ANSI/NFPA 850 An American National Standard December 10, 1985

NFPA 850 Fire Protection for Fossil Fueled Steam Electric Generating Plants 1986

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

A statement, written or oral, that is not processed in accordance with Section 16 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Users of this document should consult applicable Federal, State and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action which is not in compliance with applicable laws and this document may not be construed as doing so.

Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Licensing Provision

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

MGR-FM-85

NFPA 850

Recommended Practice for

Fire Protection for Fossil Fueled

Steam Electric Generating Plants

1986 Edition

This first edition of NFPA 850, *Recommended Practice for Fire Protection for Fossil Fueled Steam Electric Generating Plants*, was prepared by the Technical Committee on Non-Nuclear Power Generating Plants, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1985 in Baltimore, Maryland. It was issued by the Standards Council on December 10 , 1985, with an effective date of December 30, 1985.

The 1986 edition of this recommended practice has been approved by the American National Standards Institute.

Origin and Development of NFPA 850

The Committee on Non-Nuclear Power Generating Plants was organized in 1979 to have primary responsibility for documents on fire protection for non-nuclear electric generating plants. Begun early in 1980, this is the Committee's first document.

Technical Committee on Non-Nuclear Power Generating Plants

Leonard R. Hathaway, *Chairman*
M & M Protection Consultants

C. D. Kinney, *Secretary*
Southern Co. Services Inc.

Thomas L. Allen, US Fidelity & Guaranty Co.
Rep. American Ins. Services Group Inc.
Thomas C. Clayton, Black & Veatch
J. Walter Coon, Burns & McDonnell Engineering Co.
John R. Corcoran, Niagara Mohawk Power Corp.
Donald A. Diehl, Alison Control Inc.
Paul H. Dobson, Factory Mutual Research Corp.
Kenneth W. Dungan, Professional Loss Control Inc.
Melville A. Gould Jr., Great Northern Nekoosa Corp.
George M. Hidzick, Kemper Group
Rep. Alliance of American Insurers
Deane R. Holmes, Alexander & Alexander Inc.
William P. Paulsen, Ebasco Services Inc.
G. W. Powell, Baltimore Gas & Electric Co.
George S. Rye, Honeywell Inc.
Rep. NEMA
W. D. Snell, Georgia Power
L. T. Warnick, Virginia Electric & Power Co.
George D. Weatherford, Gibbs & Hill
Walker S. Weathers, Houston Lighting & Power Co.
R. L. Weich, Cincinnati Gas & Electric Co.
Rep. Edison Electric Inst.
Jack A. Wood, Viking Corp.
Rep. Nat'l Fire Sprinkler Assn.
Myron Zajac, Industrial Risk Insurers

Alternates

James M. Connolly, M & M Protection Consultants
(Alternate to L. R. Hathaway)
Phillip A. Davis, Kemper Group
(Alternate to G. M. Hidzick)
Ralph Lischio, Grinnell Fire Prot. Systems Co. Inc.
(Alternate to J. A. Wood)
Frank E. Rademacher, Industrial Risk Insurers
(Alternate to M. Zajac)

Nonvoting

Stewart Kidd, Ministry of Works, Power & Water, Bahrain

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NFPA 850

Recommended Practice for

Fire Protection for Fossil Fueled Steam Electric Generating Plants

1986 Edition

Information on referenced publications can be found in Chapter 7.

Chapter 1 Introduction

1-1 Scope. This document provides recommendations (not requirements) for fire prevention and fire protection for gas, oil, or coal-fired steam electric generating plants.

1-2 Purpose. This document is prepared for the guidance of those charged with the design, construction, operation and protection of gas, oil, or coal-fired steam electric generating plants. This document provides fire prevention and fire protection recommendations for the safety of construction and operating personnel, the physical integrity of plant components, and the continuity of plant operations. Nothing in this document is intended to restrict new technologies or alternative arrangements.

1-3 Application.

1-3.1 The recommendations contained in this document are intended for new installations only, as the application to existing installations may not be practicable.

1-3.2 It must be recognized that rigid uniformity of generating station design and operating procedures does not exist, and that each facility will have its own special conditions which impact on the nature of the installation. Many of the specific recommendations herein may require modification after due consideration of all local factors involved.

1-4 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Combustible. Any material which does not comply with the definition of either noncombustible or limited combustible.

Combustible Liquid. A liquid having a flash point at or above 100°F (37.8°C). (*See NFPA 30, Flammable and Combustible Liquids Code.*)

Fire Barrier. A fire barrier is a continuous membrane, either vertical or horizontal, such as a wall or floor assembly, that is designed and constructed with a specified fire resistance rating to limit the spread of fire and which will also restrict the movement of smoke. Such barriers may have protected openings.

Fire Loading. The amount of combustibles present in a given area, expressed in Btu per sq ft (KJ/m^2).

Fire Prevention. Measures directed toward avoiding the inception of fire.

Fire Protection. Methods of providing for fire control or fire extinguishment.

Fire Protection Rating. The time, in minutes or hours, that materials and assemblies used as opening protection have withstood a fire exposure as established in accordance with test procedures of NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, and NFPA 257, *Standard for Fire Tests of Window Assemblies*, as applicable.

Fire Rated Penetration Seal. An opening in a fire barrier for the passage of pipe, cable, duct, etc., which has been sealed so as to maintain a barrier rating.

Fire Resistance Rating. 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.*

Flammable Liquid. Any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psia (276 kPa) absolute pressure at 100°F (37.8°C). (*See NFPA 30, Flammable and Combustible Liquids Code.*)

High Fire Point Liquid. A combustible dielectric liquid listed as having a fire point of not less than 572°F (300°C).

Interior Finish. The exposed interior surfaces of buildings including, but not limited to, fixed or movable walls and partitions, columns, and ceilings. Interior finish materials are grouped in the following classes:

Class A Interior Finish. Materials having flame spread 0-25, smoke developed 0-450 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials.* Includes any material classified at 25 or less on the flame spread test scale and 450 or less on the smoke test scale where any element thereof when so tested does not continue to propagate fire.

Class B Interior Finish. Materials having flame spread 26-75, smoke developed 0-450 when tested in accordance with NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials.* Includes any material classified at more than 25, but not more than 75 on the flame spread test scale and 450 or less on the smoke test scale.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Limited Combustible. As applied to a building construction material, a material, not complying with the definition of noncombustible material, that in the form in which it is used has a potential heat value not exceeding 3500 Btu per lb (8.14×10^6 J/kg) (*see NFPA 259, Standard Test Method for Potential Heat of Building Materials*), and complies with one of the following paragraphs (a) or (b):

(a) Materials having a structural base of noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.175 mm) that has a flame spread rating not greater than 50.

(b) Materials, in the form and thickness used, other than as described in (a), having neither a flame spread rating greater than 25 nor evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread rating greater than 25 nor evidence of continued progressive combustion as tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials.*

Materials subject to increase in combustibility or flame spread rating beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Noncombustible. A material which in the form in which it is used and under the conditions anticipated will not aid combustion or add appreciable heat to an ambient fire. Materials when tested in accordance with Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C (1382°F), ASTM E136, and conforming to the criteria contained in Section 7 of the referenced standard shall be considered as noncombustible.

Nonflammable Fluid. A nonflammable dielectric fluid that does not have a flash point and is not flammable in air.

Should. Indicates a recommendation or that which is advised but not required.

1-5 Units. Metric units in this document are in accordance with the International System of Units, which is officially abbreviated SI in all languages. For a full explanation see the Metric Practice Guide, ASTM E380; ANSI Z210.1.

Chapter 2 Administrative Controls

2-1 General.

2-1.1 This chapter provides recommended criteria for the development of administrative procedures and controls necessary for the execution of the fire prevention and fire protection activities and practices for gas, oil and coal-fired steam electric generating plants.

2-1.2 The administrative controls recommended in this chapter should be reviewed and updated periodically.

2-1.3 The intent of this chapter can be met by incorporating the features of this chapter in the plant's operating procedures or otherwise as determined by plant management.

2-2 Management Policy and Direction.

2-2.1 Corporate management should establish a policy and institute a program to promote the conservation of property and continuity of operations as well as protection of safety to life by adequate fire prevention and fire protection measures at each facility.

2-2.1.1 Proper preventative maintenance of operating equipment as well as adequate operator training are important aspects of a viable fire prevention program.

2-3 Fire Risk Evaluation.

2-3.1 A fire risk evaluation should be initiated as early in the design process as practical to assure that the fire prevention and fire protection recommendations as described in this document have been evaluated in view of

the plant-specific considerations regarding design, layout, and anticipated operating requirements. The evaluation should result in a list of recommended fire prevention features to be provided based upon acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources, and the suppression of fires.

2-4 Fire Prevention Program.

2-4.1 A written plant fire prevention program should be established and as a minimum should include the following:

(a) Firesafety information for all employees and contractors. This information should include, as a mini-

Table 2-5.2.1
Fire Equipment Inspection, Testing, and Maintenance Frequency Schedule

Item	Weekly	Monthly	Semiannual	Annual	NFPA's No.
Supervisory Alarm Circuits	X	T			71/72A-D/72H/26
Fire and Smoke Detectors		A	M/T		71/72E/72H
Manual Fire Alarms		A	M/T		71/72H
Sprinkler Water Flow Alarms		M/T			13A/71/72H
Sprinkler and Water Spray Systems	X	A	M	T (1,2)	15/13A
Foam Systems	X	A	M	T (1,2)	11/11A/16
Halogenated Agent, Chemical & CO_2 Systems	X	A	M	T (1,2)	12/12A/17/12B
Fire Pumps & Booster Pumps	T (3)	M		T (4)	20
Water Tanks & Alarms	X	A	M/T		13A/71
P.I.V.'s and O.S. & Y. Valves	X (5)	X (5)		M/T	13A/26/72H
Fire Hydrants and Associated Valves		X		M/T	13A/24/26
Fire Hose & Standpipes		X		T (6)	14/1962
Portable Fire Extinguishers & Hose Nozzles		X		M	10/1962
Fire Brigade Equipment		X (7)		T	1972
Fire Doors	X	T			80
Smoke Vents		X		M/T	204M
Emergency Lighting		X/T			70
Radio Communication Equip.		T			

Code: X = Inspection
T = Operational Test
M = Maintenance
A = Alarm Test (Transmitters)

Notes:

1. Testing of these systems should be done where possible after necessary precautions have been taken to eliminate any hazardous conditions which would result from the discharge of the extinguishing agent.
2. On systems where flow testing is not practical, a representative number of nozzles should be removed and checked for signs of blockage. In these cases the annual test will consist of a trip test of deluge/preaction valves, or valve operators as applicable.
3. This is a test to verify pump operability only.
4. Performance tests to be conducted under load to verify that the pumps meet design conditions.
5. Valves not locked to be inspected weekly. Valves locked or electrically supervised to be inspected monthly.
6. Testing of standpipes to include water flow at highest elevations.
7. Inspections and testing of emergency breathing apparatus in accordance with current OSHA/NIOSH rules and regulations.

mum, familiarization with fire prevention procedures, plant emergency alarms and procedures, and how to report a fire.

(b) Documented plant inspections including provisions for handling of remedial actions to correct conditions that increase fire hazards.

(c) A description of the general housekeeping practices and the control of transient combustibles.

(d) Control of flammable and combustible liquids and gases in accordance with appropriate NFPA standards.

(e) Control of ignition sources to include smoking, grinding, welding, and cutting. (*See NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes.*)

(f) Fire prevention surveillance. (*See NFPA 601A, Standard for Guard Operations in Fire Loss Prevention.*)

(g) Fire report, including an investigation and a statement on the corrective action to be taken (*see Appendix A*).

2-5 Testing, Inspection, and Maintenance.

2-5.1 Upon installation, all fire protection systems should be preoperationally inspected and tested in accordance with applicable NFPA standards. Where appropriate standards do not exist, inspection and test procedures outlined in the purchase and design specifications should be followed.

2-5.2 All fire protection systems and equipment should be periodically inspected, tested, and maintained.

2-5.2.1 Table 2-5.2.1 is provided for guidance.

2-5.3 Testing, inspection and maintenance should be documented with written procedures, results and follow-up actions recorded.

2-6 Impairments.

2-6.1 A written procedure should be established to address impairments to fire protection systems and other plant systems that impact the level of fire hazard (e.g., dust collection systems, HVAC systems, etc.). As a minimum this procedure should include the following:

(a) Equipment not available for service should be identified.

(b) Identify personnel to be notified (e.g., plant fire brigade chief, public fire department, etc.)

(c) Increased fire surveillance as is needed. [*See 2-4.1(g).*]

2-6.2 Impairment to fire protection systems should be as short in duration as practical. If the impairment is planned, all necessary parts and manpower should be assembled prior to removing the protection system(s) from service. When an impairment is not planned, the repair work should be expedited until the repairs are completed.

2-6.3 Once repairs are complete, tests that will ensure proper operation and restoration of full fire protection equipment capabilities should be made. Following restoration to service, the parties previously notified of the impairment should be advised.

2-7 Fire Emergency Plan.

2-7.1 A written fire emergency plan should be developed and, as a minimum, this plan should include the following:

(a) Response to fire alarms and fire systems supervisory alarms.

(b) Notification of personnel identified in the plan.

(c) Evacuation of employees, not directly involved in fire fighting activities, from the fire area.

(d) Coordination with security forces or other designated personnel to admit public fire department and control traffic and personnel.

(e) Fire extinguishment activities.

(f) Periodic drills to verify viability of the plan.

(g) Control room operator(s) activities during fire emergencies. Approved breathing apparatus should be readily available in the control room area.

2-8 Fire Brigade.

2-8.1 The size of the plant and its staff, the complexity of fire fighting problems, and the availability of a public fire department should determine the requirements for a fire brigade.

2-8.2 If a fire brigade is provided, its organization and training should be identified in written procedures.

NOTE: Recommendations contained in NFPA 27, *Recommendations for Organization, Training and Equipment of Private Fire Brigades*, and OSHA 1910.156 should be consulted for additional information.

2-8.3 The following items discuss special fire fighting conditions unique to fossil-fueled steam electric generating plants. This information might be useful in fire brigade training and fire preplanning.

(a) *Regenerative Air Heaters.* Since laboratory tests and reported incidents indicated a rapid increase in temperature to the 2800-3000°F (1573-1684°C) range in an air preheater fire, great care should be given to manual fire fighting. Large amounts of water will be needed to both cool and extinguish a preheater fire. Fire preplanning should be accomplished to ensure use of an adequate number of access doors and safe access to the doors.

(b) *Electrostatic Precipitators.* Once a fire is detected, the unit should go into emergency shutdown immediately. It should be recognized that during operation the atmosphere in the precipitator is oxygen deficient and opening doors or running system fans following a fuel trip could cause conditions to worsen (increased potential for backdraft explosion). Once the flow of air and fuel to the fire has been stopped and the electrostatic precipitator has been shut down and de-energized, the precipitator doors may be opened and water hoses employed if necessary.

(c) *Cable Trays.* Cable tray fires should be handled like any fire involving energized electrical equipment. It may not be practical or desirable to de-energize the cables involved in the fire. Water is the most effective extinguishing agent for cable insulation fires, but must be applied with an electrically safe nozzle. Some cables [polyvinyl chloride (PVC), Neoprene, or Hypalon] can produce dense smoke in a very short time. In addition,

PVC liberates hydrogen chloride (HCL) gas. Self-contained breathing apparatus should be used by personnel attempting to extinguish cable tray fires.

(d) *Hydrogen System.* Due to the wide explosive limits of hydrogen (4 percent to 75 percent volume of gas in air), under most conditions it is safer to allow a hydrogen fire to burn in a controlled manner until the gas can be shut off rather than to risk an explosion. It may be necessary to extinguish the fire in order to gain access to the shutoff valves.

(e) *Coal Storage and Handling.*

1. Once the location and extent of a fire in a coal storage pile has been determined, the coal should be dug out and the heated coal removed. Since moisture accelerates oxidation, water used for fire fighting can aggravate the situation if the seat of the fire is not reached.

2. Coal dust presents both a fire and explosion hazard. Combustible, finely divided material is easily ignited. However, there is a possibility that a deep seated hard-to-extinguish fire can occur.

(i) Clearly marked access panels in equipment should be provided for manual fire fighting.

(ii) Caution: application of an extinguishing agent that disturbs coal dust deposits could result in a dust explosion.

(f) *Coal Pulverizers (see NFPA 85E, Standard for Prevention of Furnace Explosions in Pulverized Coal-Fired Multiple Burner Boiler-Furnaces, and NFPA 85F, Standard for the Installation and Operation of Pulverized Fuel Systems).*

Chapter 3 General Plant Design

3-1 Plant Arrangement.

3-1.1 Fire Area Determination.

3-1.1.1 The electric generating plant should be subdivided into separate fire areas as determined by the fire risk evaluation for the purpose of limiting the spread of fire, protecting personnel, and limiting the resultant consequential damage to the plant. Fire areas should be separated from each other by approved fire barriers, spatial separation, or other approved means.

3-1.1.2 Determination of fire area boundaries should be based on consideration of the following: types, quantity, density, and locations of combustible material; location and configuration of plant equipment; consequence of losing plant equipment; and location of fire detection and suppression systems. It is recommended that most fire barriers separating fire areas be of two hours fire resistance rating. If a fire area is defined as a detached structure, it should be separated from other structures by an appropriate distance (e.g., 30 ft (9.1 m) minimum for a structure with moderate combustible loading and with a non-fire rated enclosure). Unless consideration of the above factors indicates otherwise, it is recommended that fire area boundaries be provided as follows:

(a) To separate cable spreading room(s) and cable tunnel(s) from adjacent areas.

(b) To separate the control room, computer room, or combined control/computer room from adjacent areas. Where the control room and computer room are separated by a common wall, the wall need not have a fire resistance rating.

(c) To separate rooms with major concentrations of electrical equipment, such as switchgear room and relay room, from adjacent areas.

(d) To separate battery rooms from adjacent areas.

(e) To separate maintenance shop(s) from adjacent areas.

(f) To separate main fire pump(s) from reserve fire pump(s), when these pumps provide the only source of fire protection water.

(g) To separate fire pumps from adjacent areas.

(h) To separate warehouses from adjacent areas.

(i) To separate emergency diesel generators from each other and from adjacent areas.

(j) To separate fossil fuel-fired auxiliary boiler(s) from adjacent areas.

(k) To separate fuel oil pumping and/or fuel oil heating facilities used for continuous firing of the boiler from adjacent areas.

(l) To separate storage areas for flammable and combustible liquid tanks and containers from adjacent areas.

(m) To separate office buildings from adjacent areas.

3-1.2 Hydrogen Storage.

3-1.2.1 Hydrogen storage facilities should be separated from adjacent areas. (*See NFPA 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites, and NFPA 50B, Standard for Liquid Hydrogen Systems at Consumer Sites.*)

3-1.3 Outdoor Oil-Insulated Transformers.

3-1.3.1 Outdoor oil-insulated transformers should be separated from adjacent structures and from each other by firewalls, spatial separation, or other approved means, for the purpose of limiting the damage and potential spread of fire from a transformer failure.

3-1.3.2 Determination of the type of physical separation should be based on consideration of the following: type and quantity of oil in the transformer, size of a postulated oil spill (surface area and depth), type of construction of adjacent structures, power rating of the transformer, fire suppression systems provided, and type of electrical protective relaying provided.

3-1.3.3 Unless consideration of the factors in 3-1.3.2 indicates otherwise, it is recommended that any oil insulated transformer containing 500 gal (1893 l) of oil or more be separated from adjacent noncombustible or limited combustible structures by a 2-hr rated firewall, or by spatial separation in accordance with Table 3-1.3.3. Where a firewall is provided between structures and a transformer, it should extend vertically and horizontally as indicated in Figure 3-1.3.3.

NOTE 1: As a minimum, the firewall should extend at least 1 ft (0.31 m) above the top of the transformer casing and oil conservator tank and at least 2 ft (0.61 m) beyond the width of the transformer and cooling radiators.

NOTE 2: If columns for the turbine building roof are protected, line-of-sight protection (*see Figure 3-1.3.3*) of the firewall does not need to extend above the operating floor of the turbine building.

Table 3-1.3.3
Outdoor Oil Insulated Transformer Separation Criteria

Transformer Oil Capacity	Minimum (Line-of-Sight) Separation Without Firewall
Less than 500 gal (1893 L)	See 3-1.3.2
500 to 5,000 gal (1893-18,925 L)	25 ft (7.6 m)
over 5,000 gal (18,925 L)	50 ft (15 m)

3-1.3.4 Unless consideration of the factors in 3-1.3.2 indicates otherwise, it is recommended that adjacent oil insulated transformers containing 500 gal (1893 L) or more of oil, be separated from each other by a 2-hr rated firewall, or by spatial separation in accordance with Table 3-1.3.3. Where a firewall is provided between transformers, it should extend at least 1 ft (0.31 m) above the top of the transformer casing and oil conservator tank and at least 2 ft (0.61 m) beyond the width of the transformer and cooling radiators.

3-1.3.5 Where a firewall is provided, it should be designed to withstand the effects of exploding transformer bushings or lightning arrestors.

NOTE: A higher noncombustible shield may be provided to protect against the effects of an exploding transformer bushing.

3-1.3.6 Where a firewall is not provided, the edge of the postulated oil spill (i.e. containment basin, if provided) should be separated by a minimum of 5 ft (1.5 m) from the exposed structure to prevent direct flame impingement on the structure.

3-1.3.7 Outdoor transformers insulated with a high fire point liquid should be separated from each other and from adjacent structures which are critical to power generation by firewalls or spatial separation based on consideration of the factors in 3-1.3.2 and 3-1.3.5.

3-1.4 Indoor transformers.

3-1.4.1 Oil-insulated transformers of greater than 100 gal (379 L) oil capacity installed indoors should be separated from adjacent areas by fire barriers of three hours fire resistance rating.

NOTE: Where multiple transformers of less than 100 gal (379 L) capacity each are located within close proximity, additional fire protection may be required based on the fire risk evaluation.

3-1.4.2 Transformers having a rating greater than 35 KV, insulated with a high fire point liquid or nonflammable fluid, and installed indoors should be separated from adjacent areas by fire barriers of three hours fire resistance rating.

3-1.4.3 Where transformers are protected by an automatic fire suppression system, the fire barrier fire resistance rating may be reduced to one hour.

3-1.5 Openings in Fire Barriers.

3-1.5.1 All openings in fire barriers should be provided with fire door assemblies, fire dampers, penetration seals (fire stops), or other approved means having a fire protection rating consistent with the designated fire resistance rating of the barrier. Windows in fire barriers (e.g., control rooms or computer rooms) should be provided with a fire shutter or automatic water curtain. Penetration seals provided for electrical and piping openings should be listed or should meet the requirements for a "T" rating when tested in accordance with ASTM E814, *Fire Tests of Through-Penetration Fire Stops*. Other test methods for qualifications of penetration seals, such as IEEE 634, *Testing of Fire Rated Penetration Seals*, may be considered for this application.

NOTE: Listed penetration seals for large diameter piping or isophase buswork may not be commercially available.

3-1.5.2 Fire door assemblies, fire dampers, and fire shutters used in two hour rated fire barriers should be rated not less than 1½ hrs (*see NFPA 80, Standard for Fire Doors and Windows*).

3-1.5.3 Fire dampers may be omitted in fire barriers of one hour or less fire resistance rating (*see NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems*).

3-2 Life Safety.

3-2.1 For Life Safety for fossil fueled steam electric generating plants see NFPA *101®*, *Life Safety Code®*.

3-2.2 Structures should be classified as follows, as defined in NFPA *101*:

(a) General areas should be considered as a special purpose industrial occupancy.

NOTE: It is generally recognized that boiler and turbine buildings meet the intent of NFPA *101*, *Life Safety Code*, for additional travel distances.

(b) Open structures and underground structures (e.g., tunnels) should be considered as occupancies in unusual stuctures.

(c) General office structures should be considered as a business occupancy.

(d) Warehouses should be considered as a storage occupancy.

(e) Coal preparation buildings (e.g., enclosed crusher houses) should be considered high hazard occupancies.

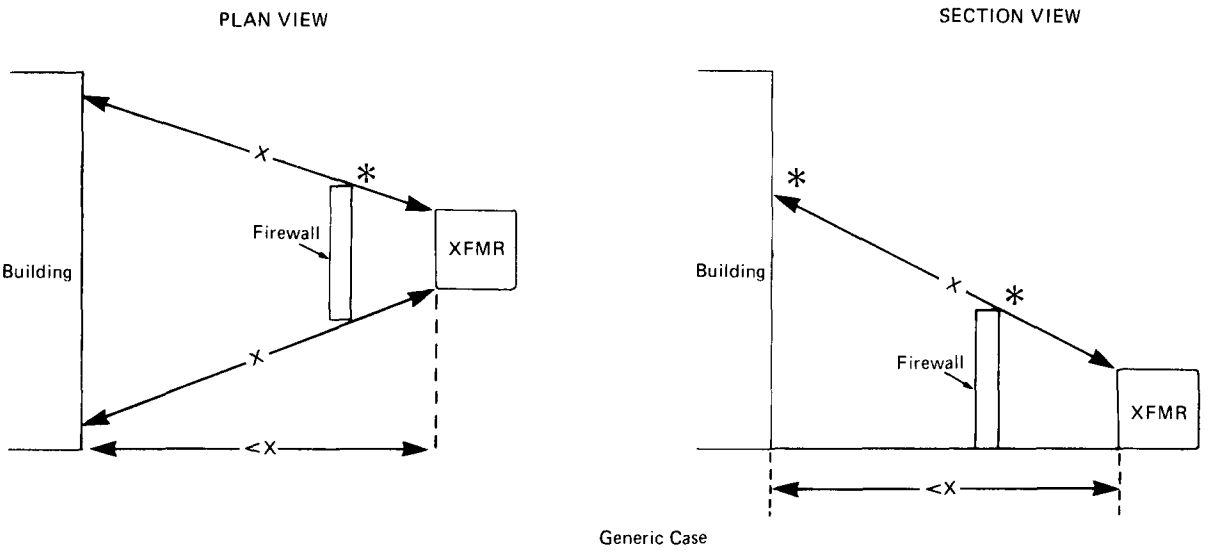
3-3 Building Construction Materials.

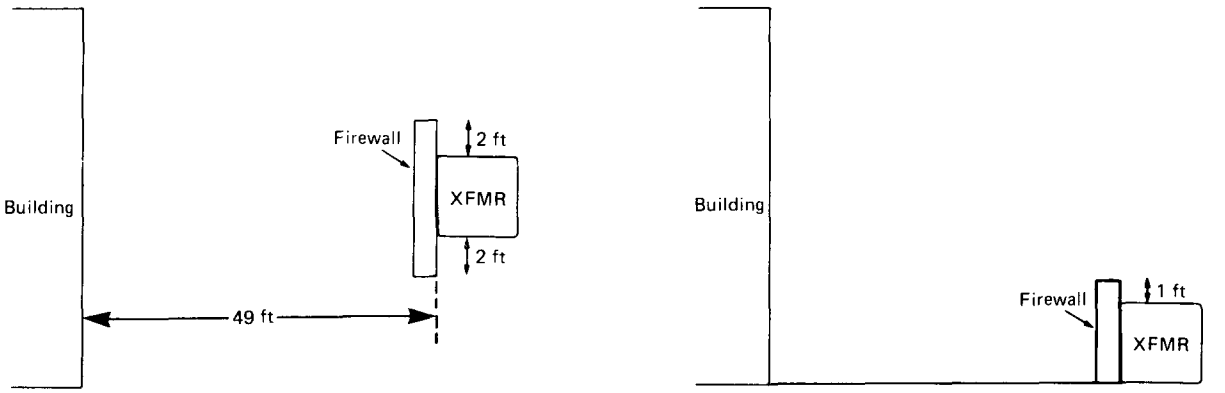
3-3.1 Construction materials being considered for electric generating plants should be selected based upon the fire risk evaluation and upon consideration of the following NFPA standards:

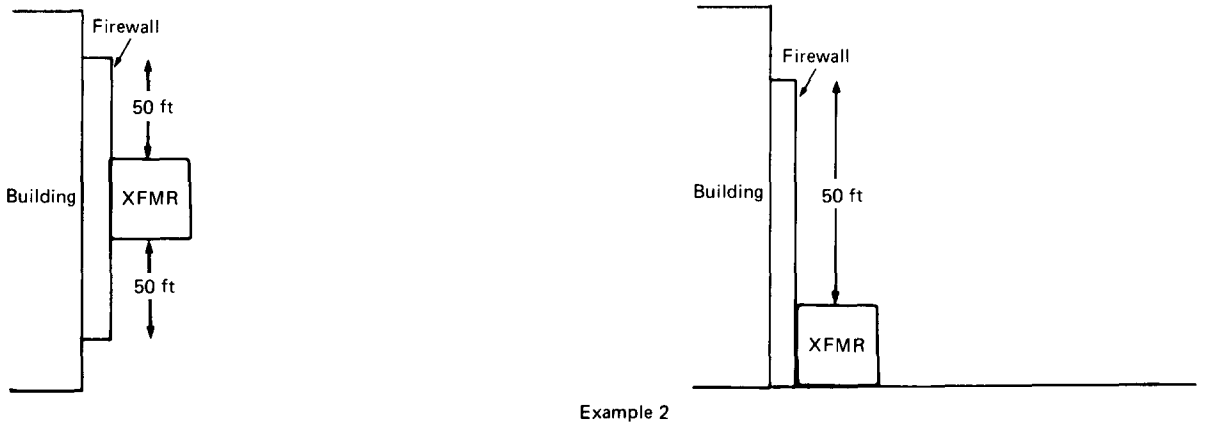
(a) NFPA 220, *Standard on Types of Building Construction*.

(b) NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

(c) NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*.







Notes:

X = Minimum separation distance from Table 3-1.3.3.
* Also see 3-1.3.3, Notes 1 and 2.
For SI Units: 1 ft = 0.305 m.

Figure 3-1.3.3 Illustration of Oil-Insulated Transformer Separation Recommendations

(d) NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials.*

(e) NFPA 259, *Standard Test Method for Potential Heat of Building Materials.*

3-3.2 Construction materials used in the boiler or turbine-generator buildings or other buildings critical to power generation should meet the definition of noncombustible or limited combustible; except roof coverings which should be as outlined in Section 3-3.5; and except for limited use of translucent reinforced plastic panels as allowed by the fire risk evaluation.

3-3.3 Buildings not critical to power generation may contain construction materials meeting the definition of limited combustible. Materials not meeting this requirement should be approved and should be provided with appropriate fire protection, in accordance with the fire risk evaluation.

3-3.4 Interior Finish.

3-3.4.1 Cellular or foamed plastic materials (*as defined in Appendix A of NFPA 101, Life Safety Code*) should not be used as interior finish.

3-3.4.2 Interior finish in buildings critical to power generation should be Class A.

3-3.4.3 Interior finish in buildings not critical to power generation should be Class A or Class B.

3-3.5 Roof covering should be Class A in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*. Metal roof deck construction, when used, should be "Class I" or "fire classified."

3-4 Smoke and Heat Venting, Heating, Ventilating, and Air Conditioning.

3-4.1 Smoke and Heat Venting.

3-4.1.1 Smoke and heat vents are not substitutes for normal ventilation systems unless designed for dual usage. They should not be used to assist such systems for comfort ventilation. They should not be left open where they can sustain damage from high wind conditions. They should be included in surveillance programs to assure availability in emergency situations.

3-4.1.2 Heat vents should be provided for areas identified by the fire risk evaluation. Where heat vents are provided, heat generated under fire conditions should be vented from its place of origin directly to the outdoors.

3-4.1.2.1 Heat vents in the boiler and turbine building may be provided through the use of automatic heat vents or windows at the roof eave line. Heat venting in areas of high combustible loading can reduce damage to structural components. (*See NFPA 204M, Guide for Smoke and Heat Venting.*)

3-4.1.3 Smoke venting should be provided for areas identified by the fire risk evaluation. Where smoke venting is provided, smoke shall be vented from its place of origin in a manner that does not interfere with the operation of the plant.

3-4.1.3.1 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. (*See NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems and NFPA 204M, Guide for Smoke and Heat Venting.*) Smoke venting may also be accomplished through the use of portable smoke ejectors.

3-4.1.3.2 Consideration should be given to smoke venting for the following areas: control room, cable spreading room(s), and switchgear room.

3-4.1.3.3 In the areas with gaseous fire extinguishing systems, the smoke ventilation system should be properly interlocked to assure the effective operation of the gaseous fire extinguishing system.

3-4.1.3.4 Smoke removal system dampers, where installed, are normally operable only from an area immediately outside of, or immediately within, the fire area served since it is desired to have entry into, and inspection of, the fire area by fire fighting personnel prior to restoring mechanical ventilation to the fire area. Smoke removal system dampers may be operable from the control room if provisions are made to prevent premature operation. This can be accomplished using thermal interlocks or administrative controls.

3-4.1.4 The fan power supply wiring and controls for smoke exhaust should be located external to the fire area served by the fan or be installed in accordance with the fire risk evaluation.

3-4.2 Normal Heating, Ventilating, and Air Conditioning Systems.

3-4.2.1 For normal heating, ventilating, and air conditioning systems, see NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, or NFPA 90B, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*, as appropriate.

3-4.2.2 Air conditioning for the control room should provide a pressurized environment to preclude the entry of smoke in the event of a fire outside the control room.

3-4.2.3 Plastic ducts, including listed fire retardant types, should not be used for ventilating systems. Listed plastic fire retardant ducts with appropriate fire protection may be used in areas with corrosive atmospheres.

3-4.2.4 Fire dampers (doors) compatible with the rating of the barrier should be provided at the duct penetrations to the fire area (*see Section 3-1*) unless the duct is protected throughout its length by a fire barrier equal to the rating required of fire barrier(s) penetrated.

3-4.2.5 Smoke dampers, where installed, should be installed in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems.*

3-4.2.6 The fresh air supply intakes to all areas should be located remotely from the exhaust air outlets and smoke vents of other fire areas to minimize the possibility of drawing products of combustion into the plant.

3-5 Drainage.

3-5.1 Provisions should be made in all fire areas of the plant for removal of all liquids directly to safe areas or for containment in the fire area without flooding of equipment and without endangering other areas. (*See Appendix A of NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection.*) Drainage and prevention of equipment flooding should be accomplished by one or more of the following:

(a) Floor drains.

(b) Floor trenches.

(c) Open doorways or other wall openings.

(d) Curbs for containing or directing drainage.

(e) Equipment pedestals.

(f) Pits, sumps, and sump pumps.

3-5.2 The provisions for drainage and any associated drainage facilities should be sized to accommodate all of the following:

(a) The spill of the largest single container of any flammable or combustible liquids in the area.

(b) The maximum expected number of fire hose lines [500 gpm (31.5 L/sec) minimum] operating for a minimum of ten minutes.

(c) The maximum design discharge of fixed fire suppression systems operating for a minimum of ten minutes.

Note: Design discharge for the turbine building should be based on the expected time necessary to take the turbine off line and put it on turning gear, but not less than ten minutes.

3-5.3 The drainage system for continuous fuel oil-fired boilers should consist of curbs and gutters arranged to confine the area of potential fuel oil discharge. Consideration should also be given to provide the same measures for coal-fired boilers using oil for ignition. Walking surfaces in the vicinity of burners should be made impervious to oil leakage by the use of checkered steel plate, sheet metal drip pans or other means. Curbs in passageways should have ramps or steps or be otherwise constructed to present no obstacle to foot traffic. Gutter outlet pipes and all other drains should be trapped to prevent the passage of flames and permit the flow of oil. A clearance between the boiler front and the walk structure is required for the differential movement when the heated boiler elongates. This clearance space in the vicinity of the burners should be flashed and counter-flashed with sheet metal or otherwise arranged to allow movement and to redirect dripping oil, which may impinge on the boiler face.

3-5.4 Floor drainage from areas containing flammable or combustible liquids should be trapped to prevent the spread of burning liquids beyond the fire area.

3-5.5 Where gaseous fire suppression systems are installed, floor drains should be provided with adequate seals or the fire suppression system should be sized to compensate for the loss of fire suppression agent through the drains.

3-5.6 Drainage facilities should be provided for outdoor oil insulated transformers or the ground should be sloped such that oil spills will flow away from buildings, structures, and adjacent transformers. Unless drainage from oil spills is accommodated by sloping the ground around transformers away from structures or adjacent equipment, consideration should be given to providing curbed areas or pits around transformers. The pit and/or drain system should be sized in accordance with Section 3-5. The curbed area or pit may be filled with uniformly graded, crushed stone, as a means of minimizing ground fires.

3-5.7 For facilities consisting of more than one generating unit, a curb or trench drain should be provided on solid floors where the potential exists for an oil spill, such that oil released from an incident on one unit will not expose an adjacent unit.

3-6 Lighting.

3-6.1 Emergency lighting should be provided for means of egress (*See NFPA 101, Life Safety Code*).

3-7 Lightning Protection.

3-7.1 Lightning protection should be provided for those structures having a risk index (R) of four or greater when evaluated in accordance with Appendix I to NFPA 78, *Lightning Protection Code*.

Chapter 4 General Fire Protection Systems and Equipment

4-1 General.

4-1.1 All fire protection systems, equipment, and installations should be dedicated to fire protection purposes.

4-2 Water Supply.

4-2.1 The water supply for the permanent fire protection installation should be based on the largest fixed fire suppression system demand plus the maximum hose stream demand of not less than 500 gpm (31.5 L/sec) for a two-hour duration.

4-2.2 Where an adequate and reliable water supply such as a lake, cooling pond, river, or municipal water system is unavailable, at least two separate water supplies should be provided for fire protection purposes with each supply capable of meeting the fire water flow requirements determined by 4-2.1.

4-2.2.1 Where multiple fire pumps are required, the pumps should not be subject to a common failure, electrical or mechanical, and should be of sufficient capacity to meet the fire flow requirements determined by 4-2.1 with the largest pump out of service.

4-2.2.2 Fire pumps should be automatic starting with manual shutdown. The manual shutdown should be at the pump controllers only. (*See NFPA 20, Standard for the Installation of Centrifugal Fire Pumps.*)

4-2.2.3 If tanks are of dual-purpose use, a standpipe or similar arrangement should be provided to dedicate the

amount determined by paragraph 4-2.1 for fire protection use only. (*See NFPA 22, Standard for Water Tanks for Private Fire Protection.*)

4-2.2.3.1 Where tanks are used, they should be filled from a source capable of replenishing the two-hour supply for the fire protection requirement in an eight-hour period. The eight-hour (time) requirement for refilling may be extended if the initial supply exceeds the minimum storage requirement on a volume per time ratio basis. It is normally preferred for the refilling operation to be accomplished on an automatic basis.

4-2.3 Each water supply should be connected to the yard main by separate connections arranged and valve controlled to minimize the possibility of multiple supplies being impaired simultaneously.

4-3 Valve Supervision.

4-3.1 All fire protection water supply and system control valves should be under a periodic inspection program (*see Chapter 2*) and should be supervised by one of the following methods:

(a) Electrical supervision with audible and visual signals in the main control room or another constantly attended location.

(b) Locking valves open. Keys should be made available only to those individuals directly involved with and responsible for plant fire safety and security.

(c) Sealing of valves. This option should be followed only when valves are within fenced enclosures under the control of the property owner.

4-4 Yard Mains, Hydrants, and Building Standpipes.

4-4.1 Yard mains and outdoor fire hydrants should be installed on the plant site. (*See NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*)

4-4.1.1 Remotely located plant-related facilities should be reviewed on an individual basis to determine the need for fire protection. If excessively long extensions of underground fire mains are necessary for fire protection at these locations, it may be acceptable to supply this need from an available service main in the immediate area.

4-4.1.2 The supply mains should be looped around the main power block and should be of sufficient size to supply the flow requirements determined by 4-2.1 to any point in the yard loop considering the most direct path to be out of service. Pipe sizes should be designed to encompass any anticipated expansion and future water demands.

4-4.1.3 Indicator control valves should be installed to provide adequate sectional control of the fire main loop to minimize plant protection impairments.

4-4.2 Each hydrant should be equipped with a separate shutoff valve located on the branch connection to the supply main.

4-4.3 Interior fire protection loops are considered an extension of the yard main and should be provided with at least two valved connections to the yard main with appropriate sectional control valves on the interior loop.

4-4.4 Standpipe and Hose Systems.

4-4.4.1 Standpipe and hose systems should be installed (*see NFPA 14, Standard for the Installation of Standpipe and Hose Systems*). The standpipe and hose system is an extension of the yard fire main and hydrant system. The hose stations should be capable of delivering the hose stream demand for the various hazards in buildings.

4-4.4.2 Fire main connections for standpipes should be arranged so that a fire main break may be isolated without interrupting service simultaneously to both fixed protection and hose connections protecting the same hazard or area. For the important hazards the arrangement should permit operation of at least two hose lines on a fire. For areas of high water demand, the installation should meet the requirements for a Class III system (*see NFPA 14, Standard for the Installation of Standpipe and Hose Systems*). For other areas, a Class II system may suffice.

4-4.4.3 The standpipe piping should be capable of providing minimum volume and pressure for the highest hose stations.

4-4.4.4 Due to the open arrangement of these plants, locations of hose stations should take into account safe egress for personnel operating hose lines.

4-4.5 Hose Nozzles.

4-4.5.1 Spray nozzles having shutoff capability and listed for use on electrical equipment should be provided on hoses located in areas near energized electrical equipment.

4-4.6 Hose Threads.

4-4.6.1 Hose threads on hydrants and standpipe systems should be compatible with fire hose used by the responding fire departments.

4-5 Portable Fire Extinguishers.

4-5.1 Portable fire extinguishers should be provided (*see NFPA 10, Standard for Portable Fire Extinguishers*).

4-6 Fire Suppression Systems and Equipment — General Requirements.

4-6.1 Fire suppression systems and equipment should be provided in all areas of the plant as identified in Chapter 5 or as determined by the Fire Risk Evaluation. The applicable NFPA standards should be used for design of the fire suppression systems except as modified in this chapter.

4-6.2 Selection of extinguishing agent should be based upon:

(a) Type of hazard.

(b) Effect of agent discharge on equipment.

(c) Health hazards.

4-7 Fire Signaling Systems.

4-7.1 Fire detection and automatic fixed-fire suppression systems should be equipped with local audible and/or visual signals with annunciation in the main control room or another constantly attended location. Audible fire alarms should be distinctive from other plant system alarms.

4-7.2 Automatic fire detectors should be installed in accordance with NFPA 72E, *Standard on Automatic Fire Detectors*.

4-7.3 A fire signaling panel should be installed in the main control room or another constantly attended location (*see NFPA 72D, Standard for the Installation, Maintenance and Use of Proprietory Protective Signaling Systems*).

4-7.4 The fire signaling system or plant communication system should provide the following:

(a) Manual fire alarm devices (e.g., pull boxes or page party stations) should be installed in all occupied buildings. Manual fire alarm devices should be installed for remote yard hazards as identified by the Fire Risk Evaluation.

(b) Plant-wide audible fire alarm and/or voice communication systems for purposes of personnel evacuation and alerting of plant emergency organization. The plant public address system, if provided, should be available on a priority basis.

(c) Two-way communications for the plant emergency organization during emergency operations.

(d) Means to notify the public fire department.

Chapter 5 Identification of and Protection Against Hazards

5-1 General. This chapter identifies fire and explosion hazards that are unique to gas, oil, or coal-fired steam electric generating plants, and recommends protection criteria.

5-2 Fuel Handling — Gas.

5-2.1 For the storage and piping systems for boiler fuel gases in the gaseous or liquefied state see NFPA 85B, *Standard for Prevention of Furnace Explosion in Natural Gas-Fired Multiple Burner Boiler-Furnaces*, and NFPA 58, *Standard for Storage and Handling of Liquefied Petroleum Gases*.

5-2.2 Electrical equipment in areas with potentially hazardous atmospheres should be designed and installed in compliance with Articles 500 and 501 of NFPA 70, *National Electrical Code®*, and ANSI C2, *National Electric Safety Code*.

5-3 Fuel Handling — Oil.

5-3.1 General.

5-3.1.1 For the fuel oil storage and handling facilities, see NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 31, *Standard for the Installation of Oil Burning Equipment*; NFPA 85D, *Standard for the Prevention of Furnace Explosion in Fuel Oil-Fired Multiple Burner Boiler-Furnaces*; and Articles 500 and 501 of NFPA 70, *National Electrical Code* and ANSI C2, *National Electric Safety Code*.

5-3.1.2 Internal tank heaters needed to maintain oil pumpability should be equipped with temperature sensing devices, which alarm in a constantly attended area prior to overheating of the oil.

5-3.1.3 External tank heaters should be interlocked with a flow switch to shut off the heater if oil flow is interrupted.

5-3.1.4 Tank filling operations should be monitored to prevent overfilling.

5-3.1.5 While oil unloading operations are in progress, the unloading area should be manned by personnel properly trained in the operation of pumping equipment, valving, and firesafety.

5-3.2 Piping and Pumps.

5-3.2.1 For piping and pumping facilities see NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 31, *Standard for the Installation of Oil Burning Equipment*; and ANSI B31.1, *Power Piping*. Pump installations should not be located within tank dikes, and should be provided with curbs and/or drains to divert or contain leakage.

5-3.2.2 For electrical installations see NFPA 30, *Flammable and Combustible Liquids Code*; Articles 500 and 501 of NFPA 70, *National Electrical Code*; and ANSI C2, *National Electric Safety Code*.

5-3.2.3 To prevent hazardous accumulations of flammable vapors, ventilation for indoor pumping facilities should provide at least 1 cubic foot of exhaust air per sq ft of floor area (0.30 m^3 per m^2), but not less than 150 cu ft per minute (0.071 m^3/sec).

5-3.3 Fire Protection.

5-3.3.1 Indoor fuel oil pumping and/or heating facilities should be protected with automatic sprinklers, water spray, foam water sprinklers, or gaseous total flooding system(s). Local application dry chemical systems may be used in areas that normally do not have re-ignition sources such as steam lines or hot boiler surfaces.

5-3.3.2 The provision of foam systems for tank protection should be considered in the fire hazard evaluation with consideration of exposure to other important structures, product value, and resupply capability.

5-3.3.3 Fuel oil handling and storage areas should be provided with hydrant protection in accordance with Section 4-4.

5-4 Fuel Handling — Coal.

5-4.1 Storage.

5-4.1.1 Coal storage piles are subject to fires caused by spontaneous heating of the coal. The coals most susceptible to self-heating are those with high pyritic content and high intrinsic moisture and oxygen content such as low-rank coals. The mixing of high pyritic coals with high moisture and oxygen coals increases self-heating.

There are measures that can be taken to lessen the likelihood of coal pile fires. These measures are dependent upon the type and rank of coal. Among the more important are:

(a) Short duration, active, or "live" storage piles should be worked to prevent dead pockets of coal, a potential source of spontaneous heating.

(b) Coal piles should not be located above sources of heat such as steam lines, or sources of air such as manholes.

(c) Coal placed in long term storage should be piled in layers, appropriately spread and compacted prior to the addition of subsequent layers to reduce air movement and to minimize water infiltration into the pile.

(d) Different types of coal that are not chemically compatible should not be stored in long term storage piles.

(e) Access to coal storage piles should be provided for fire fighting operations and for pulling out hot pockets of coal.

5-4.2 Bins, Bunkers, and Silos.

5-4.2.1 The following recommendations should be considered to reduce the probability of serious fire. (*See NFPA 85F, Standard for the Installation and Operation of Pulverized Fuel Systems.*)

(a) Storage structures should be of noncombustible construction and designed to minimize corners or pockets that cause coal to remain trapped and present a potential for spontaneous combustion.

(b) During planned outages, coal bins, bunkers, or silos should be emptied to the extent practical.

(c) The period of shutdown requiring emptying of the bins depends on the spontaneous heating characteristics of the coal. Inerting idle silos should be considered to reduce or eliminate spontaneous heating.

(d) Once spontaneous heating develops to the fire stage it becomes very difficult to extinguish the fire short of emptying the bin, bunker, or silo. Therefore, provisions for emptying the bunker should be provided. This may take the form of conveyors discharging to a stacking out pile. Another method would use flanged openings for removing the coal if adequate planning and necessary equipment have been provided.

(e) Care should be taken when working in enclosed areas near coal bins, bunkers, or silos in confined areas since spontaneous heating of coal can generate gases that are both toxic and explosive. Fixed or portable carbon monoxide monitoring should be provided to detect spontaneous heating and hazardous conditions.

(f) Dust-tight barriers should be provided between the boiler house and the areas of the coal handling system above the bin, bunker, or silo.

5-4.3 Dust Suppression and Control.

5-4.3.1 Coal dust generated due to coal handling constitutes a fire and explosion hazard that should be controlled by one or more of the following methods:

(a) Dust collection system

(b) Dust suppression system

(c) Open-air construction.

Where dust collection or suppression systems are installed to prevent hazardous dust concentration, appropriate electrical and mechanical interlocks should be provided to prevent the operation of coal handling systems prior to the starting and sustained operation of the dust control equipment.

5-4.3.2 Dust suppression systems usually consist of spray systems using water and/or surfactants to reduce the dust generation of coal handling operations. The sprays are normally applied at or near those locations where the coal is transferred from one conveyor to another.

5-4.3.3 For dust collection systems provided for handling combustible dusts, see NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*. Other recommendations for reducing the probability of explosion and fire from coal dust are:

(a) Fans for dust collectors should be installed downstream of the collectors so that they handle only clean air.

(b) For dust collectors vented to the outside see NFPA 68, *Guide for Explosion Venting*. Explosion suppression systems may be provided for dust collection systems which cannot be safely vented to the outside. (*See NFPA 69, Standard on Explosion Prevention Systems.*)

(c) Dust collection hoppers should be emptied prior to shutting down dust removal systems to reduce the likelihood of collector fires originating from spontaneous heating in the dust hopper.

(d) High level detection with annunciator alarm should be provided for the dust hoppers.

5-4.3.4 Cleaning methods such as vigorous sweeping of dust or blowing down with steam or compressed air should not be used since these methods can produce an explosive atmosphere. Preferred cleaning methods would use appropriate portable or fixed pipe vacuum cleaners of a type approved for dust hazardous locations or low velocity water spray nozzles and hose.

5-4.4 Coal Conveyors.

5-4.4.1 Coal conveyor belts should be of material designed to resist ignition. U.S. Mine Safety and Health Administration and Canadian Bureau of Mines Standards for fire retardant conveyor belt materials should be used as a guide. However, "fire retardant" belt materials will burn and therefore may require additional fire protection.

5-4.4.2 Each conveyor system should be arranged to automatically shut off driving power in the event of belt slowdown of greater than 20 percent, or misalignment of belts. In addition, a complete belt interlock shutdown

system should be provided so that, if any conveyor stops, the power to all conveyor systems feeding that belt would be automatically shut down.

5-4.4.3 Hydraulic systems should use only listed fire retardant hydraulic fluids. Where unlisted hydraulic fluids must be used, consideration should be given to protection by a fire suppression system.

5-4.4.4 Foreign materials pose a threat to crushers, pulverizers, and feeders by interrupting the flow of coal or by causing sparks capable of igniting coal dust/air mixtures. Methods of removing tramp metals and other foreign materials include magnetic separators, pneumatic separators, and screens. Means for removing such foreign material should be provided as early in the coal handling process as possible.

5-4.5 Coal Conveying and Handling Structures.

5-4.5.1 Coal conveying and handling structures and supports should be of noncombustible construction.

5-4.5.2 The accumulation of coal dust in enclosed buildings can be reduced by designing structural members such that their shape or method of installation minimizes the surface area on which dust can settle. Consideration should be given to installing structural members exterior to the enclosure. Access should be provided to facilitate cleaning of all areas.

5-4.5.3 For explosion venting for enclosed structures see NFPA 68, *Guide for Explosion Venting*.

5-4.5.4 Provision should be made for de-energizing both lighting and electrical power circuits without requiring personnel to enter dust-producing sections of the plant during emergencies.

5-4.5.5 Heating equipment is one of the major causes of fire in coal handling structures. Areas of the coal handling system requiring heat should use approved heaters suitable for hazardous areas. The heating equipment should be kept free of dusts and should be designed to limit surface temperature to 329°F (165°C).

5-4.5.6 Electrical equipment within the coal handling areas should be listed and installed, as appropriate, for use in hazardous locations Class II, Division 1 or Division 2, Group G. Electrical equipment subject to accumulations of methane gas or carbon monoxide should also be listed and installed, as appropriate, for use in hazardous locations Class I, Division 2, Group D. (*See Articles 500 and 501 of NFPA 70, National Electrical Code, and Section 127 of ANSI C2, National Electrical Safety Code.*)

NOTE: Under some unusual conditions coal dust may need to be treated as Class II, Group E, due to its resistivity.

5-4.5.7 Static electricity hazards should be minimized by the permanent bonding and grounding of all equipment, including duct work, conveyor drive belts, pulleys, idlers, take-up reels, motor drives, dust collection equipment, and vacuum cleaning equipment. (*See NFPA 77, Recommended Practice on Static Electricity.*)

5-4.6 Fire Protection.

5-4.6.1 Automatic sprinkler or water spray systems should be provided for coal handling structures, which are critical to power generation and subject to accumulations of coal or coal dust. Sprinkler systems should be designed for a minimum of 0.25 gpm per sq ft (0.17 L/sec-m²) density over a 2500 sq ft (232 m²) area. If water spray systems are used to protect structures, the same densities should be used.

5-4.6.2 Automatic water spray or sprinkler systems should be provided for coal conveyors, which are critical to continuous power generation. (*See NFPA 13, Standard for the Installation of Sprinkler Systems, and NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection.*)

5-4.6.2.1 If a sprinkler system is used to protect the coal conveyor, particular care must be exercised in locating closed sprinkler heads so that they will be in the path of the heat produced by the fire and still be in a position to provide good coverage of all belt surfaces along the conveyor.

5-4.6.2.2 Conveyors that are below grade or enclosed are extremely hazardous to maintenance or fire fighting personnel in the event of a fire. Automatic water spray or sprinkler systems should be provided for these conveyors even though they may not be critical to plant operations.

5-4.6.2.3 Actuation of water spray or sprinkler systems should shut down the conveyor belts in the area involved and all conveyor belts feeding the area.

5-4.6.2.3.1 Dust collectors and fans should automatically shut down along with other related equipment upon detection of fire.

5-4.6.2.3.2 Draft barriers installed at the end and midpoints of enclosed conveyors should be considered in the fire risk evaluation. Draft barriers will reduce the response time of installed detection systems and minimize the chimney effects in the event of fire.

5-4.6.3 Stacker-reclaimer conveyors present unique fire protection concerns. Protection of the equipment and safety of the personnel is made more difficult due to the movement-in-place capabilities of the equipment and its mobility and movement along a fixed rail system. Provision of hydrants "in the area" may not be sufficient protection primarily due to the extreme delay in response in the event of fire emergency and the difficulty in reaching all areas involved in a fire with hand-held hose equipment.

Consideration should be given to the installation of an automatic water spray or sprinkler system over the conveyor belt and striker plate areas within the stacker-reclaimer. Water supply could be from a 3000 to 5000 gal (11,355 to 18,925 L) capacity pressure tank located onboard. A fire department pumper connection should be provided so connection can be made to the fire hydrants in the area during down or repair periods to provide a more adequate water supply. Consideration should be given to protecting enclosed electrical control cabinets by

a pre-engineered fixed automatic gaseous-type suppression system activated by a fixed temperature detection system.

5-4.6.4 Bag-type coal dust collectors that are located inside buildings or structures should be protected with automatic sprinkler or water spray systems inside of the collectors.

5-4.6.4.1 Sprinklers for bag-type dust collectors should be designed for ordinary hazard systems. Sprinkler and water spray systems should be designed for a density of 0.20 gpm (0.013 L/sec) over the projected plan area of the dust collector.

5-4.6.4.2 Protection inside dust collectors should include the clean air plenum and the bag section. If the hopper is shielded from water discharge, sprinklers should also be provided in the hopper section.

5-4.6.4.3 Consideration should be given to provide automatic sprinkler systems for bag-type dust collectors located outdoors that:

(a) are in continuous operation,

(b) process large amounts of coal dust,

(c) have limited access for manual fire fighting. An example of limited access would be collectors that have catwalks for access.

5-5 Steam Generator.

5-5.1 For boiler-furnaces see NFPA 85A, *Standard for Prevention of Furnace Explosions in Fuel Oil and Natural Gas-Fired Single Burner Boiler-Furnaces*; NFPA 85B, *Standard for Prevention of Furnace Explosions in Natural Gas-Fired Multiple Burner Boiler-Furnaces*; NFPA 85D, *Standard for Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler-Furnaces*; NFPA 85E, *Standard for Prevention of Furnace Explosions in Pulverized Coal-Fired Multiple Burner Boiler-Furnaces*; and NFPA 85G, *Standard for the Prevention of Furnace Implosions in Multiple Burner Boiler-Furnaces.*

5-5.2 Fire Protection.

5-5.2.1 Boiler furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam water sprinkler systems covering the burner front oil hazard.

5-5.2.2 Boiler front fire protection systems should be designed to cover the fuel oil burners and ignitors, adjacent fuel oil piping and cable, a 20 ft (6.1 m) distance from the burner and ignitor including structural members and walkways at these levels. Additional coverage should include area where oil may collect. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft² (0.17 L/sec-m²) over the protected area.

5-5.3 Pulverizers.

5-5.3.1 For pulverized fuel systems see NFPA 85F, *Standard for the Installation and Operation of Pulverized Fuel Systems.*

5-5.3.2 Carbon monoxide gas detection systems should be considered for pulverizers as an early warning for conditions leading to fires and explosions.

5-5.4 Boiler Feed Pumps.

5-5.4.1 Coverage of steam driven boiler feed pumps should include oil lubrication lines, bearings, and oil reservoirs. Accidental water discharge on bearing points and hot turbine parts should be considered. If necessary these areas may be protected by shields, and casing insulation with metal covers. Boiler feed pumps that are electric motor driven, with lubricating or hydraulic oil hazards, may require protection depending on the quantity of oil, oil pressure or exposure to other equipment.

5-5.4.2 Hydraulic and lubricating oil hazards associated with boiler feed pumps that are driven with steam turbines should be protected with automatic sprinkler, water spray, or foam water sprinkler systems.

5-6 Flue Gas.

5-6.1 Forced Draft, Induced Draft, and Flue Gas Recirculation Fans.

5-6.1.1 Coverage of steam driven fans should include oil lubrication lines, bearings, and oil reservoirs. Accidental water discharge on bearings points and hot turbine parts should be considered. If necessary, these areas may be protected by shields and casing insulation with metal covers. Water spray systems for steam turbine-driven forced draft and induced draft fans should be designed for a density of 0.25 gpm/ft² (0.17 L/sec-m²) over the oil containment equipment surface. Water spray systems should be designed for 0.25 gpm/ft² (0.17 L/sec-m²) for a minimum 20 ft (6.1 m) from the hazard. Combustible oil hazards associated with forced and induced draft fans driven with steam turbines should be protected with automatic sprinkler, water spray, or foam-water sprinkler systems. (*See NFPA 13, Standard for the Installation of Sprinkler Systems; NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection; and NFPA 16, Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems.*)

5-6.1.2 Forced draft fans, induced draft fans, and flue gas recirculation fans should use a listed fire resistant fluid for hydraulic drives. Where non-approved hydraulic fluids are used, protection should be provided as described in 5-6.1.1.

5-6.2 Regenerative Air Heaters.

5-6.2.1 Fires have occurred in air heaters after the accumulation of appreciable quantities of unburned combustibles on plate surfaces resulting from incomplete combustion of fuel in the boiler. Incomplete combustion is most likely to occur during startup. Incomplete combustion can also occur during load changes, periods of low firing rate, or normal operation due to unstable or over-rich firing.

Fire-loss experience does not presently indicate the need for special protection for other than regenerative-type air heaters. Regenerative-type air heater fires have occurred when firing on all types of fuel. Fires have oc-

curred most frequently when firing oil or shortly after changing to pulverized coal from oil.

5-6.2.2 Temperature sensors should be provided in the inlet and outlet ducts for both flue gas and air. An alarm should be provided in the control room to alarm when air or flue gas temperatures exceed 50°F (28°C) above normal operating temperature. Temperature sensors alone may not be adequate to provide early warning of a fire in an air heater. In large air heaters, air flow rates are high enough so that a fire will be well developed before temperature increases enough to alarm and warn the operator. The length of time the operator has to take action is greatly reduced and severe damage can occur. The installation of a special detection system may allow operators time to quickly detect a fire, isolate the air heater, open drains, and activate the water spray system.

NOTE: Infrared detection systems to monitor rotor or stator are under development. An alternative to infrared detection for a stationary plate air heater is the use of line-type detectors between the intermediate and cold-end basket layers. Both systems are being tried in power stations. There has been no significant fire experience with either system to date. Low light television cameras mounted outside the air heater have a possible application in air heater fire detection.

5-6.2.3 A minimum of one observation port should be provided in the inlet and/or outlet ducts for both flue gas and air. Large air heaters may require more than one observation port. Observation ports should be placed such that they are accessible for viewing the rotor or stator surface.

5-6.2.4 A manual water spray system should be provided to protect the rotor or stator. The water spray system should be capable of being activated from the control room and/or from the air heater area. When the rotor or stator is horizontal, water spray applied to the upper surface can be expected to flow by gravity down over plate surfaces. A minimum of 0.60 gpm/ft² (0.41 L/sec-m²) density is recommended. When the rotor or stator is vertical, water spray must be applied to both sides to obtain adequate penetration. A minimum of 0.30 gpm/ft² (0.20 L/sec-m²) density is recommended on both sides. Water wash systems may not be adequate to give full coverage because of rotor drive failure.

5-6.2.5 Access hatches for use of hose streams should be provided. Hatches should be designed for quick access. A minimum of one hatch should be provided per 10 ft (3.0 m) of rotor or stator diameter. For horizontal shaft air heaters, access should be provided on both sides of the rotor or stator. For vertical shaft units, access hatches should be provided above the rotor or stator with one hatch below for units under 20 ft (6.1 m) diameter and two hatches below for units 20 ft (6.1 m) or more in diameter.

5-6.2.6 Drains from air heaters and/or ducts should be accessible or controlled by remotely operated valves.

5-6.2.7 A zero speed switch with alarm in the control room should be provided on the rotor shaft or on the output shaft from the fluid coupling or gear reducer. A zero speed alarm warns of stoppage of the rotor or air hoods. This could be due to failure of the drive motor or coupling that will lead to overheating of a section of the rotor or stator, which may result in a fire. Stoppage may also be caused by high temperatures generated by a fire that has caused the rotor to bind against the housing, or the air hoods to bind against the stator.

5-6.3 Flue Gas Bag Type Dust Collectors.

5-6.3.1 Flue gas bag-type dust collectors (also known as fabric filters) can be damaged by overheating or fire. Filter media can be damaged by flue gases entering at a temperature above the operating temperature of the filter media. Fires have been caused by incomplete combustion in the boiler resulting in carry-over of burning particulate igniting the filter media, and by maintenance operations such as cutting and welding.

5-6.3.2 Collectors equipped with bags that have an operating temperature limit exceeding 400°F (204°C) should be subdivided into compartments by noncombustible partitions. The partitions should extend through the flue gas bag area. The filter bag area provided in each compartment should be such that the fabric filter systems will not limit boiler load with one compartment fully isolated to repair damaged filter bags. The pressure drop across the fabric filter system should not increase significantly when one compartment is isolated.

5-6.3.3 Collectors equipped with other types of bags should be subdivided into compartments by partitions of 30 minute fire resistance if no automatic sprinkler protection is provided, or noncombustible partitions if sprinklers are provided. Partitions should extend from the hopper, through the bag area to the clean air plenum. Protection inside dust collectors should include the bag area. The design density should be 0.20 gpm/sq ft (0.14 L/sec-m²) over the plan area of the dust collector.

If automatic sprinkler protection is provided, structural design of the collector should take into consideration maximum water loading. A method should be provided for drainage of water from the hoppers.

5-6.3.4 Each compartment should be equipped with a heat detection system, arranged to alarm in a constantly attended area at a temperature 50°F (28°C) above normal operating temperature.

5-6.3.5 One of the following should be provided to prevent high temperature inlet flue gas from damaging the bags:

(a) Where permitted for emergency conditions, an automatic isolation valve and bypass duct to divert inlet gas streams around the flue gas bag collector, or

(b) A flue gas tempering water spray system in the duct between the boiler and the flue gas bag collector.

5-6.3.6 Manual fire fighting equipment should be available to personnel performing maintenance on a collector. A standpipe system should be provided such that each compartment is accessible by at least one hose system.

5-6.3.7 Access doors or hatches for manual fire fighting and viewing ports should be provided for all compartments.

5-6.4 Electrostatic Precipitators.

5-6.4.1 Electrostatic precipitators can be damaged by heat from a fire. High temperatures can warp collecting plates, decreasing collection efficiency. Combustibles may be generated by over-rich boiler-furnace firing. Solid and liquid products of incomplete combustion can be collected on plate surfaces. Ignition can occur by arcing in the electrostatic precipitator.

5-6.4.2 Temperature sensors should be provided in the inlet and outlet ducts. Alarms should be provided in the control room to indicate abnormal operating temperatures.

NOTE: Temperature sensors alone may not be adequate to provide early warning of a fire in an electrostatic precipitator.

5-6.4.3 Transformer-rectifier sets should use high fire point insulating fluids or should be of the dry type. If mineral oil insulating fluids are used, hydrants or standpipes should be located so that each transformer-rectifier set can be reached by at least one hose stream. In addition either of the following should be provided:

(a) Automatic sprinkler or automatic water spray protection. Fire protection water spray systems provided for transformer-rectifier sets should be designed for a density of 0.25 gpm/ft² (0.17 L/sec-m²) over the exposed surface of the transformer-rectifier set. Automatic sprinkler systems should be designed for a density of 0.25 gpm/sq ft (0.17 L/sec-m²), over 3500 sq ft (325 m²). The drain system should be capable of handling oil spillage plus the largest design water flow from the fire protection system.

(b) Fire barrier(s) or spatial separation in accordance with Chapter 3. (*See 3-1.3 and 3-1.4.*)

5-6.5 Scrubbers and Exhaust Ducts.

5-6.5.1 Fires can occur in scrubbers and ducts with plastic or rubber linings. Many of these fires have been experienced during construction. Sparks or hot metal from cutting and welding are frequent sources of ignition. Some types of plastic or rubber linings are more difficult to ignite than others, but all are combustible. Scrubbers, linings, and ducts should be constructed of noncombustible materials. Where combustible linings are used, the linings should be protected with automatic water spray systems. These systems may be the spray systems designed for normal scrubber operation or a specially designed fire protection system. Corrosion-resistant materials should be used for the water spray fixed system. Water spray systems required for combustible-lined scrubbers should be carefully designed such that spray patterns are not obstructed and cover the liner completely. The design density will be dependent on the specific material used in the liner, its ease of ignition, flame spread, rate of heat release, etc.

Corrosion resistant blow-off caps on the spray nozzles are desirable to prevent nozzle plugging.

5-6.5.2 Signs should be placed to identify all combustible-lined equipment for use in planning maintenance activities involving welding, cutting, or other hot work.

5-6.5.3 Limestone Conveyors.

5-6.5.3.1 Limestone conveyors for use with flue gas desulfurization systems should meet the fire protection recommendations of Sections 5-4.4.1, 5-4.4.2, 5-4.4.3, and 5-4.5.1.

5-6.6 Stacks.

5-6.6.1 Noncombustible liners should be used where practical. (*See Appendix B for fire tests.*)

5-6.6.2 Combustibles should not be stored in the space between the concrete shell and the combustible liner unless the liner is adequately protected by a fire barrier. The barrier could be either a two-hour fire barrier or a one-hour fire barrier if automatic sprinkler protection is provided over the combustible material.

5-6.6.3 A fire protection system should be provided for maintenance operations inside plastic stack liners. A fixed protection system installed on scaffolding is recommended. It should be capable of both manual and automatic operation; designed to protect the work platform and twice the area that can be reached by workers on the platform.

5-6.6.4 Ignition sources should be eliminated when working inside plastic liners.

5-7 Turbine-Generator.

5-7.1 Hydrogen System.

5-7.1.1 For hydrogen storage systems see NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, or NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites.*

Bulk hydrogen systems supplying one or more generators should have automatic valves located at the supply and operable either by "dead man" type controls at the generator fill point(s) or operable from the control room. This would minimize the potential for a major discharge of hydrogen in the event of a leak from piping inside the plant. Alternatively, vented guard piping may be used in the building to protect runs of hydrogen piping.

Routing of hydrogen piping should avoid hazardous areas and areas containing critical equipment.

5-7.1.2 Redundant hydrogen seal oil pumps with separate power supplies should be provided for adequate reliability of seal oil supply.

Where feasible, electrical circuits to redundant pumps should be run in buried conduit or provided with fire retardant coating if exposed in the area of the turbine generator to minimize possibility of loss of both pumps as a result of a turbine generator fire.

5-7.1.3 A flanged spool piece or equivalent arrangement should be provided to facilitate the separation of hydrogen supply when the generator is opened for maintenance.

5-7.1.4 For electrical equipment in the vicinity of the hydrogen handling equipment including detraining equipment, seal oil pumps, valves, etc., see Article 500 of

NFPA 70, *National Electrical Code*, and Section 127 of ANSI C2, *National Electrical Safety Code*.

5-7.1.5 Control room alarms should be provided to indicate abnormal gas pressure, temperature, and percentage of hydrogen in the generator.

5-7.1.6 Hydrogen lines should not be piped into the control room.

5-7.1.7 The generator hydrogen dump valve and hydrogen detraining equipment should be arranged to vent directly to a safe outside location. The dump valve should be remotely operable from the control room or an area accessible during a machine fire.

5-7.2 Hydraulic Control System.

5-7.2.1 The hydraulic control system should use a listed fire resistant fluid.

If a listed fire resistant fluid is not used, hydraulic control equipment should be protected as described in 5-7.4.

Fire extinguishing systems, where required for hydraulic control equipment, should include reservoirs and stop, intercept, and reheat valves.

5-7.3 Lubricating Oil Systems.

5-7.3.1 Noncombustible or fire resistant lubricants suitable for use on large turbine-generator units are under test in the industry. Such oils will have to be approved by the turbine-generator manufacturers before coming into widespread use for power station machines.

5-7.3.2 Turbine lubricating oil reservoirs should be provided with a vapor extractor, vented to a safe outside location.

5-7.3.3 Emergency lube oil pumps, with power from normal and emergency power supplies, should be provided to allow for continued bearing lubrication in the event of failure of the main lube oil pump.

5-7.3.4 All oil piping serving the turbine-generator should be designed and installed to minimize the possibility of an oil fire in the event of severe turbine vibration.

Piping design and installation should consider the following protective measures:

(a) Welded construction.

(b) Guard pipe construction with the pressure feed line located inside the return line, or in a separate shield pipe drained to the oil reservoir.

(c) Route oil piping clear of or below stream piping or metal parts.

(d) Insulation with impervious lagging for steam piping or hot metal parts under or near oil piping or turbine bearing points.

NOTE: On some turbine-generators employing the guard pipe principle, the guard piping arrangement terminates under the machine housing, where feed and return piping run to pairs of bearings. Such locations are vulnerable to breakage with attendant release of oil in the event of excessive machine vibration and should be protected.

5-7.3.5 It is desireable to provide for remote operation, preferably from the control room, of the condenser vacuum break valve. Breaking the condenser vacuum markedly reduces the rundown time for the machine and thus limits oil discharge in the event of a leak.

5-7.4 Fire Protection.

5-7.4.1 An automatic sprinkler or foam-water sprinkler system should be provided beneath the turbine-generator operating floor to provide coverage extending at least 20 ft (6.1 m) beyond the lubricating oil system and oil collection areas. All lower floors and condenser pit which are subject to oil flow or accumulation should be similarly protected. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should be designed to a density of 0.30 gpm per sq ft (0.20 L/sec-m^2) over an application of 3000 sq ft (279 m^2) and 0.2 gpm per sq ft (0.14 L/sec-m^2) over an area of 10,000 sq ft (929 m^2).

Electrical equipment in the area covered by a water system should be of the enclosed type to minimize damage in the event of system operation.

5-7.4.2 Turbine-generator bearings should be protected with a manually or automatically operated closed-head sprinkler system utilizing directional nozzles. Fire protection systems for turbine-generator bearings should be designed for a density of 0.25 gpm per sq ft (0.17 L/sec-m^2) over the protected area.

Accidental water discharge on bearing points and hot turbine parts should be considered. If necessary, these areas may be protected by shields and encasing insulation with metal covers.

If a manually operated water system is installed, consideration should be given to a supplemental automatic gaseous fire extinguishing system.

5-7.4.3 Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas subject to oil accumulation including the area within the turbine lagging (skirt). The automatic sprinkler system should be designed to a density of 0.30 gpm per sq ft (0.20 L/sec-m^2).

5-7.4.4 Lubricating oil reservoirs and handling equipment should be protected with automatic sprinkler, water spray, foam water sprinkler system, or total flooding gaseous-type extinguishing system. Automatic sprinkler systems for lubrication oil reservoirs and handling equipment should be designed for a density of 0.25 gpm/ft^2 (0.17 L/sec-m^2) over the enclosed area, or a minimum 2500 sq ft (232 m^2). Water spray systems should be designed for a minimum density of 0.25 gpm/sq ft (0.17 L/sec-m^2) over the reservoir and oil handling equipment.

5-7.4.5 The area inside a directly connected exciter housing should be protected with a total flooding automatic carbon dioxide system.

5-7.4.6 Hydrogen seal oil units not located beneath the turbine generator should be protected in accordance with 5-7.4.4. Sprinkler protection for hydrogen seal oil units

should be designed for a density of 0.25 gpm/sq ft (0.17 L/sec-m²) for a distance of 20 ft (6.1 m) from the oil containing equipment. Water spray protection should be designed for 0.25 gpm/sq ft (0.17 L/sec-m²) over the area where oil may accumulate.

NOTE: Additional information concerning turbine-generator fire protection can be found in EPRI Research Project 1843-2 report.

5-8 Electrical Equipment.

5-8.1 Control Rooms and Computer Rooms.

5-8.1.1 Control rooms and computer rooms should be designed and constructed in accordance with Chapter 3.

5-8.1.2 For computer rooms see NFPA 75, *Standard for the Protection of Electronic Computer/Data Processing Equipment*.

5-8.1.3 A smoke detection system should be installed throughout computer rooms, in walk-in-type consoles, above suspended ceilings where combustibles are installed, and below raised floors in computer rooms and control rooms. Where the only combustibles above the false ceiling are cables or conduit and the space is not used as a return air plenum, smoke detectors could be omitted above the ceiling.

5-8.1.4 Automatic Halon 1301 fire extinguishing systems should be provided for areas beneath raised floors (*see NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems*).

5-8.1.5 Cable raceways not terminating in the control room should not be routed through the control room.

5-8.2 Cable Spreading Room and Cable Tunnels.

5-8.2.1 Cable spreading rooms and cable tunnels should be protected with automatic sprinkler, water spray, or automatic gaseous extinguishing systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/sq ft (0.20 L/sec-m²) over 2500 sq ft (232 m²). For Halon 1301 systems a design concentration of 6 percent for a 10 minute soaking time should be provided. (*See NFPA 12, Standard on Carbon Dioxide Extinguishing Systems; NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems; NFPA 13, Standard for the Installation of Sprinkler Systems; NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection; and NFPA 16, Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems.*)

5-8.2.2 Cable spreading rooms and cable tunnels should be provided with an early warning fire detection system.

5-8.3 Grouped Electrical Cables.

5-8.3.1 Consideration should be given to the use of fire retardant cable insulation such as those passing the Flame Propagation Test of the Institute of Electrical and Electronics Engineers (IEEE-383). Grouped electrical cables should be routed away from exposure hazards or protected as indicated by the fire risk evaluation.

5-8.3.2 Cable trays subject to accumlation of coal dust and the spread of an oil spill should be covered by sheet metal. Where potential oil leakage is a problem, solid-bottom trays should be avoided. Changes in elevation can prevent oil travel along cables in a tray.

5-8.3.3 The fire risk evaluation should consider the provision of fire suppression systems and/or fire retardant cable coatings for protection of cable concentrations from exposure fires.

5-8.4 Switchgear and Relay Rooms.

5-8.4.1 Switchgear rooms and relay rooms should be provided with smoke detection systems.

5-8.5 Battery Rooms.

5-8.5.1 Battery rooms should be provided with ventilation to limit the concentration of hydrogen to 1 percent by volume.

5-8.6 Transformers.

5-8.6.1 For oil-filled main, station service, and startup transformers protected with automatic water spray systems, see NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*.

5-9 Auxiliary Equipment and Other Structures.

5-9.1 Emergency Generators.

5-9.1.1 For installation and operation of emergency generators driven by stationary combustion engines or gas turbines, see NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.

5-9.1.2 Stationary combustion engines and gas turbines located within main plant structures should be protected by automatic sprinkler, water spray, foam water sprinkler, or gaseous-type extinguishing systems. Sprinkler and water spray protection systems should be designed for a 0.25 gpm/sq ft (0.17 L/sec-m²) density over the fire area.

When gaseous suppression systems are used on combustion engines that may be required to operate during the system discharges, consideration should be given to the supply of engine combustion air and outside air for equipment cooling.

5-9.2 Storage Rooms and Shops.

5-9.2.1 For storage rooms and shops containing combustible materials that present an exposure to surrounding areas or that are critical to plant operations, see NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 231, *Standard for General Storage*; and NFPA 231C, *Standard for Rack Storage of Materials*.

5-9.3 Warehouses.

5-9.3.1 For warehouses containing high-value equipment and combustible materials that are critical to power generation or that constitute a fire exposure to other important buildings, see NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 231, *Standard for General Storage*; and NFPA 231C, *Standard for Rack Storage of Materials*.

5-9.4 Fire Pumps.

5-9.4.1 Rooms housing diesel-driven fire pumps should be protected by automatic sprinkler, water spray, or foam water sprinkler systems. If sprinkler and water spray protection systems are provided for fire pump houses, they should be designed for a density of 0.25 gpm/sq ft (0.17 L/sec-m^2) over the fire area.

5-9.5 Cooling Towers.

5-9.5.1 Cooling towers of combustible construction that are essential to continued plant operations should be protected by automatic sprinkler or water spray systems in accordance with NFPA 214, *Standard on Water-Cooling Towers*.

5-9.6 Auxiliary Boilers.

5-9.6.1 Auxiliary boiler-furnaces, their fuel burning systems, combustion products removal systems, and related control equipment should be designed, installed, and operated in accordance with 5-5.1.

5-9.6.2 Oil- or coal-fueled auxiliary boilers installed within main plant structures should be protected by automatic sprinkler, water spray, or foam water sprinkler systems. A sprinkler system is preferred throughout the auxiliary boiler room on a 0.25 gpm/sq ft (0.17 L/sec-m^2) density. As a minimum sprinkler or water spray protection should be provided as outlined in 5-5.2.

Chapter 6 Fire Protection for the Construction Site

6-1 Introduction.

6-1.1 Although many of the activities on fossil-fueled electric generating plant construction sites are similar to the construction of other large industrial plants, an above average level of fire protection is justified due to life safety consideration of the large number of on-site personnel, high value of materials, and length of the construction period. Consideration of fire protection must include safety to life, potential for delays in construction schedules and plant startup, as well as protection of property.

6-1.2 Major construction projects in existing plants present many of the hazards associated with new construction, while presenting additional exposures to the existing facility. The availability of the existing plant fire protection equipment and the reduction of fire exposure by construction activities are particularly important.

6-1.3 For fire protection for plants and areas under construction, see NFPA 241, *Standard for Safeguarding Building Construction and Demolition Operations*. This chapter addresses concerns not specifically considered in NFPA 241.

6-2 Administration.

6-2.1 The responsibility for fire prevention and fire protection for the entire site during the construction period should be clearly defined. The administrative responsibilities should be to develop, implement, and periodically update as necessary the measures outlined in this recommended practice.

6-2.2 Where construction activities are partially or entirely under the jurisdiction of the builder or construction manager, fire protection responsibilities and programs should be clearly delineated. The fire protection program to be observed, and the owner's right to administration and enforcement, should be established.

6-2.3 Written procedures should be established for the new construction site, including major construction projects in existing plants. Such procedures should be in accordance with Section 2-4 (Fire Prevention Program), Section 2-5 (Testing, Inspection and Maintenance), Section 2-6 (Impairments), Section 2-7 (Fire Emergency Plan), Section 2-8 (Fire Brigade), and the following:

(a) Security guard service, including recorded rounds, should be provided through all areas of construction during times when construction activity is not in progress (*see NFPA 601A, Standard for Guard Operations*).

(b) The first round should be conducted one half hour after the suspension of work for the day. Thereafter, rounds should be made every hour.

(c) Where partial construction activities occur on second and third shifts, the guard service rounds may be modified to include only unattended or sparsely attended areas.

(d) In areas where automatic fire detection or extinguishing systems are in service, with alarm annunciation at a constantly attended location, or in areas of limited combustible loading, rounds may be omitted after the first round indicated in 6-2.3(b).

6-2.4 Construction schedules should be coordinated so that planned permanent fire protection systems are installed and placed in service as soon as possible, at least prior to the introduction of any major fire hazards identified in Chapter 5.

In-service fire detection and fire extinguishing systems provide important protection for construction materials, storage, etc., even before the permanent hazard is present. Temporary fire protection systems may be warranted during certain construction phases. The need and type of protection should be determined by the individual responsible for fire prevention and fire protection.

Construction and installation of fire barriers and fire doors should be given priority in the construction schedule.

6-3 Construction Warehouses, Shops, and Offices.

6-3.1 All structures that are to be retained as part of the completed plant should be constructed of materials as indicated in Chapter 3, and should be in accordance with other recommendations for the completed plant.

6-3.2 Construction warehouses, offices, trailers, sheds and other facilities for the storage of tools and materials should be located with consideration of their exposure to major plant buildings or other important structures. For guidance in separation and protection see NFPA 80A,

Recommended Practice for Protection of Buildings from Exterior Fire Exposures.

6-3.2.1 Large central office facilities may be of substantial value, contain high value computer equipment, irreplaceable construction records, or other valuable contents, the loss of which may result in significant construction delays. An analysis of fire potential should be performed. This analysis may indicate a need for automatic sprinkler systems or other protection and/or the desirability of subdividing the complex to limit values exposed by one fire.

6-3.3 Warehouses that contain high value equipment (as defined by the individual responsible for fire prevention and fire protection), or where the loss of or damage to contents would cause a delay in startup dates of the completed plant, should be arranged and protected as indicated below. Although some of these structures are considered to be "temporary" and will be removed upon completion of the plant, the fire and loss potential should be thoroughly evaluated and protection provided where warranted.

6-3.3.1 Building construction types should be noncombustible. See Chapter 3.

6-3.3.2 Where contents or packaging materials are combustible, automatic sprinkler systems should be provided.

Waterflow alarms should be provided and arranged to be heard at a constantly attended location as determined by the individual responsible for fire prevention and fire protection.

6-3.3.3 Air supported structures are sometimes used to provide temporary warehousing space. Although the fabric envelope may be a fire retardant material, the combustibility of contents and the values must be considered, as with any other type of warehouse. Because it is impractical to provide automatic sprinkler protection, air supported structures should only be used for noncombustible storage. An additional consideration is that relative minor fire damage to the fabric envelope may leave the contents exposed to the elements.

6-3.4 Temporary enclosures, including trailers, inside permanent plant buildings should be prohibited except where permitted by the individual responsible for fire prevention and fire protection. Where the floor area of a combustible enclosure exceeds 100 sq ft or where the occupancy presents a fire exposure, the enclosure should be protected with an approved automatic fire extinguishing system.

6-3.5 Storage of construction materials, equipment, or supplies that are either combustible or in combustible packaging should be prohibited in main plant buildings unless:

(a) an approved automatic fire extinguishing system is in service in the storage area, or

(b) where loss of the materials or loss to the surrounding plant area would be minimal, as determined by the individual responsible for fire prevention and fire protection.

6-4 Construction Site Lay-Down Areas.

6-4.1 Fire hydrant systems with an adequate water supply should be provided in lay-down areas where the need is determined by the individual responsible for fire prevention and fire protection.

6-4.2 Combustible materials should be separated by clear space to allow access for manual fire fighting.

6-5 Temporary Construction Materials.

6-5.1 Noncombustible or fire retardant scaffolds, form work, decking, and partitions should be used both inside and outside of permanent buildings where a fire could cause substantial damage or delay construction schedules.

6-5.1.1 The use of noncombustible or fire retardant concrete form work is especially important for large structures (e.g., turbine-generator pedestal) where large quantities of forms are used.

6-5.1.2 The use of listed pressure impregnated fire retardant lumber or listed fire retardant coatings would be generally acceptable. Pressure impregnated fire retardant lumber must be used in accordance with its listing and manufacturer's instructions. When exposed to the weather or moisture (e.g., concrete forms), the fire retardant used must be suitable for this exposure. Fire retardant coatings are not acceptable on walking surfaces or surfaces subject to mechanical damage.

6-5.2 For tarpaulins and plastic films of listed weather resistant, fire retardant materials, see Large Scale Test specified in NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films.*

6-6 Underground Mains, Hydrants, and Water Supplies.

6-6.1 Where practical, the permanent underground yard system, fire hydrants, and water supply (at least one water source), as indicated in Chapter 4, should be installed during the early stages of construction. Where provision of all or part of the permanent underground system and water supply is not practical, temporary systems should be provided. Temporary water supplies should be hydrostatically tested, flushed, and arranged to maintain a high degree of reliability, including protection from freezing and loss of power.

6-6.1.1 The necessary reliability of construction water supplies, including redundant pumps, arrangement of power supplies, and use of combination service water and construction fire protection water, should be determined by the individual responsible for fire prevention and fire protection.

6-6.2 Hydrants should be installed, as indicated in Chapter 4, in the vicinity of main plant buildings, important warehouses, office or storage trailer complexes, and important outside structures with combustible construction or combustible concrete form work (e.g., cooling towers). Where practical, the underground main should be arranged to minimize the possibility that any one break will remove from service any fixed water ex-

tinguishing system or leave any area without accessible hydrant protection.

6-6.3 A fire protection water supply should be provided on the construction site and should be capable of furnishing the largest of the following for a minimum 2 hour duration:

(a) 750 gpm (47.3 L/sec), or

(b) The in-service fixed water extinguishing system with the highest water demand and 500 gpm (31.5 L/sec) for hose streams.

6-6.3.1 The highest water demand should be determined by the hazards present at the stage of construction, which may not correspond with the highest water demand of the completed plant.

6-6.3.2 As fixed water extinguishing systems are completed, they should be placed in service, even when the available construction phase fire protection water supply is not adequate to meet the system design demand. The extinguishing system will at least provide some degree of protection, especially where the full hazard is not yet present. However, when the permanent hazard is introduced, the water supply should be capable of providing the designed system demand.

6-6.3.3 The water supply should be sufficient to provide adequate pressure for hose connections at the highest elevation.

6-7 Manual Fire Fighting Equipment.

6-7.1 For first aid fire fighting equipment see NFPA 241, *Standard for Safeguarding Building Construction and Demolition Operations*, Section 5-7.

NOTE: Mobile fire fighting equipment can be utilized to provide necessary first aid fire fighting equipment.

6-7.2 Hoses and nozzles should be available at strategic locations, such as inside hose cabinets or hose houses, or on dedicated fire response vehicles.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this recommended practice and should be considered part of the recommendations of the document. The edition indicated for each reference is current as of the date of the NFPA issuance of this document. These references are listed separately to facilitate updating to the latest edition by the user.

7-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1984, *Standard for Portable Fire Extinguishers*

NFPA 11-1983, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 11A-1983, *Standard for Medium and High Expansion Foam Systems*

NFPA 12-1985, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1985, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 12B-1985, *Standard on Halon 1211 Fire Extinguishing Systems*

NFPA 13-1985, *Standard for the Installation of Sprinkler Systems*

NFPA 13A-1981, *Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems*

NFPA 14-1986, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 16-1980, *Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems*

NFPA 20-1983, *Standard for the Installation of Centrifugal Fire Pumps*

NFPA 22-1984, *Standard for Water Tanks for Private Fire Protection*

NFPA 24-1984, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 26-1983, *Recommended Practice for the Supervision of Valves Controlling Water Supplies for Fire Protection*

NFPA 27-1981, *Recommendations for Organization, Training and Equipment of Private Fire Brigades*

NFPA 30-1984, *Flammable and Combustible Liquids Code*

NFPA 31-1983, *Standard for the Installation of Oil Burning Equipment*

NFPA 37-1984, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*

NFPA 50A-1984, *Standard for Gaseous Hydrogen Systems at Consumer Sites*

NFPA 50B-1985, *Standard for Liquefied Hydrogen Systems at Consumer Sites*

NFPA 51B-1984, *Standard for Fire Prevention in Use of Cutting and Welding Processes*

NFPA 58-1986, *Standard for the Storage and Handling of Liquefied Petroleum Gases*

NFPA 68-1978, *Guide for Explosion Venting*

NFPA 69-1978, *Standard on Explosion Prevention Systems*

NFPA 70-1984, *National Electrical Code*

NFPA 71-1985, *Standard for the Installation, Maintenance and Use of Central Station Signaling Systems*

NFPA 72A-1985, *Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Service*

NFPA 72B-1986, *Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service*

NFPA 72C-1986, *Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems*

NFPA 72D-1986, *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems*

NFPA 72E-1984, *Standard on Automatic Fire Detectors*

NFPA 72H-1984, *Guide for Testing Procedures for Local, Auxiliary, Remote Station and Proprietary Protective Signaling Systems*

NFPA 75-1981, *Standard for the Protection of Electronic Computer/Data Processing Equipment*

NFPA 77-1983, *Recommended Practice on Static Electricity*

NFPA 78-1983, *Lightning Protection Code*

NFPA 80-1983, *Standard for Fire Doors and Windows*

NFPA 80A-1980, *Recommended Practice for Protection of Buildings From Exterior Fire Exposures*

NFPA 85A-1982, *Standard for Prevention of Furnace Explosions in Fuel-Oil and Natural Gas-Fired Single Burner Boiler-Furnaces*

NFPA 85B-1984, *Standard for Prevention of Furnace Explosions in Natural Gas-Fired Multiple Burner Boiler-Furnaces*

NFPA 85D-1984, *Standard for Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler-Furnaces*

NFPA 85E-1985, *Standard for Prevention of Furnace Explosions in Pulverized Coal-Fired Multiple Burner Boiler-Furnaces*

NFPA 85F-1982, *Standard for the Installation and Operation of Pulverized Fuel Systems*

NFPA 85G-1982, *Standard for the Prevention of Furnace Implosions in Multiple Burner Boiler-Furnaces*

NFPA 90A-1985, *Standard for the Installation of Air Conditioning and Ventilating Systems*

NFPA 90B-1984, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*

NFPA 91-1983, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*

NFPA *101*-1985, *Life Safety Code*

NFPA 204M-1982, *Guide for Smoke and Heat Venting*

NFPA 214-1983, *Standard on Water-Cooling Towers*

NFPA 220-1985, *Standard on Types of Building Construction*

NFPA 231-1985, *Standard for General Storage*

NFPA 231C-1986, *Standard for Rack Storage of Materials*

NFPA 241-1986, *Standard for Safeguarding Building Construction and Demolition Operations*

NFPA 251-1985, *Standard Methods of Fire Tests of Building Construction and Materials*

NFPA 252-1984, *Standard Methods of Fire Tests of Door Assemblies*

NFPA 253-1984, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*

NFPA 255-1984, *Standard Method of Test of Surface Burning Characteristics of Building Materials*

NFPA 256-1982, *Standard Methods of Fire Tests of Roof Coverings*

NFPA 257-1985, *Standard for Fire Tests of Window Assemblies*

NFPA 259-1982, *Standard Test Method for Potential Heat of Building Materials*

NFPA 601A-1981, *Standard for Guard Operations in Fire Loss Prevention*

NFPA 701-1977, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*

NFPA 1962-1979, *Standard for the Care, Use, and Maintenance of Fire Hose Including Connections and Nozzles*

NFPA 1972-1985, *Standard for Structural Fire Fighters' Helmets*

7-1.2 Other Publications.

7-1.2-1 ANSI Publications. American National Standards Institute Inc., 1450 Broadway, New York, NY 10018.

ANSI C-2, *National Electrical Safety Code, 1981*

ANSI B31.1, *Power Piping*

ANSI Z210.1, *Metric Practice Guide*

7-1.2.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19105.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*

ASTM E380, *(See ANSI Z210.1)*

ASTM E814, *Fire Tests of Through-Penetration Fire Stops*

7-1.2.3 IEEE Publications. Institute of Electrical and Electronics Engineers, 345 East 47 St., New York, NY 10070.

IEEE 383, *Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations*

IEEE 634, *Testing of Fire Rated Penetration Seals*

7-1.2.4 OSHA Publication. Occupational Safety and Health Administration, Washington, D.C.

OSHA 1910.156, *Fire Brigades, 1981*

7-1.2.5 EPRI Publications. Electric Power Research Institute, 3412 Hillview Avenue, P.O. Box 10412, Palo Alto, CA 94303.

EPRI Research Project 1843-2

Appendix A Sample Fire Report

This Appendix is part of the recommendations of this NFPA document.

Name of Company _____
Date of fire: _____ Time of Fire: _____ Operating Facility _____
Under Construction _____
Plant or location where fire occurred: _____

Description of facility, fire area or equipment (include nameplate rating) involved: _____
_____

Cause of fire, such as probable ignition source, initial contributing fuel, equipment failure causing ignition, etc: _____
_____
_____

Story of fire, events and conditions, preceding, during and after the fire: _____
_____
_____
_____

Types and approx. quantities of portable extinguishing equipment used: _____
_____
_____

Was fire extinguished with portable equipment only? _____ Public fire department called _____
Employee Fire Brigade at this location? _____ Qualified for incipient fires? _____
For interior structural fires? _____
Was fixed fire extinguishing equipment installed? _____
Type of fixed extinguishing system: _____
Automatic operation _____, manually actuated _____ or both _____
Specific type of detection devices: _____
Did fixed extinguishing system control _____ and/or extinguish fire? _____
Did detection devices and extinguishing system function properly? _____
"no," why not? _____
_____
Estimated direct damage due to fire, $ _____, or, between $ _____ and $ _____
Estimated additional (consequential) loss, $ _____. Nature of additional loss: _____
_____
_____

Esimated time to complete repairs/replacement of damaged equipment/structure: _____

Number of persons injured: _____ Number of fatalities: _____

What corrective or preventive suggestions would you offer to other utilities who may have similar equipment, structures or extinguishing systems? _____
_____
_____

Submitted by _____ Title _____

Appendix B Fire Tests

NOTE: Footnotes refer to reference list numbers at end of Appendix B.

This Appendix summarizes the results of fire tests in which automatic sprinklers or water spray systems were used to extinguish or control fires in oil and grouped cables. Also included in this appendix are results of tests conducted on fiberglass stack liners. This Appendix is not a part of the recommendations of this NFPA document, but is included for information purposes.

B-1 Combustible Oil Fire Tests.

B-1.1 General.

Oils (except for crude oil) handled in bulk in power stations are limited to combustible liquids that lend themselves to control and extinguishment by water-type protective systems.

In order to assure satisfactory results on such fires, the system design must take into account the physical nature of the expected fire, which will take one or more of three