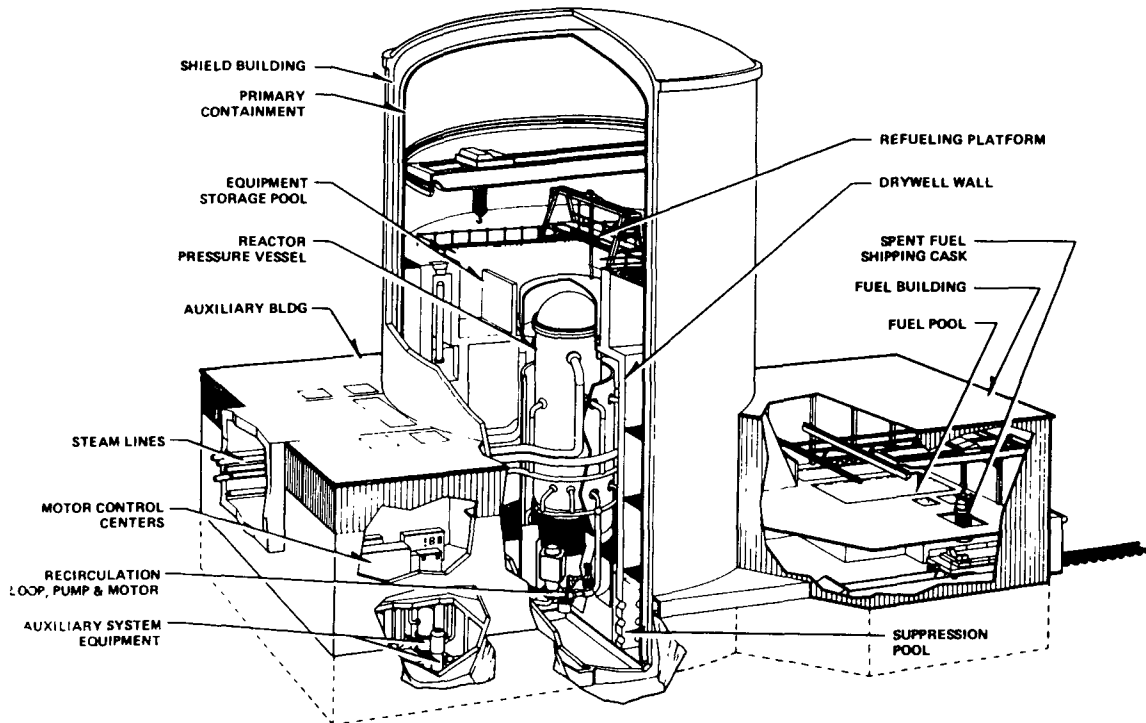
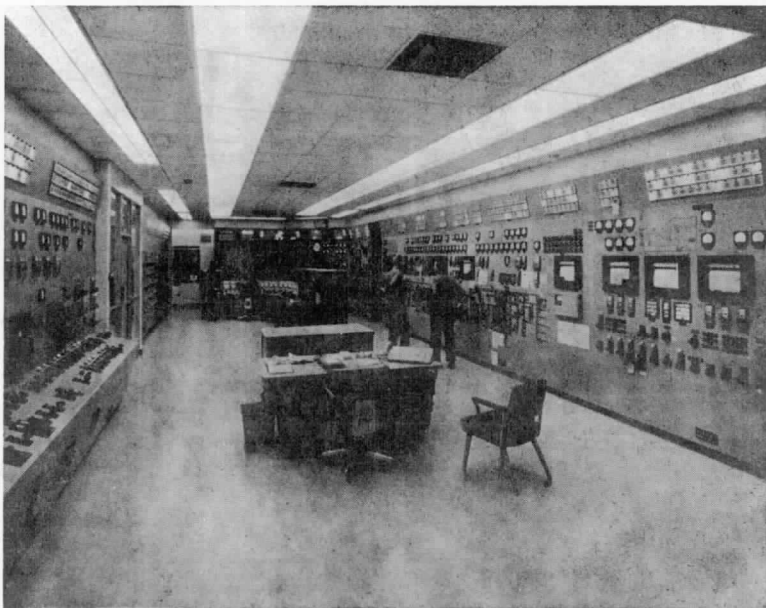


Figure 2-1(a). Mark III Reactor Building, Fuel Building, and Auxiliary Building.



(Credit: Philadelphia Electric Company)

Figure 2-1(b). Typical Control Room.

Station Transformers. Those transformers which provide auxiliary power to the plant or transmit power from the plant.

(b) Typical Secondary Facilities.

Fuel Building. Inclusion of primary equipment in this building would require upgrading of the affected portions of the building to primary facility status.

Radwaste Building. Houses the equipment for processing radioactive waste from the plant.

Makeup Water Treatment Plant. Facility for producing high purity water before use in the reactor or its support systems.

Condenser Circulating Water Treatment Building. Houses the plant and condenser circulating water biocide treatment system.

Demineralizer Regeneration Building. Contains facilities for regeneration and cleaning of resins from the plant condensate polishing system.

(c) Typical Support Facilities.

Office Building. Houses the offices for the plant's administrative employees and contains plant records.

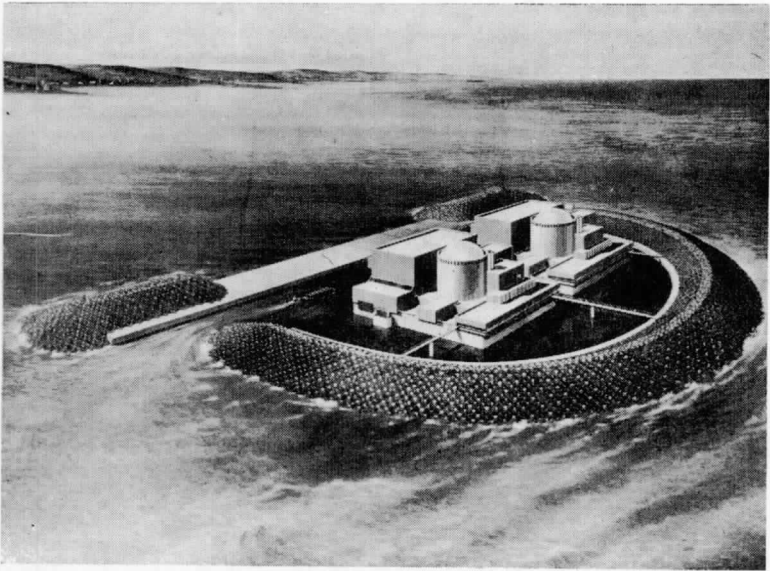


Figure 2-1(c). Offshore Power Plant. A specialized case of a twin PWR station under active development in 1978.

Service Building. Encompasses the guard house, main gate, and office space for the plant's security force.

Auxiliary Boiler Building. Contains boilers for providing heating steam and steam to operate plant auxiliary equipment during the time that the nuclear steam supply is not available.

2-2 For these three types of facilities, safety to the lives of on-site construction and operating personnel and loss of property shall be given consideration as specified in Chapter 17 and elsewhere in this standard.

2-3 For primary and secondary facilities the cost of lost revenue and replacement power in addition to property loss shall be factored into the fire hazard analysis for determining the cost/benefit ratio for selecting the appropriate fire protection systems.

***2-4** A fire hazard analysis shall be developed that will define the fire hazards that can exist and describe the loss limiting criteria to be used in the design of the facility. The fire hazard analysis shall take into consideration the basic data of the plant such as the functional subdivision of the facility, the controlled zones which have limited access, and the general plant layout of equipment or systems to develop the fire zone and the ratings of fire barriers.

Chapter 3 Inventory of Hazardous Materials

3-1 Combustible materials in both large and small concentrations will be present in nuclear power plants, as in most other industrial plants, and it shall be assumed that outbreaks of fire occur for a variety of reasons.

3-2 For the purpose of assessing the fire loading, an inventory of all flammable and combustible materials shall be made for each fire area, identifying the location, type, quantity and form of the materials. The materials shall be classified into:

(a) **Flammable and Combustible Materials.** Typical examples of flammable and combustible materials found in a nuclear power plant are:

Conventional fuels for emergency power units, auxiliary boilers, etc.

Lubricants and hydraulic oil.

Insulating materials (thermal and electrical).

Building materials (incl. PVC and other plastics).

Filtering materials (e.g., oil bath filters, charcoal, etc.).

Cleansing materials.

Paints and solvents.

Packaging materials (e.g., bitumen, etc.).

Neutron shields (if organic materials).

Clothing.

(b) **Flammable Gases.** Typical examples of flammable gases found in a nuclear power plant are:

Hydrogen for generator cooling, for coolant conditioning of gas-cooled reactors, and from battery charging.

Propane or other fuel gases.

O₂ and H₂ by radiolysis in the core and addition of H₂ for improved recombination.

Gas for cutting and welding.

(c) **Combustible Radioactive Substances.** Typical examples of radioactive substances external to the reactor are:

Sealed radioactive material, such as irradiated and/or plutonium containing fuel elements, irradiated control rods, neutron sources, etc.

Unsealed radioactive material, such as ion exchanger fillings and filter cartridges which have become loaded with radioactive substances, radwaste materials, etc.

(d) **Reactive Metals.** Typical examples of reactive materials found in an LMFBR nuclear power plant are:

Sodium.

Sodium-potassium eutectic (NaK).

3-3 While assessing the hazardous substances, ways and means of transporting the supplies of consumable goods on the site shall be considered.

3-4 Temporary but predictable and repetitive concentrations of combustible materials shall also be considered. These may include:

- (a) Replacement of lubricating or hydraulic oils.
- (b) Repainting equipment or structures.
- (c) Replacement of combustible filter materials.
- (d) Scaffolding or dunnage necessary to maintain or replace equipment.
- (e) Spare equipment in shipping crates or boxes awaiting installation.

Chapter 4 Control of Combustible Material

4-1 Combustibles, other than those which are an inherent part of operation, shall be restricted to protected compartments or spaces.

4-2 As part of the protective measures, consideration shall be given to reducing the fire loading of contents in primary or secondary facilities by reducing the amount of combustible materials, wherever possible, as indicated in the following design features:

(a) Provision of separate piping systems for the lubricating system and control system of the turbogenerators.

(b) Use of an approved low hazard synthetic hydraulic fluid in the control systems.

(c) Use of air circuit breakers, low oil content circuit breakers, or sulfur-hexafluoride circuit breakers.

(d) Use of approved noncombustible insulation materials on components.

(e) Use of air filters meeting the requirements of UL Class 1 and HEPA filters UL 586 (charcoal filters excepted).

4-2.1 Combustible liquid storage greater than 1100 gallons (4164 litres) shall be located outside of the building unless enclosed by a three-hour fire barrier (*see NFPA 30, 31, and 37*).

4-2.2 Hydrogen. The storage and use of hydrogen shall be in accordance with NFPA 50A.

4-2.3 Flammable and combustible liquid and gas piping shall be in accordance with ANSI B31.1-1973 or ANSI B31.7-1969, including Addenda a-1972, b-1971, and c-1971, as applicable.

4-2.4 Auxiliary gas or oil-fired boilers shall comply with NFPA 85, *Single Burner Boiler-Furnaces*.

Chapter 5 Construction Materials and Fire Loading on Buildings

5-1 The use of plastics such as polyurethane and polyvinyl chloride (PVC) shall be minimized and used generally at locations totally inaccessible to ignition and effects of fire exposure.

NOTE: Halogenated plastics release chlorine and hydrogen chloride gas during a fire; these gases are toxic and corrosive.

5-2 Construction materials for nuclear power plants shall be classified by at least one of the following tests:

(a) NFPA 255, *Surface Burning Characteristics of Building Materials* (UL 723 & ASTM E-84).

(b) NFPA 251, *Fire Tests of Building Construction and Materials* (ASTM E-119).

5-2.1 Certain materials of construction that do not meet the definition of noncombustible or limited combustible may have to be used in a nuclear power plant, and thus the location in the plant, the amount exposed to ignition, and the proposed fire protection system shall be justified in writing and the approval of the plant fire protection manager and the authority having jurisdiction shall be obtained.

5-3 Wall and structural components, thermal insulation materials, radiation shielding materials, and soundproofing shall be noncombustible, limited combustible or listed by a nationally recognized testing laboratory for flame spread, smoke, and fuel contribution, of 25 or less in its use configuration.

5-4 Suspended ceilings, including light diffusers, and their supports shall be of noncombustible or limited combustible construction. Electrical wiring above suspended ceilings shall be in metallic conduit or solid bottom, solid covered ferrous raceways. Otherwise concealed spaces shall be devoid of combustibles.

5-5 Roof coverings shall be Class A as determined by tests described in NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*. Metal roof deck construction shall be Class I (Factory Mutual Approved) or "fire-acceptable" (as tested by Underwriters Laboratories Inc.).

5-6 Transformers installed inside of buildings shall be either dry type or insulated and cooled with an approved liquid, unless installed in vaults in accordance with Article 450 (C) of NFPA 70-1978, *National Electrical Code*.

5-7 Combustible cooling towers shall be protected with deluge sprinkler systems in accordance with NFPA 214, *Water Cooling Towers*. Fire hydrants shall be operational at the cooling tower site prior to beginning construction activities.

NOTE: Since cooling towers can be vital to the operation of the plant and reconstruction can be lengthy, noncombustible construction should be used.

Chapter 6 General Building Arrangement

6-1 General Fire Area Requirements.

6-1.1 The nuclear power plant shall be subdivided into separate fire areas to minimize the risk of spread of fire and the resultant consequential damage from corrosive gases, fire suppression agents, smoke, and contamination from radioactive substances.

6-1.2 In multi-unit plants, each unit shall be separated from the other either by distance or fire barriers. The distance or fire barrier rating shall be determined from the fire hazard analysis. (See *NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures.*)

6-2 Specific Fire Separation Requirements.

6-2.1 An approved fire rated barrier of three-hours fire resistance, with equivalent rated automatic fire doors, and with approved penetration protection, shall be provided as follows:

(a) To separate all contiguous buildings, such as turbine, reactor containment, auxiliary fuel handling, control, radwaste, service, administration, and other areas as dictated by reactor design and fire hazard analysis.

(b) To isolate turbine generator lube oil conditioning or system room and lube oil storage tank from turbine buildings and adjacent areas.

(c) To isolate emergency diesel generator rooms or buildings (emergency power generating areas) from each other and adjacent plant areas.

(d) To separate diesel fire pumps from other pumps in the same pumphouse.

(e) To separate all areas with concentrations of cables, such as cable spreading rooms, cable tunnels, cable penetration areas, cable shafts or chases, included within the reactor containment, from adjacent areas.

(f) To isolate auxiliary boiler rooms from adjacent areas.

6-2.2 Where vertical fire barriers are required, stairwells, elevators, and trash chutes shall be enclosed in an approved fire rated enclosure of two-hour construction with approved automatic or self-closing fire doors.

6-2.3 Buildings shall be protected from exposure fires involving oil filled transformers, by locating the transformer facilities at least 50 feet (15.2 m) from other facilities or by providing a two-hour fire barrier between transformers and exposed facilities (see Fig. 6-2.3). A one-hour fire barrier or a distance of 30 feet (9.1 m) shall be provided between adjacent transformers. Means shall be provided to contain oil spills.

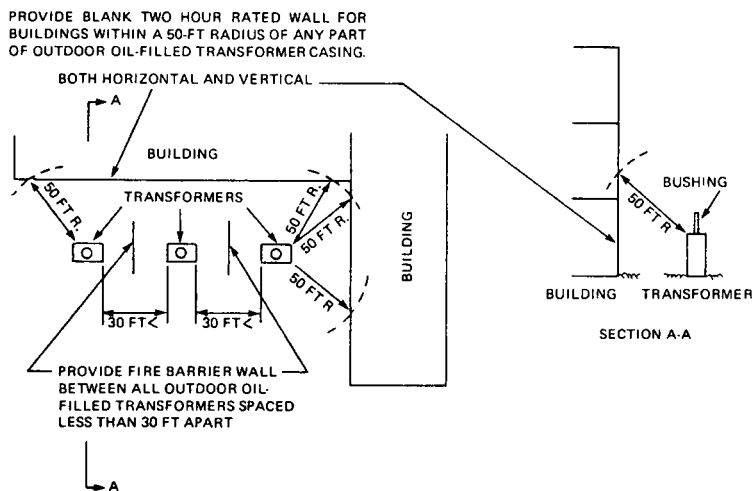


Figure 6-2.3

6-3 Protection of Openings in Fire Walls and Subdivisions.

6-3.1 Electrical and Mechanical Penetrations.

6-3.1.1 Where electrical and mechanical equipment (except for ventilation ducts) (see Chapter 7) must penetrate a fire barrier, the penetration shall be sealed (fire stopped) with a material or device having a fire resistant rating equivalent to the designated fire resistant rating of the barrier. The penetration seal (fire stop) shall be qualified in accordance with NFPA 251, *Fire Tests of Building Construction and Materials* (ASTM E-119), except as modified herein:

(a) Temperatures on the unexposed surfaces of the penetration seal (fire stop) shall be measured and reported to the authorities having jurisdiction. The temperatures on the unexposed side for the metallic parts of the penetration (e.g., cable trays, conductors, pipe, etc.) shall also be measured and reported to the authorities having jurisdiction. The results of the test shall be incorporated into the plant's fire hazard analysis (see Section 2-4).

(b) Immediately following the termination of the fire endurance test a hose stream test shall be conducted using the NFPA 251 solid-stream test or a spray-stream test conforming to the following criteria:

(1) Spray nozzle that produces a long-range, narrow-angle (not exceeding 30°) high velocity spray.

(2) Nozzle shall discharge a minimum of 75 gpm @ 75 psi at 10 feet (4.7 litres/sec @ 517 kPa at 3 m) from the test specimen.

(3) Duration of application shall be not less than 2½ minutes for every 100 square feet (9 m²) of area.

(c) The penetration seal (fire stop) shall be determined acceptable provided that:

(1) Fire does not propagate to the unexposed side of the test assembly nor shall there be any visible flaming on the unexposed side.

(2) Temperature readings on the unexposed side shall not be high enough to ignite combustible material as evaluated in the fire hazard analysis.

(3) Penetration seal does not permit projection of water from hose stream test.

NOTE: If cable chases or shafts pass through a fire area without opening into that area the fire stops may be deleted provided the construction of the shaft has the same or better fire rating than the fire area enclosure it violates.

6-4 Reliability Considerations.

6-4.1 In accordance with the scope of this standard, it shall be recognized that continuing power production consideration dictates additional fire subdivision of the plant beyond that required for nuclear safety.

NOTE 1: The subdivision into fire areas for redundant nuclear safety systems is covered by other documents. (See Appendix B.)

NOTE 2: A fire which might be capable of damaging only one division of a redundant system, and therefore be acceptable from the standpoint of nuclear safety, may not be acceptable from a standpoint of forced plant outage. Additional fire protection systems or fire barriers may be required.

6-4.2 When evaluating the length of plant outage, as a result of possible fire, consideration shall be given to the length of time required to satisfy the demands of all of the authorities having jurisdiction for examining causes of the fire, planning of the repairs and reconstruction, testing, and documentation of the adequacy of the restoration process.

6-4.3 Cable Construction.

6-4.3.1 Cable insulating materials represent a major source of fire loading throughout the plant and special consideration shall be given to their installation and protection.

6-4.3.2 As a minimum requirement, cable construction shall meet the fire and flame test requirements of IEEE No. 383. Meeting the requirements of IEEE No. 383 shall not eliminate the need for protection as specified in this standard.

Chapter 7 Heating, Ventilating and Air Conditioning

7-1 Introduction. Ventilation of a nuclear power plant involves balanced air differentials between plant areas, comfort ventilation, and heat removal from areas where heat is generated by equipment. This need also includes fire area isolation and smoke removal equipment, as well as equipment for filtering radioactive gases. The design of ventilation systems is further complicated by the seismic, tornado, and missile criteria for building penetrations.

7-2 Basic Standards. NFPA Standards 90A, 91 and 204 are the basic standards that shall be followed for the design installation and operation of the ventilation systems necessary for normal and emergency operation of the plant except as modified below.

7-3 General Requirements.

7-3.1 Smoke and Corrosive Gas Removal.

***7-3.1.1** Automatic shutdown of ventilation systems by temperature or smoke detectors as prescribed by applicable NFPA standards in the following buildings shall be consistent with nuclear safety and safety of on-site personnel:

- (a) Reactor building.
- (b) Auxiliary building.
- (c) Control building.
- (d) Turbine building.
- (e) Intake pumping station.
- (f) Emergency service water pumping station.
- (g) Condenser circulating water pumping station.
- (h) Electrical control and communications building.
- (i) Fuel building.
- (j) Emergency power generating building.

7-3.1.2 Smoke, corrosive gases and the nonradioactive substances which might be freed by the fire shall be vented from their place of origin directly to a safe location. Radioactive materials that might be released by the fire shall be confined, removed from the exhaust ventilation air stream or released under controlled conditions.

7-3.1.3 Ventilation systems designed to exhaust smoke or corrosive gases shall be evaluated to ensure that inadvertent operation or failures will not violate the controlled areas of the plant design.

7-3.1.4 Smoke ventilation shall be provided for fire areas based upon the fire hazard analysis.

NOTE 1: Separate smoke ventilation systems are preferred; however, smoke venting can be integrated into normal ventilation systems using automatic or manually positioned dampers and motor speed control.

NOTE 2: The lack of smoke and heat venting in areas of relatively high combustible loading can result in significant damage to structural components.

NOTE 3: Automatic or manual actuation of smoke and heat venting will be determined by the fire hazard analysis.

Smoke ventilation from areas that may contain radioactive substances shall not be ventilated outside the building. These smoke ventilation systems shall be connected to gas treatment systems to preclude release of radioactive substances.

7-3.1.5 The fresh-air supply intakes to all areas shall be located remotely from the exhaust air outlets and smoke vents of other fire areas to minimize the possibility of contaminating the intake air with the products of combustion.

7-3.1.6 Enclosed stairwells shall be designed to minimize smoke infiltration during a fire.

NOTE: Stairwells serve as escape routes and fire fighting access routes. A suitable method of ensuring a smoke-free stairwell is using a slight positive pressure for the stairwell ventilation system.

7-3.1.7 When natural-convection ventilation is used, a minimum ratio of vent area to floor area shall be one to 200 except in oil hazard areas where a one to 100 ratio shall be provided.

NOTE: When mechanical ventilation is used, 300 cfm (8.5 m³/min) is equal to one square foot (0.09 m²) of natural convection vent area.

7-3.1.8 To prevent corrosion which might be caused by direct release of chemicals in case of fire, the acids and alkalines used for the primary coolant treatment plant and stored in appreciable quantities on the site shall be protected so as not to increase the risk of damage in case of a fire.

7-3.1.9 The power supply and controls for mechanical ventilation systems shall be located outside the fire area served by the system or protected from fire damage.

7-3.2 Duct Systems.

7-3.2.1 Plastic ducts, including fire retardant types, shall not be used for ventilating systems.

7-3.2.2 Ventilation ducts that pass through fire areas which they do not serve shall not degrade the fire integrity of the fire rated enclosure.

NOTE: Fire dampers or fire doors compatible with the rating of the barrier may be required at the duct penetrations to the fire area (*see 7-3.2.3*).

7-3.2.3 Fire dampers equal in rating to the fire barrier shall be provided to prevent the passage of smoke, heat, or flame through ventilation ducts from one fire area to another, except in locations where shutdown of the ventilation system is not allowed.

NOTE: Two 1½ hour rated dampers are considered acceptable where a three-hour rating is required.

7-3.2.4 Fire dampers shall be equipped with thermal elements. The closure of fire dampers shall be guaranteed by mounting the damper directly into the separating wall or by protecting the duct up to the damper according to the fire resistance of the separating wall structure.

7-3.2.5 Interconnections of individual fire areas via the ventilation system shall be avoided insofar as possible. Where this is not possible, the necessary precautions shall be taken to prevent the spread of smoke and fire by such routes.

NOTE: Fire dampers in the interconnecting ventilation ducts should be provided when the ventilation system cannot be sectioned off in the normal manner (*see 7-3.2.3*).

7-3.2.6 False floors or suspended ceilings shall not be employed as common pressure equalizing chambers for redundant ventilation systems but may be used for distribution of air to the corresponding room.

***7-3.3 Filters.**

7-3.3.1 Air entry filters shall have noncombustible filter media. They shall produce a minimum amount of smoke (UL Class 1) when subjected to heat. In order to decrease the fire hazard of these filters and of oil bath type filters, only approved fire-resistive adhesives and oils with an open-cup flash point equal to or greater than 464°F (240°C) and which do not produce appreciable smoke shall be used. HEPA filters shall meet UL Standard No. 586.

7-3.3.2 Fire suppression systems shall be installed to protect filters which collect combustible material, unless the elimination of such protection is justified by the fire hazard analysis.

7-3.4 Special Equipment for Emergency Personnel.

7-3.4.1 Self-contained breathing apparatus using full-face positive-pressure masks approved by NIOSH (National Institute for Occupational Safety and Health) shall be provided for fire brigade and control room personnel.

NOTE: Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir, if practical. Service or operating life should be a minimum of one-half hour for the self-contained units. At least two extra air bottles should be located on site for each self-contained breathing unit. In addition, an on-site 6-hour supply of reserve air should be provided and arranged to permit quick and complete replenishment of exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air should be used.

Chapter 8 Fire Prevention Measures

8-1 Administrative Procedures and Controls.

NOTE: This section provides criteria for development of administrative procedures and controls necessary for the execution of the fire prevention and protection activities and practices for the operating plant. Included herein are the minimally accepted actions required of cognizant plant management to assure the performance of fire protection systems and personnel and the compliance with the fire prevention program.

8-1.1 The plant manager or his delegated fire protection manager shall be responsible for the periodic update of the fire hazard analysis.

8-1.2 The plant manager or his delegated fire protection manager shall be responsible for the following:

(a) Develop, implement, and periodically update as necessary a fire brigade plan in accordance with Chapter 14.

(b) Maintain housekeeping in such a manner so as to minimize the probability of fire causing loss of life or property damage.

(c) Develop, implement, and periodically update as necessary an emergency evacuation plan for all personnel.

(d) Develop, implement, and periodically update as necessary a welding and cutting safety procedure using NFPA 51B and NFPA 241 as guides (*see Chapter 15*).

(e) Restrict smoking and other sources of ignition to properly designated and supervised safe areas of the plant.

(f) Develop, implement, and periodically update as necessary a fire prevention surveillance plan integrated with periodic recorded rounds to all accessible unattended sections of the plant.

(g) Coordinate the periodic testing of all systems and equipment affecting fire prevention and fire protection in accordance with the applicable NFPA standards and/or the manufacturers'/installers' instructions and procedures to include maintenance of appropriate documentation.

(h) Develop an alternate protection plan for those instances when it becomes necessary to remove any fire protection equipment or system from service.

(i) Fire investigation and the coordination of all plant fire reporting. Responsibilities including reviewing fire reports, taking corrective action, and making the proper distribution of the reports.

(j) Conduct periodic inspections of the plant. A prepared checklist shall be used for the inspection. The areas of primary containment and high radiation areas normally inaccessible during plant operation shall be inspected as plant conditions permit but at least during each refueling outage. The results of each inspection shall be documented and retained for a period of two years.

8-1.3 Plant administrative procedures shall specify appropriate requirements governing the storage, use, and handling of flammable liquids and gases.

8-1.4 Plant administrative procedures shall specify appropriate requirements governing the control of electrical appliances, i.e., portable electrical heaters in critical areas.

8-1.5 The reduction and control of temporary fire loads in the plant is essential to provide defense-in-depth protection. As a minimum, plant administrative procedures shall require that the total fire loads, including temporary and permanent, will not exceed those quantities established for extinguishment by permanently installed fire protection systems and equipment except in approved controlled conditions. Under such conditions, the plant fire protection manager shall evaluate temporary fire loads using appropriate documented guidelines and shall be responsible for ensuring that applicable additional personnel and/or fire protection equipment is provided when limits are exceeded. The fire protection manager or his designated representative shall conduct weekly walk-through inspections to ensure implementation of required controls. During major maintenance operations the frequency of these walk-throughs shall be increased to daily. These inspections shall be documented and the records retained for a period of two years.

Transient fire loads, when allowed, shall be controlled and shall require the implementation of additional protective measures such as supplemental portable fire equipment, fire retardant impregnation and fire watches, depending upon the types and quantities of the transient combustibles and the potential fire exposure they present to the plant. When the work is completed, the plant fire protection manager shall have the area inspected to confirm that the transient fire loads have been removed from the area. Extra equipment shall then be returned to its proper location. The results of this inspection shall be documented and retained for a period of two years.

8-1.6 Plant administrative procedures shall specify that all wood routinely used in the plant shall be approved pressure impregnated fire retardant type prior to being introduced into the plant.

8-1.7 Plant administrative procedures shall require an inplant review and prior approval of all work plans to assess potential fire hazard situations to critical areas. Where such conditions are determined to exist special precautions shall be taken to define appropriate conditions under which the work is authorized.

8-2 Prevention Measures for Buildings. The plant shall be equipped with an approved lightning protection system. (*See NFPA 78.*)

8-3 Prevention Measures for Plant Equipment.

8-3.1 The ignition of leaked or spilled oil shall be minimized by:

(a) Keeping the oil from contact with hot parts of the steam systems (wall temperature \geq ignition temperature), such as steam pipes and ducts, entry valve, turbine casing, reheater, and by-pass valve.

NOTE: Oil pipes should be located below steam lines.

(b) Using suitable electrical equipment.

(c) Sealing the insulation of hot plant components to prevent oil saturation.

(d) Use of concentric piping.

8-3.2 The ignition of gas shall be minimized by:

(a) Providing electrical installations suitable for hazardous locations as defined in Article 500 of NFPA 70, *National Electrical Code*, in those areas where the fire hazard analysis shows these locations to exist.

8-3.3 Ignition of flammable materials in auxiliary equipment shall be minimized by:

(a) Providing approved combustion safeguards on boilers and other fossil fuel-fired equipment in accordance with NFPA 85, 85B, 85D, or 85E.

(b) Constructing and installing equipment containing flammable or combustible liquids in accordance with NFPA 30, Chapter 5.

(c) Equipping all oil-filled transformers with:

(1) High oil temperature limit switches in accordance with the manufacturer's recommendations, with an audible and visual signal or an automatic device to de-energize the transformer.

- (2) An overcurrent protection device.
- (3) A differential relay.
- (4) A gas detector and fault over-pressure relays with a warning signal and automated shut-down for equipment over 10 MW.

(d) Equipping generators with warning signals, automated shut-down, and the following protective devices:

- (1) Overvoltage or undervoltage.
- (2) Overcurrent.
- (3) Differential relays.
- (4) Reverse power relays.
- (5) Proper performance of systems providing cooling and sealing gas.

(e) Installing only air circuit breakers, low oil content circuit breakers or circuit breakers filled with sulfur hexafluoride (SF_6) or similar nonflammable fluids when located indoors.

8-4 Prevention Measures for Operation of the Plant. (*See Chapter 15.*)

Chapter 9 Fire Signaling Systems

9-1 A signaling system shall be provided and designed with the consultation of the fire protection manager and shall be based upon the fire hazard analysis. The signaling system shall be selected from and comply with the following: NFPA 71, NFPA 72A, NFPA 72B, NFPA 72C, or NFPA 72D, except as herein modified.

NOTE: Multiplex systems should be considered.

9-2 The signaling system shall provide emergency operation for fire detection, fire alarm, and water flow alarms during a single break or single ground fault of the signaling line circuit.

9-3 Fire signaling systems shall give audible and visual alarm and annunciation in the control room. Local alarms shall be provided in the affected fire zone.

9-4 Audible fire detection alarms shall be distinctive and unique. They shall not be capable of being confused with any other plant system alarms.

9-5 Fire detection, alarm, and actuation systems shall be connected to an emergency power supply.

9-6 Automatic fire detectors shall be selected, installed, and maintained in accordance with NFPA 72E, *Standard for Automatic Fire Detectors*.

9-7 Manual fire alarm boxes (pull boxes) shall be installed on the basis of need by the fire hazard analysis.

9-8 The fire control panel shall contain, as a minimum, the following readouts:

- (a) Visual alarm.
- (b) Audible alarm.
- (c) Indicators for control functions directly initiated by fire detection or protection devices.
- (d) Control instrumentation for fire suppression systems.
- (e) Uninterruptible or emergency power supply condition.
- (f) Data acquisition system for recording of signals.

9-9 Communications.

9-9.1 The plant public address system shall be available on a priority basis for fire announcements, directing plant fire brigades, and evacuation information.

9-9.2 Radio communications shall be provided to back up the public address system.

9-10 Alarm system testing shall be performed and a written report shall be submitted to the plant manager and to the plant fire protection manager. The testing requirements of NFPA 72D and 72E shall be the minimum requirements.

Chapter 10 Fire Suppression Systems

10-1 Automatic fire suppression systems shall be provided in all areas of the plant as required by the fire hazard analysis. Except as modified in this chapter, the following NFPA standards shall be used:

- NFPA 11, *Foam Extinguishing Systems*
- NFPA 11A, *High Expansion Foam Systems*
- NFPA 11B, *Synthetic Foam and Combined Agent Systems*
- NFPA 12, *Carbon Dioxide Systems*
- NFPA 12A, *Halon 1301 Systems*
- NFPA 12B, *Halon 1211 Systems*
- NFPA 13, *Installation of Sprinkler Systems*
- NFPA 15, *Water Spray Fixed Systems*
- NFPA 16, *Foam-Water Sprinkler and Spray Systems*
- NFPA 17, *Dry Chemical Systems*.

10-1.1 The extinguishing systems chosen shall be based upon the design parameters required as a result of the fire hazard analysis. When the fire hazard analysis shows that a fixed extinguishing system is needed, Table 10-1.1 shall be used in selecting the type of system or combination of systems to be installed.

10-1.2 Selection of extinguishing agent shall be based upon:

- (a) Type or class of hazard.
- (b) Effect of agent discharge on critical equipment such as thermal shock, continued operability, water damage, over-pressurization, cleanup, etc.
- (c) Health hazards.

10-1.3 A designated person(s) working in the plant shall be trained in the maintenance, inspection, operation and emergency actuation of all fixed fire suppression systems installed in the plant, whether automatic or manual.

***10-1.4** Each fire suppression system shall be equipped with approved alarm devices, annunciated locally or in the hazard area, and in the control room. Alarm circuits to the control room shall be installed and supervised in accordance with Chapter 9.

Table 10-1.1

Area or Hazard To Be Protected	Water Systems			Liquefied Compressed Gases			Foam Systems			Dry Chemical
	Automatic Sprinklers	Pre- Action Sprinklers	Deluge- Water Spray	Halon 1301	Halon 1211	Carbon Dioxide	Mech.	Foam Water Systems	High Expansion	
Auxiliary Oil or Gas Boiler Room	X	X					X (oil)	X (oil)		X
Battery Rooms	X	X		X	X	X				
Cable Penetration Rooms and Spreading Rooms	X (note 1)	X (note 1)	X (note 1)	X (note 2)	X (note 2)	X (note 2)				
Cable Tunnels, Shafts, Chases, Cable Tray Run Concentrations	X (note 1)	X (note 1)	X (note 1)	X (note 2)	X (note 2)	X (note 2)				X (multipur- pose only)
Combustible (Charcoal) Filters			X							
Computer Rooms (Includ- ing under floor space)	X	X		X		X (note 4)				
Control Room		X		X						
Diesel Fire Pump Room	X									
Diesel Generator Rooms (note 3)	X	X		X	X	X	X	X	X	X
Diesel Fuel Day Tank Rooms	X	X	X	X	X	X	X	X	X	X
Diesel Fuel Storage Tank, If Not Buried	X		X	X	X	X	X	X	X	X

Table 10-1.1 (Continued)

Area or Hazard To Be Protected	Water Systems			Liquefied Compressed Gases			Foam Systems			Dry Chemical
	Automatic Sprinklers	Pre-Action Sprinklers	Deluge-Water Spray	Halon 1301	Halon 1211	Carbon Dioxide	Mech.	Foam Water Systems	High Expansion	
Filter Rooms and Plenums	X	X	X							
Flammable Liquid Storage Areas	X		X	X	X	X	X	X	X	X
Fuel Oils Storage Tanks	X		X				X	X	X	X
Hydrogen Seal Oil Units			X							X
Instrument Rack Rooms				X	X	X				
Laboratories	X	X		X	X	X				
Oil Lines & Reservoirs at Steam Turbine Driven Equip. (if more than 50 gallons)	X	X	X	X (note 5)	X (note 5)	X (note 5)				X
Reactor Coolant/Recirculation Pumps	X	X	X			X	X	X		X
Record Storage Rooms	X	X		X (note 6)	X (note 6)	X (note 6)				
Relay Rooms/Cabinets	X	X		X	X	X				
Switchgear Rooms		X		X	X	X				

Table 10-1.1 (Continued)

Area or Hazard To Be Protected	Water Systems			Liquefied Compressed Gases			Foam Systems			Dry Chemical
	Automatic Sprinklers	Pre- Action Sprinklers	Deluge- Water Spray	Halon 1301	Halon 1211	Carbon Dioxide	Mech.	Foam Water Systems	High Expansion	
Transformer Outdoor (if combustible oil filled)			X							
Transformer Indoor (if combustible oil filled)	X	X	X	X	X	X				X
Turbine Bldg. Beneath Operating Floor Where Oil Can Spread	X	X					X	X		X
Turbine Generator Governor Housing (if combustible fluid)		X	X	X (note 5)	X (note 5)	X (note 5)				X
Turbine Generator Bearings (seals)		X	X	X (note 5)	X (note 5)	X (note 5)				X
Turbine Generator Lube Oil Conditioning or System Room	X	X	X	X	X	X	X	X	X	X
Turbine Generator Lube Oil Storage Rooms	X	X	X	X	X	X	X	X	X	X
Steam Valves (if com- bustible hydraulic fluid)			X			X				X
Staging, Storage and Warehousing Areas	X	X							X	

Table 10-1.1 (Continued)

Area or Hazard To Be Protected	Water Systems			Liquefied Compressed Gases			Foam Systems			Dry Chemical
	Automatic Sprinklers	Pre-Action Sprinklers	Deluge-Water Spray	Halon 1301	Halon 1211	Carbon Dioxide	Mech.	Foam Water Systems	High Expansion	
Truck and Railroad Bays (other areas of combustible occupancy)	X	X								
Cooling Towers (combustible)			X							

Note 1. Systems shall be designed so that water is directed into every tray. Where closed head sprinkler or thermal detection systems are used, means shall be provided for prompt actuation.

Note 2. Ceiling sprinklers may be required in addition.

Note 3. Release of extinguishing agent shall not be prevented if equipment is operating.

Note 4. Under floor only.

Note 5. Design concentrations shall be maintained during the entire coast down period.

Note 6. Combustible storage should be in metal cabinets.

***10-1.5** All shut-off valves controlling fire suppression systems (see 10-2.2) shall be supervised by one of the following methods:

- (a) Electrical supervision with an audible signal in the control room (see Chapter 9).
- (b) Locking valves open.

10-2 Automatic Sprinkler and Water Spray Systems.

10-2.1 Where water is used as an extinguishing agent, systems shall be designed, installed, and maintained in accordance with the provisions of NFPA 13 and NFPA 15.

NOTE: Hydraulically calculated systems are preferred.

10-2.2 Each system shall have an independent connection to the plant yard main and be equipped with an approved indicating type control or shut-off valve.

NOTE: Multiple sprinkler and standpipe systems may be supplied by interior headers or fire protection loops. When provided, such headers or loops are considered an extension of the yard main system and should be provided with at least two connections to the yard main. The arrangement should be supplied and valved so that no single impairment can affect sprinkler and hose protection at the same time.

10-2.3 Automatic sprinkler and water spray systems shall not be designed to protect more than one fire area.

10-2.4 Drainage of all buildings shall be assessed to assure safe run-off or retention of fire protection water and to minimize damage.

NOTE 1: Equipment vulnerable to water damage should be placed on pedestals and floor openings should be curbed or sealed.

NOTE 2: The installation of a completely, properly engineered automatic sprinkler or water spray system in a building will generally reduce the draining and retention tank requirements, as compared to a building which relies primarily on manual fire fighting.

10-3 Liquefied Compressed Gas Suppression Systems.

10-3.1 In areas where appreciable Class C hazards exist and where the use of other agents might result in equipment malfunction or damage as determined by the fire hazard analysis, liquefied com-

pressed gas extinguishing agent systems shall be installed. These systems, where required, shall be designed, installed, and maintained in accordance with the appropriate agent standard as follows:

Halon 1301 — NFPA 12A

Halon 1211 — NFPA 12B

Carbon Dioxide — NFPA 12.

10-3.2 When liquified compressed gas extinguishing agent systems are used, they shall be automatically actuated by an approved method of detection meeting the requirements of NFPA 72E. To ensure rapid detection, particular attention shall be given to the choice of actuation means, the air flows usually involved, and the heat release rates for the hazard under fire conditions.

NOTE 1: For carbon dioxide total flooding systems that are automatically actuated in normally occupied areas, a predischage alarm and time delay are required to allow for personnel evacuation of the area.

NOTE 2: Halon 1211 is not acceptable for total flooding use in normally occupied areas.

NOTE 3: Electrical equipment need not be de-energized prior to the discharge of these extinguishing agent systems, but shut-down is desirable if it can be accomplished.

10-4 Foam Systems.

10-4.1 Where fires involving flammable liquids and gases under pressure are likely, foam systems shall not be used. These systems, where required by the fire hazard analysis, shall be designed, installed, and maintained in accordance with the appropriate agent standard as follows:

Foam Extinguishing Systems — NFPA 11

High Expansion Foam Systems — NFPA 11A

Synthetic Foam and Combined Agent Systems — NFPA 11B

Foam Water Sprinkler and Spray Systems — NFPA 16.

NOTE 1: Foam systems may be used in areas where appreciable Class B hazards exist, especially where flammable liquid fuel in-depth or spills are likely.

NOTE 2: High expansion foam systems are particularly suited for total flooding applications, but should not be used in normally occupied areas.

10-4.2 Foam systems shall be designed to be automatically actuated by an approved method of detection meeting the requirements of NFPA 72E.

10-4.3 Foam systems shall not be used to protect hazards involving energized electrical equipment.

10-5 Dry Chemical Systems.

10-5.1 Where appreciable Class B hazards exist, dry chemical systems shall be considered as appropriate protection.

NOTE 1: Dry chemical systems, utilizing multipurpose dry chemical, are also effective on Class A hazards, provided that "deep-seated" fires are not likely.

NOTE 2: Dry chemical systems may be used in conjunction with AFFF in a combined agent application, where securing action is required in addition to extinguishment.

NOTE 3: Electrical equipment need not be de-energized prior to system discharge, but shut-down is desirable if it can be accomplished.

NOTE 4: Dry chemical systems are not recommended for use in hazard areas where sensitive electrical equipment is located, due to the potential for damage to the equipment from the dry chemical and its products of decomposition where moisture and high temperatures are likely.

10-5.2 Where dry chemical systems are required by the fire hazard analysis, they shall be designed, installed, and maintained in accordance with the requirements of NFPA 17.

10-5.3 Dry chemical systems shall be designed to be automatically actuated by an approved method of detection meeting the requirements of NFPA 72E.

Chapter 11 Yard Mains and Hydrants

11-1 Outdoor fire hydrants and associated equipment shall be provided on the plant site for fire suppression undertaken by the plant fire brigade in the event of a major fire.

11-2 The yard mains shall be looped and shall be of sufficient size to meet the flow requirements specified in Section 12-4.

NOTE 1: Twelve-inch diameter cement-lined pipe is recommended. (See *NFPA 24, Outside Protection.*) Main sizes should be designed to encompass any anticipated expansion.

NOTE 2: The underground main should be arranged such that any one break will not put both a fixed water extinguishing system and hose lines protecting the same area out of service.

11-3 Sufficient indicator valves shall be installed to provide adequate sectional control of the fire water supply.

11-3.1 Sectional control valves shall be supervised by one of the following methods:

- (a) Electrical supervision with signal in the control room.
- (b) Locking valves open.

11-4 A sufficient number of hydrants shall be installed to provide two streams for every part of the interior of each building not covered by standpipe protection and to provide hose stream protection for every part of each building. There shall be sufficient hydrants to concentrate the required fire flow about any important structure with no hose line exceeding 500 feet (152 m) in length. Each hydrant shall have its own gate valve.

11-5 American National Fire Hose connection screw thread shall be specified. (See *NFPA 194, Standard for Screw Threads and Gaskets for Fire Hose Connections.*)

11-5.1 Where threads of responding fire departments differ, adapters shall be provided at the hydrants.

Chapter 12 Water Supply

12-1 The water supply system for the permanent fire protection installation shall be determined by the fire hazard analysis.

12-2 A water supply shall be provided during the initial construction period as specified in Section 16-3(b).

12-3 The fire main system piping shall not serve service water system functions. The fire water loop shall meet the construction requirements of NFPA 24, *Outside Protection*.

12-4 The water supply for the permanent fire protection installation shall be based on the maximum automatic sprinkler or fixed water spray system demand, with simultaneous flow of 750 gpm at grade (2835 litres/min) for hose streams and the shortest portion of the fire loop main out of service.

12-4.1 The use of multiple approved fire pumps shall be based on supplying the demand required in Section 12-4 with the largest pump out of service, utilizing different power sources.

12-4.2 Fire pumps shall meet the requirements of NFPA 20, *Centrifugal Fire Pumps*, and shall be automatic starting.

12-5 An automatic pressure maintenance pump (jockey pump) or a head tank shall be provided to keep the fire water main pressure at approximately 10 psig (68.9 kPa) above the start pressure setting of the fire pump(s).

12-6 Pumps shall take suction from acceptable sources of water (*see NFPA 20*). If the source is from tanks, at least two tanks shall be provided and each tank shall be sized to contain a minimum 2-hour fire water flow demand. Where tanks are used, these tanks shall be automatically filled from a source capable of providing a 2-hour supply for the fire protection requirement in 8 hours. Fire water supply tanks shall comply with NFPA 22, including freeze protection requirements.

NOTE: The 8-hour requirement for refilling may be reduced or eliminated if the initial supply exceeds the 2-hour supply requirement on a volume/ratio basis.

12-7 Salt and tidal water shall not be acceptable primary natural water sources.

12-8 The following supervisory signals, where applicable, shall be received in the control room:

- (a) Pump running
- (b) Power failure
- (c) Failure to start
- (d) Water level
- (e) Pump room and tank temperatures.

Chapter 13 Portable Fire Extinguishers and Hand Hose Lines

13-1 Hand Portable and Wheeled Fire Extinguishers.

13-1.1 Hand portable and wheeled fire extinguishers shall be installed, inspected, maintained, and tested in accordance with NFPA 10, and approved or listed by a recognized testing laboratory.

13-1.2 Hand portable and wheeled fire extinguishers shall be selected for the specific class or classes of hazards using the following descriptive guide.

13-1.2.1 Class "A" Hazards. Hand portable and wheeled fire extinguishers for protecting Class "A" hazards shall be selected from the following: water types, foam, Halon 1211, or multipurpose dry chemical.

NOTE 1: Hand portable and wheeled fire extinguishers that contain water, water/antifreeze, or foam, should not be used on energized electrical equipment because a personal electrical shock hazard would be present.

NOTE 2: Multipurpose dry chemical is not recommended for installation in locations having sensitive electronic equipment, due to the potential for damage to this equipment from the dry chemical and its decomposition products.

13-1.2.2 Class "B" Hazards. Hand portable and wheeled fire extinguishers for protection of Class "B" hazards shall be selected from the following: dry chemical types, Halon 1211, foam or carbon dioxide.

NOTE 1: In addition to its extinguishing capabilities, foam can be utilized to secure a flammable liquid spill before ignition.

NOTE 2: Some of the extinguishing agents, i.e., carbon dioxide and foam, are relatively ineffective on fires involving flammable liquids under pressure.

13-1.2.3 Class "C" Hazards. Hand portable and wheeled fire extinguishers for protecting Class "C" hazards shall be selected from the following: Halon 1211, carbon dioxide, dry chemical types.

NOTE 1: Carbon dioxide units equipped with metal horns should not be used on fires in energized electrical equipment.

NOTE 2: Dry chemical is not recommended for use in an area where sensitive electrical equipment is located, due to the potential for damage to this equipment from a dry chemical and its products of decomposition.

13-1.2.4 Class "D" Hazards. Hand portable and wheeled fire extinguishers and extinguishing agents for the protection of Class "D" hazards shall be of types approved for use on the specific combustible metal hazard.

NOTE 1: Where approvals are not available for a specific combustible metal, recommendations of a manufacturer may be utilized providing proper test data or use records are available.

NOTE 2: Agent for Class "D" hazards can be applied utilizing a scoop and a container.

13-1.3 A sign shall be located adjacent to each hand portable and wheeled fire extinguisher and shall plainly indicate the type of fire for which it is intended.

13-1.4 All persons working in an area shall be thoroughly trained in the use of all types of hand portable and wheeled fire extinguishers in the area and shall be familiar with their location. This training shall include both the capabilities and limitations of each available type of extinguisher.

13-2 Hand Hose Lines.

13-2.1 Hand hose lines utilizing water, foam, carbon dioxide, or dry chemical shall be installed, inspected, and maintained in accordance with the following NFPA standards, respectively: NFPA 14, NFPA 11, NFPA 11B, NFPA 12, and NFPA 17.

13-2.2 Hand hose lines utilizing water, foam, carbon dioxide, and dry chemical shall be selected for the specific class or classes of hazards utilizing the following descriptive guide.

13-2.2.1 Class "A" Hazards. Hand hose lines for the protection of Class "A" hazards shall be selected from the following: water, foam, and dry chemical (multipurpose only). The nozzles for these hand hose lines shall be approved, electrically safe nozzles in the plant areas where Class "A" hazards involve energized electrical equipment.

13-2.2.2 Class "B" Hazards. Hand hose lines for the protection of Class "B" hazards shall be selected from among the following: water, foam, and dry chemical.

NOTE: Foam is not considered suitable alone for fires involving gases and liquefied gases nor for three-dimensional flammable liquid fires. If these hazards are encountered, hand portable, wheeled dry chemical fire extinguishers or dry chemical hand hose lines are most effective especially when used in combination.

13-2.2.3 Class "C" Hazards. Hand hose lines for the protection of Class "C" hazards shall be selected from: water, carbon dioxide, and dry chemical. Approved nozzles shall be provided for use on Class "C" hazard fires.

13-2.2.3.1 The use of hand hose lines involving water on energized electrical equipment shall take into consideration:

- (a) The voltage of the equipment.
- (b) The type of water stream used, i.e., solid vs. spray.
- (c) The effect of electrically conductive water on the operability of the equipment.
- (d) The most probable distance between the fire fighter and the energized electrical equipment.
- (e) The location of energized electrical equipment in the drainage path that is likely to be encountered when water is used.

13-2.2.3.2 Where sensitive electrical control equipment is involved, due consideration shall be given to the effects of thermal shock on the operability of this equipment when using carbon dioxide hand hose lines.

13-2.2.3.3 Carbon dioxide hand hose lines shall not be used in normally inhabited enclosures unless provisions for evacuation (alarm, annunciation, etc.) are made before use.

13-2.2.4 Class "D" Hazards. Hand hose lines involving water, foam, and carbon dioxide shall not be used for the protection of Class "D" hazards.

13-2.3 A sign shall be located adjacent to each hand hose station and shall plainly indicate the type of fire for which it is intended.

13-2.4 Designated persons working in the area shall be thoroughly trained in the inspection, location, and use of all hand hose line devices. This training shall include the capabilities and limitations for each type of hose station.

Chapter 14 Mobile Fire Fighting

14-1 Mobile fire fighting forces shall be available from:

- (a) The fire fighting squad formed from the shift personnel.
- (b) The public fire department from the nearest town.

NOTE: Due to the relatively remote location of most nuclear plants, such departments are usually a considerable distance away.

14-2 Action Plan. Detailed action plans shall be worked out by the fire protection manager for proper deployment of in-plant fire fighting personnel. The plan shall require testing to verify its practicability and completeness by means of semi-annual fire drills. Such drills shall be documented and kept on file at the plant for a minimum period of one year. The action plan shall consider the need for coordination between private and public fire fighting forces during drills and emergencies.

NOTE: Involvement of state and local agencies in semi-annual drills is encouraged.

14-3 Standard for Fire Defense Measures. All fire protection systems and devices such as automatic fixed fire extinguisher systems, automatic fire alarm and various layout arrangements, i.e., fire doors, fire dampers, ventilation arrangements, smoke venting, etc., shall be subjected to recurring and documented checks and tests. The staff shall be trained and drilled so that each person is capable of acting quickly and efficiently in the event of fire or danger of fire. A senior management representative, along with the fire protection manager, shall be responsible for ensuring that the plant fire defense is the best possible in all respects, including that all fire fighting equipment and systems are in working order. This supervisory activity shall be done by developing a plant emergency plan.

14-4 Liaison with Public Fire Authorities. Liaison between and interfacing with the fire protection manager and the public fire authorities shall be maintained. It shall be the duty of the fire protection manager, together with the plant manager and plant security manager, in consultation with the public fire department, to make plans for fire fighting and rescue, including assistance from other organizations, and to maintain these plans in a current mode. Fire fighters from the public fire department and from other fire departments, including other industrial fire brigades which may be expected to respond to a fire at the plant, shall be familiarized

with the plant layout. The access routes to fires in the controlled area (to which access doors are locked) shall be planned in detail in advance. The public fire department shall be given instructions and trained how to react in areas where radioactive materials, radiation, or hazardous materials may be present.

14-5 Regular Training and Drills. Fire brigade members shall be given regular training and practice in fire fighting and rescue routines, including radioactivity and health physics considerations, to ensure that each member is thoroughly familiar with the steps to be taken in the event of fire, which will contribute to maintaining the best possible preparedness for such contingencies. Each fire brigade member shall be capable of acting:

- (a) To alarm the plant fire brigade and public fire department.
- (b) To identify any alarm zone or fire protection system that has operated.
- (c) To use available rescue and extinguishing devices.
- (d) To actuate the fixed fire extinguishing systems, the smoke venting systems, etc.
- (e) To cooperate with and assist the public fire department in its work.
- (f) To train plant personnel in room entry procedures where total flooding fire suppression systems are used. (*See NFPA 12, NFPA 12A and NFPA 12B.*)

14-6 Equipment for the Plant Fire Brigade.

14-6.1 The conventional equipment (*see NFPA 27*) for the plant fire brigade shall be selected to suit the entire plant site. To complement the conventional equipment the following equipment shall be provided to cope with the nuclear hazard:

- (a) Protective clothing.
- (b) Respiratory protective equipment (*refer to NFPA 19B*).
- (c) Radiation monitors.
- (d) Personal dosimeters.

14-6.2 A formal program for the care and maintenance of the fire brigade equipment shall be established by the owner through the fire protection manager.

Chapter 15 Planning and Fire Protection

15-1 The owner or his delegated fire protection manager shall be responsible for the entire fire protection of the plant site from conception and throughout the operating life of the plant. Fire protection shall be accorded the same consideration as nuclear hazards.

15-2 Fire protection shall be incorporated into the design specifications for the plant.

15-3 Fire protection measures shall keep pace with the advancement of the plant construction and corresponding fire hazards.

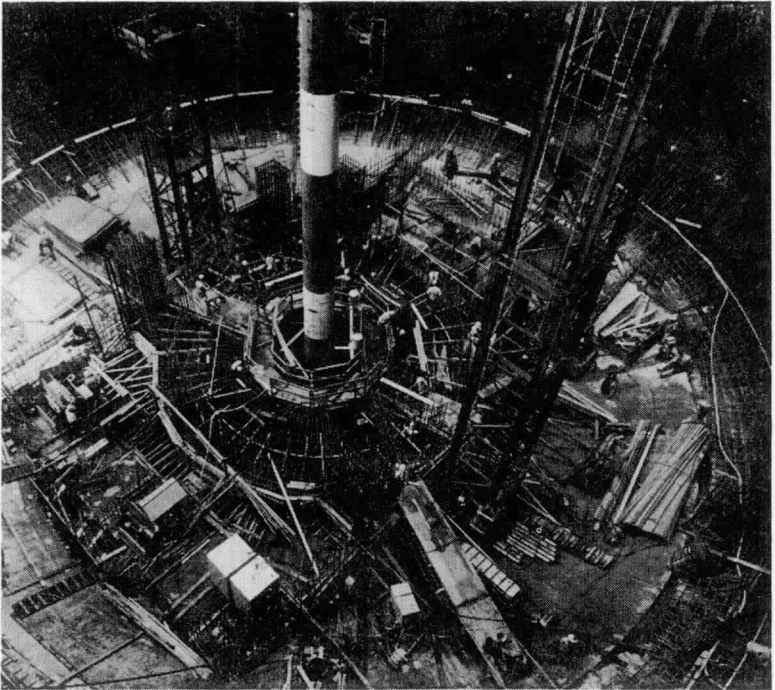
15-4 Special hazard fire protection shall be operational prior to the introduction of the hazard, such as energizing a transformer or filling oil tanks within the plant. Fire barriers and fire doors shall be given priority for construction and installation to reduce the spread of fire.

15-5 Repairs and Revision Work. Special attention shall be paid to repairs and revision work. The requirement that written permission from the fire protection manager must be obtained before embarking on cutting, welding, use of other open flames in repairing fire protection systems, and similar operations shall be adopted. (*See NFPA 51B.*)

Chapter 16 Fire Protection for the Construction Site

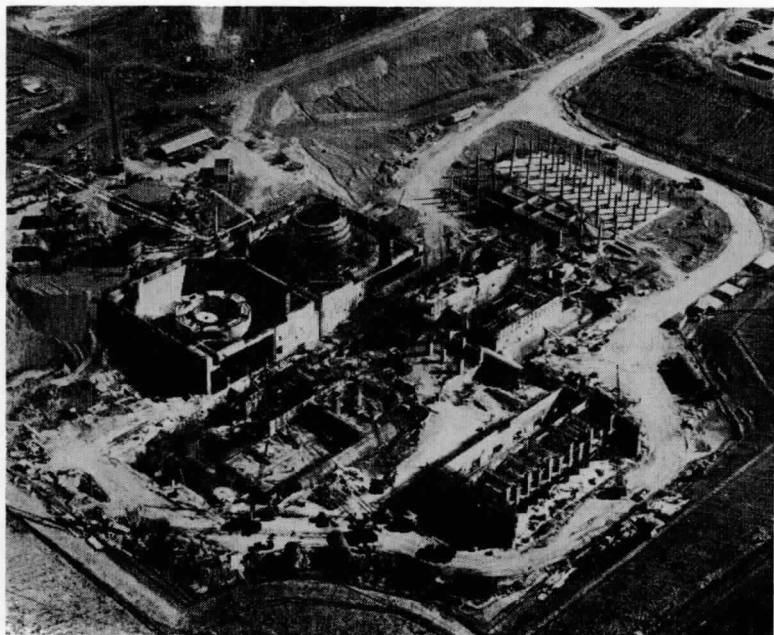
16-1 Fire at the construction site shall not threaten the safety of the operating plant.

NOTE: Under construction and prior to the receipt of nuclear fuel, a nuclear power plant does not differ in any fundamental respect from a conventional steam generating plant or any other industrial plant of similar size with respect to fire protection problems. Due to large numbers of on-site personnel, high density, and high value materials, an above-average level of fire protection on the site is justified during erection of the plant. When a nuclear power plant is constructed in the vicinity of an existing plant it is important that the exposure to the existing plant be taken into consideration.



(Credit: Hanford Engineering Development Laboratory)

Figure 16-1(a). Major test facility under construction.



(Credit: General Electric Company)

Figure 16-1(b). Major twin reactor facility under construction.

16-2 Fire Prevention. The owner or his designated fire protection manager shall be responsible for fire prevention of the entire plant site during the construction period. The duties shall be to:

(a) Develop, implement, and periodically update as necessary a fire procedure for the project and a fire brigade plan.

(b) Maintain housekeeping in such a manner so as to minimize the probability of fire causing loss of life or property damage.

(c) Provide periodic coordination with the public fire department and the plant fire brigade. (See Chapter 14.)

(d) Develop, implement, and periodically up-date as necessary an emergency evacuation plan for all personnel.

(e) Develop, implement, and periodically up-date as necessary a welding and cutting safety procedure using NFPA 51B and NFPA 241 as guides.

(f) Prohibit the use of temporary buildings (shacks or shanties) within the confines of the plant unless the construction and occupancy is noncombustible or an approved automatic extinguishing system is provided if either the construction or occupancy is combustible.

(g) Specify the use of noncombustible scaffolds, form work, decking, and partitions both inside and outside permanent buildings.

(h) Establish a hazardous material control plan prohibiting the storage of flammable liquids, Class II combustible liquids, gases, or other hazardous material in permanent buildings. These materials shall be stored in a building at least 50 feet (15.2 m) from any permanent building and stored in accordance with NFPA 30. Flammable liquids and Class II combustible liquids shall be handled in listed containers in accordance with NFPA 30.

(i) Specify the use of approved tarpaulins.

(j) Develop, implement, and periodically update as necessary a fire prevention surveillance plan to include periodic recorded rounds to all unattended sections of the plant.

(k) Coordinate the initial and periodic testing of all systems and equipment affecting fire prevention and fire protection in accordance with the applicable NFPA standards and/or the manufacturers'/installers' instructions and procedures to include maintenance of appropriate documentation.

(l) Develop an alternate protection plan for those instances when it becomes necessary to remove any fire protection equipment or system from service.

(m) Specify labeled heating devices and their fuel supply systems for use inside or within 30 feet (9.1 m) of temporary and permanent buildings.

16-3 Fire Protection. The owner or his designated fire protection manager shall be responsible for the provision of the following fire protection systems and/or equipment:

(a) *General Alarm System.* The system(s) shall be such that personnel on the site will be alerted.

(b) Minimum construction water supply shall be available on the site and capable of furnishing at least 750 gpm (2835 litres/min) plus the demand of the largest fixed water extinguishing system at a residual pressure of 75 psig (517 kPa) for minimum 2-hour duration.

(c) A temporary hydrant system with a maximum distance between any two hydrants of 250 feet (76.2 m). Hose and hydrant equipment shall be provided to assure an overlap of protection.

(d) A standpipe system in any permanent building that has as much as two-floor equivalent wall heights erected. Additional standpipe hose connections shall be added to each floor level as soon as sufficient landings are available to fight fires from that level. Protection from freezing shall be addressed.

(e) Fire extinguishers in accordance with NFPA 10.

(f) Automatic fire extinguishing system in any building or area of combustible construction or occupancy if there is a life safety hazard or large concentration of valuable equipment, the loss of which would cause an economic impact (i.e., delay in start-up dates) to the completed plant. Examples: Warehouses, offices, craft shops, etc.

16-4 Requirements for plants and areas under construction shall be determined by NFPA 241, *Safeguarding Building Construction and Demolition Operations*, and it is recognized that egress requirements may need to exceed those of completed facilities due to personnel, materials, and operations involved.