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Recommended Practice for Fire Prevention and Control on Fixed Open-type Offshore Production Platforms

Upstream Segment

API RECOMMENDED PRACTICE 14G
FOURTH EDITION, APRIL 2007

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FOREWORD

This Recommended Practice (RP) is under the jurisdiction of the American Petroleum Institute (API) Executive Committee on Drilling and Production Operations. It has been prepared with guidance from API and the Offshore Operators Committee (OOC). It is essential that operations on offshore production platforms are conducted in a manner providing for the safety of personnel and property and the protection of the environment. Process systems and operating practices are designed to prevent the unintentional release of hydrocarbons to the atmosphere and their subsequent ignition. However, the possibility of such an occurrence must be considered and methods employed not only to prevent fires but, where practical, to control a fire that may occur.

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1 General

1.1 INTRODUCTION

For many years, the petroleum industry has prepared documents representing the knowledge and experience of industry on various phases of oil and gas producing operations. In a continuation of this effort, this RP presents guidance for minimizing the possibility of accidental fires and for designing, inspecting, and maintaining the fire control systems on open type offshore platforms. Application of these practices, combined with proper design, operation, and maintenance of the entire production facility can provide adequate protection from the threat of fire.

1.2 SCOPE

This publication presents recommendations for minimizing the likelihood of having an accidental fire, and for designing, inspecting, and maintaining fire control systems. It emphasizes the need to train personnel in fire fighting, to conduct routine drills, and to establish methods and procedures for safe evacuation. The fire control systems discussed in this publication are intended to provide an early response to incipient fires to prevent their growth. However, this discussion is not intended to preclude the application of more extensive practices to meet special situations or the substitution of other systems which will provide an equivalent or greater level of protection.

This publication is applicable to fixed open-type offshore production platforms which are generally installed in moderate climates and which have sufficient natural ventilation to minimize the accumulation of vapors. Enclosed areas, such as quarters buildings and equipment enclosures, normally installed on this type platform, are addressed. Totally enclosed platforms installed for extreme weather conditions or other reasons are beyond the scope of this RP.

1.3 INDUSTRY CODES, STANDARDS, AND RECOMMENDED PRACTICES

Various organizations have developed standards, codes, specifications, and recommended practices which have substantial acceptance by government and industry. Listed below are publications that may be useful to persons designing, installing, and operating fire control systems on offshore production platforms. The latest edition of these publications should be consulted. It should be recognized that portions of some of these publications are not applicable to offshore operations:

API

RP 14C	*Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms*
RP 14E	*Design and Installation of Offshore Production Platform Piping Systems*
RP 14F	*Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations*
RP 14FZ	*Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1 and Zone 2 Locations*
RP 14J	*Design and Hazards Analysis for Offshore Production Facilities*
RP 75	*Development of a Safety and Environmental Management Program for Offshore Operations and Facilities*
RP 500	*Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*
RP 505	*Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2*
RP 520	*Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries*
RP 521	*Guide for Pressure-relieving and Depressurizing Systems*
RP 2003	*Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*
Publ 2030	*Application of Fixed Water Spray Systems for Fire Protection in the Petroleum and Petrochemical Industries*
Publ 2218	*Fireproofing Practices in Petroleum and Petrochemical Processing Plants*
RP T-1	*Orientation Programs for Personnel Going Offshore for the First Time*

NFPA[1]

National Fire Codes
Fire Protection Handbook

ASTM[2]

B 163	*Standard Methods of Fire Tests of Window Assemblies*
D 2996	*Standard Specifications for Filament Wound Reinforced Thermosetting Resin Pipe*
D 4024	*Standard Specification for Reinforced Thermosetting Resin (RTR) Flanges*
E 84	*Standard Methods of Test for Surface Burning Characteristics of Building Materials*
E 119	*Standard Test Methods for Fire Tests of Building Construction and Materials*
E 152	*Standard Methods of Fire Tests of Door Assemblies*
E 814	*Standard Methods of Through Penetration Fire Stops*

UL[3]

UL 711	*Classification, Rating, and Fire Testing of Class A B, and C Fire Extinguishers and for Class D Extinguishers or Agents for Use on Combustible Metals*
UL 1709	*Rapid Rise Fire Tests of Protection Materials for Structural Steel*

1.4 CONVERSIONS

Conversions of English units to International System (SI) metric units are provided throughout the text of this Recommended Practice in parenthesis; e.g., 6 in. (152.4 mm). English units are in all cases preferential and shall be the standard in this Recommended Practice. Products are to be marked in the units in which ordered unless there is an agreement to the contrary between the purchaser and the manufacturer. The factors used for conversion of English units to SI units were taken from API Publ 2564 and are listed as follows:

Length

1 inch (in.) = 25.4 millimeters (mm)

1 foot (ft) = 0.3048 meters (m)

Pressure

1 pound per square inch (psi) = 0.06894757 bar

Note: 1 bar = 100 kilopascals (kPa)

Temperature

The following formula is used to convert degrees Fahrenheit (F) to degrees Celsius (C):

$$C = {}^5/_9\,(F - 32)$$

Flow Rate

1 gallon per minute per square foot (gpm/ft^2) = 40.746 liters per minute per meters squared (liters/min per m^2)

1 gallon per minute (gpm) = 0.06309020 cubic decimeters per second (dm^3/s)

Area

1 square foot (ft^2) = 0.0929304 square meters (m^2)

Mass

1 pound (lb) = 0.4535924 kilograms (kg)

[1]National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, Massachusetts 02269-9101, www.nfpa.org.
[2]ASTM International, 100 Bar Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
[3]Underwriters Laboratories, 333 Pfingsten Road, North brook, Illinois 60062, www.ul.com.

Power (Electric)

1 horsepower (HP) = 0.746 kilowatts (kW)

Volume

1 gallon = 3.785412 liters

1.5 DEFINITIONS

1.5.1 combustible: Capable of burning.

1.5.2 combustible liquid (Class II, IIIA, and IIIB liquids): A liquid having a flash point at or above 100°F (37.80°C).

Combustible liquids are subdivided as follows:

Class II liquids, those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIA liquids, those having flash points at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids, those having flash points at or above 200°F (93°C). (See NFPA 30.)

1.5.3 combustion: The oxidation of materials accompanied by the development of heat and usually the production of flame.

1.5.4 enclosed area: A three-dimensional space enclosed by more than two thirds ($^2/_3$) of the possible protected plane surface area and of sufficient size to allow the entry of personnel. For a typical building, this would require that $^2/_3$ or more of the walls, ceiling, and/or floor are present.

1.5.5 fire: The phenomenon of combustion manifested in light, flame, and heat.

1.5.6 fire protection, active: Any fire protection system or component which requires the manual or automatic detection of a fire and which initiates a consequential response.

1.5.7 fire protection, passive: Any fire protection system or component, which, by its inherent nature, plays an inactive role in the protection of personnel and property from damage by fire. Passive fire protection functions independently of a requirement for human, mechanical, or other intervention to initiate a consequential response.

1.5.8 flammable: Capable of igniting easily, burning intensely, or spreading flame rapidly.

1.5.9 flammable (explosive) limits: The lower and upper percentages by volume of concentration of gas in a gas-air mixture that will form an ignitable mixture. (See NFPA 325M.)

1.5.10 flammable liquid (Class M III, and Class IC liquids): A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lb per sq. in. absolute (276 kilopascals) at 100°F (37.8°C). Flammable (Class 1) liquids are subdivided into Classes IA, IB, and IC. (See NFPA 30.)

1.5.11 flash point: The lowest temperature at which the vapor pressure of the liquid is just sufficient to produce a flammable mixture at the lower limit of flammability.

1.5.12 fuel: Any material which will burn.

1.5.13 ignite: To cause to burn.

1.5.14 ignitable (flammable) mixture: A gas-air mixture that is capable of being ignited by an open flame, electric arc or spark, or device operating at or above the ignition temperature of the gas-air mixture. See **flammable (explosive) limits**.

1.5.15 ignition source: A source of temperature and energy sufficient to initiate combustion.

1.5.16 incipient stage fire is a fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers or small hose systems without the need for protective clothing or breathing apparatus.

1.5.17 manned platform: A platform on which at least one person occupies an accommodation space (living quarters).

1.5.18 open-type platform: A platform that has sufficient natural ventilation to minimize the accumulation of vapors.

1.5.19 primary means of escape: Fixed stairways or fixed ladders of non-combustible construction.

1.5.20 secondary means of escape: Fixed stairways or fixed ladders of non-combustible construction or portable flexible ladders, knotted manropes, or other devices, approved by the regulatory agency.

1.5.21 station bill: A posted list, which sets forth the special duties and duty stations of each member of the personnel of a manned platform for emergencies, including a fire.

1.5.22 ventilation, adequate: Ventilation (natural or artificial) that is sufficient to prevent the accumulation of significant quantities of vapor-air mixtures in concentrations above 25% of their lower flammable (explosive) limit (LFL).

1.5.23 ventilation, inadequate: Ventilation that is less than adequate.

1.6 ABBREVIATIONS

ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
CFR	*Code of Federal Regulations*
DOT	Department of Transportation
ESD	Emergency Shutdown
IR	Infrared
LFL	Lower Flammable Limit
MCC	Motor Control Center
MODU	Mobile Offshore Drilling Unit
NEC	*National Electric Code*
NFC	*National Fire Code*
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
NVIC	Navigation and Vessel Inspection Circular
OOC	Offshore Operators Committee
P&ID	Process and Instrument Diagram
PFD	Process Flow Diagram
RP	Recommended Practice
SI	International System
Std	Standard
TLP	Tension Leg Platform
TSE	Temperature Safety Element
UL	Underwriters Laboratories
USCG	United States Coast Guard
UV	Ultraviolet

2 Fuels and Ignition Sources

2.1 GENERAL

The three essentials that must be present for the occurrence of fire are fuel, air (oxygen), and a source of ignition. Fire prevention procedures mainly involve identification and elimination or separation of these three essentials.

2.2 FUELS

Fuels may conveniently be grouped as to the type of fire they create on the basis of the materials burning or which have the potential to burn. To facilitate the proper use of extinguishers on different types of fires, the National Fire Protection Association (NFPA) has classified fires as follows:

a. *Class A Fires*. Class A fires are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. Examples of such materials commonly found on offshore platforms are the following:

- Construction Materials and Supplies—wood decking, framework, and skids; shipping containers and fiber ropes.
- Operational Materials and Supplies—cleaning rags and tarpaulins.
- Waste Materials—used paper and rags.

b. *Class B Fires*. Class B fires are fires in flammable liquids, gases, and greases. Examples of such materials commonly found on offshore platforms are the following:

- Produced Fluids—oil and condensate, gas and vapors, residue from produced or stored hydrocarbons.
- Construction Materials and Supplies—paints, welding and cutting gases.
- Operational Materials and Supplies—heat transfer fluids, glycols, hydraulic fluids, lubricants, and fuels.
- Miscellaneous—Cleaning compounds and cooking oils and greases.

c. *Class C Fires*. Class C fires are fires that involve energized electrical equipment. In this situation, electrical non-conductivity of the extinguishing agent is of importance. When electrical equipment is de-energized, the fire becomes a Class A or B fire.

d. *Class D Fires*. Class D fires are fires of combustible metals, such as magnesium, zirconium, sodium, and potassium.

2.3 IGNITION SOURCES

Ignition occurs when sufficient heat is produced to cause combustion. Factors influencing resultant combustion from a given ignition source are temperature, exposure time, and energy. Ignition sources that may be present in offshore production operations include:

a. *Chemical Reactions*. Chemical reactions may produce heat. This heat can ignite the substances reacting, products of the chemical reaction, or nearby materials. A chemical reaction that might occur on an offshore platform is spontaneous combustion.

Offshore facilities producing hydrogen sulfide may develop iron sulfide as a product of corrosion. Iron sulfide may be a source of heat and ignition due to spontaneous combustion when exposed to air.

b. *Electric Sparks and Arcs*. An electric spark is the discharge of electric current across a gap between two dissimilarly charged objects. Although static electricity and lightning are forms of electric spark, they are listed as separate ignition sources to emphasize their importance. Electric sparks from most electric supply installations will usually ignite a flammable mixture because the spark intensity and duration create enough heat for combustion. An electric arc occurs when an electric circuit carrying current is interrupted, either intentionally as by a switch or accidentally as when a contact or terminal becomes loosened or a current-carrying conductor is broken. The arc can be considered electric momentum. Electric current that is flowing through a contact will try to keep flowing when the contact is broken. The same charge will travel across a wider gap as an arc than as a spark. For this reason, the opening of switches is a potentially greater ignition source than the closing of switches. Sources of electric sparks and arcs could include but are not limited to the following:

- Electric motors and generators.
- Switches, relays, and other arcing components of electric circuits under normal operating conditions.
- Electric wiring and equipment malfunctions.
- Electric arc welding.
- Storage batteries.
- Fired vessel ignition devices.
- Internal combustion engine ignition systems.
- Lighting fixtures.
- Electric powered hand tools.

c. *Lightning*. Lightning is the discharge of an electric charge on a cloud to an opposite charge on another cloud or on the earth. Lightning can develop very high temperatures in any material of high resistance in its path. Lightning tends to discharge to high points such as antennae and flare stacks. See API RP 521 and NFPA 78 for additional information that may be useful to the designer.

d. *Static Electrical Sparks*. If two objects are in physical contact and then separated, the objects sometimes collect an electric charge through friction or induction. Similar electric charges can be generated by rapid flow of gases or liquids. If the objects are not bonded or grounded, they may accumulate sufficient electric charges that a spark discharge may occur. The terms bonding and grounding are sometimes used interchangeably; however, the terms have different meanings. Bonding is done to eliminate a difference in potential between objects. Grounding is done to eliminate a difference in potential between an object and ground. API RP 2003 *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents* can be referenced for additional information.

Static electrical sparks are normally of very short duration and do not produce sufficient heat to ignite ordinary combustible materials, such as paper. Some, however, are capable of igniting flammable vapors and gases. This situation is more common in a dry atmosphere. Static electrical sparks may be a problem in situations such as the following:

1. Fueling operations.
2. Filling containers, tanks, and pressure vessels.

3. High exit fluid velocities.
4. Drawing samples.
5. Drive belt operation.
6. Abrasive blasting.
7. Steam cleaning.

e. *Flame.* When common fuels are burned, energy is released in the form of heat. The burning is generally accompanied by a luminosity called flame. Examples of situations where flames may be present on a platform are the following:

1. Hydrocarbon flaring.
2. Fired production equipment burner operation.
3. Gas welding and cutting.
4. Engine operation (backfires and hot exhaust gases).
5. Heating, cooking, and other appliances operation.

f. *Hot Surfaces.* Hot surfaces can be a source of ignition. These sources may include the following:

1. Welding slag.
2. Fired vessel stacks.
3. Hot process piping and equipment.
4. Engine exhaust systems.
5. High-temperature electrical devices such as incandescent lighting fixtures.
6. Frictional heat such as a slipping belt against a pulley, unlubricated bearings, etc.
7. Heating and cooking appliances.
8. Hot metal particles from grinding.
9. Clothes dryers and exhaust systems.

g. *Heat of Compression.* If a flammable mixture is compressed rapidly, it will be ignited when the heat generated by the compressing action is sufficient to raise the temperature of the vapor to its ignition point. Combustion as a result of heat of compression may occur when hydrocarbon vapors or gases are mixed with air under situations such as the following:

1. Improper purging of pressure vessels and other equipment when introducing hydrocarbons.
2. Packing or seal failure that allows supply air to mix with supply or process hydrocarbons.
3. Lubricating system failure in air compressors.
4. Admission of air into the suction of hydrocarbon gas compressors.

3 Fire Prevention Practices

3.1 GENERAL

The best protection against the occurrence of fire will be realized through the provision of well-designed facilities and the training of personnel to employ safe operating practices. The facility should be designed and operated to account for all phases of the producing operations, including temporary situations such as drilling, workover, construction, etc. Facilities and operating practices should be capable of isolating fuel sources should a fire occur.

3.2 FACILITY DESIGN

The facility should be designed to contain hydrocarbons, prevent ignition of those that do escape, and provide mitigation should a fire occur. Some specific items that should be considered are the following:

a. *Platform Safety System.* Platform safety systems play an important role in preventing fires and minimizing their effect. The primary purpose of a safety system is to detect abnormal conditions and initiate appropriate action to prevent situations that could result in an accidental fire. The primary action normally initiated by the safety system is to shut off process flow, thus eliminating the major fuel source on a platform. The safety system may also shut down potential ignition sources such as engines, compressors, and heaters. The proper design, operation, and maintenance of these safety systems are addressed by API RP 14C.

b. *Equipment Arrangement.* Within the limits of practicality, equipment should be arranged on a platform to provide maximum separation of fuel sources and ignition sources and paths of access and egress for personnel. Guidelines for the arrangement of production equipment are presented in API RP 14J. Particular consideration should be given to the location of fired process vessels and the placement of temporary equipment during workover, completion, and construction activities.

c. *Ignition Prevention Devices.* Natural draft components should be equipped with spark and flame arrestors to prevent spark emission. Recommended safety systems for fired components are presented in API RP 14C.

d. *Hot Surface Protection.* Surfaces with a temperature in excess of 400°F (204°C) should be protected from liquid hydrocarbon spillage and mist, and surfaces in excess of 900°F (482°C) should be protected from combustible/flammable gases and vapors. API RP 14C and API RP 14E should be consulted for guidance.

e. *Fire Barriers.* Barriers constructed from fire resistant materials may be helpful in special situations to prevent the spreading of forces and to provide a heat shield. Locations of fire barriers should be reviewed carefully due to the possibility that the fire barriers may impede natural ventilation to such an extent that hydrocarbon vapors and gases may accumulate. Further information on ventilation can be found in API RP 500. Further information on fire barrier arrangement can be found in API RP 14J. A discussion of fire barrier ratings and construction is included in Section 9 of this document.

f. *Electrical Protection.* Protection from ignition by electrical sources should be provided by designing and installing electrical equipment in accordance with API RP 14F or API RP 14FZ using the area classification as designed by API RP 500 or API RP 505.

g. *Combustible Gas Detectors.* The concentration of a combustible gas can be determined by detection devices that may initiate alarms or shutdowns. The usual practice is to activate an alarm at a low gas concentration and to initiate action to shut off the gas source and/or ignition source if the concentration reaches a preset limit below the Lower Flammable Limit (LFL). API RP 14C, API RP 14F, API RP 14FZ, API RP 500 and API RP 505 contain guidelines for the installation and operation of combustible gas detectors.

h. *Bulk Storage.* The inventories of flammable/combustible fluids should be consistent with operational needs and should be minimized to the greatest extent practical. Recommended practices for permanent bulk storage (crude oil, condensate, methanol, jet fuel, diesel, etc.) include the following:

1. Tanks should be installed as far as practical from ignition sources and protected from damage (lifting operations, etc.).
2. Tanks should be enclosed by curbs, drip pans, or deck drains, to prevent liquid accumulation. The drain system should be designed with provisions to prevent vapor return.
3. Tanks should be adequately vented or equipped with a pressure or pressure/vacuum relief valve and should be electrically grounded (see API RP 14F or API RP 14FZ).
4. Fire detection devices should be installed in the storage area.

i. *Helicopter Fueling Facilities.* Recommended practices for helicopter fueling facilities include the following:

1. Fire extinguishing equipment should be readily accessible to the helicopter fueling area.
2. Helicopter landing areas with fueling facilities located above living quarters should be constructed so as not to retain flammable liquids and to preclude these liquids from spreading to, or falling on, other parts of the platform unless this has been considered in the heliport fire management design. Confined drainage is not practical for timber decks. Special precautions should be taken to minimize the risk of fire to the area beneath wooden decks.
3. The helicopter fuel hose should be of a type recommended for aircraft fuel service and should be equipped with a static grounding device and a "deadman" type nozzle. The helicopter should be bonded with self-releasing or spring-clamp bond cables (same potential as hose).
4. Suitable storage should be provided for the fueling hose. The fuel transfer pump should be equipped so that it can be shut down from the fueling station.

NFPA 418 *Standard for Heliports* should be consulted for additional information.

3.3 OPERATING PROCEDURE

Safe operating practices will reduce the probability of an accidental fire on a platform. Personnel should be trained in their duties and responsibilities and be attentive to conditions that might lead to a fire. On observation of such conditions, personnel should correct the conditions and/or report them to the proper supervisor so corrective action can be taken. Additional operating procedures may be desirable. See API RP 75 and API RP 14J for guidance. As a minimum, practices should be established for the following:

a. *Housekeeping.* Provisions should be made for the safe handling and storage of materials such as dirty rags, trash, waste oil and chemicals. Flammable liquids and chemicals spilled on the platform should be immediately cleaned up. Particular care should be taken to provide proper storage for paint, chemicals, hydrocarbon samples, welding and cutting gases, and other flammable substances. Access to means of escape and to firefighting equipment should not be blocked.

b. *Cutting and Welding.* Cutting and welding operations should be conducted in accordance with safety procedures established by the operator. NFPA 51B *Standard for Fire Prevention in Use of Cutting and Welding Processes* should be consulted when developing cutting and welding practices.

c. *Personnel Smoking.* Smoking should be restricted to designated platform areas. Smoking areas should not be located in a platform area classified by API RP 500 or API RP 505. All personnel should receive instructions in the rules regarding smoking and use of matches and cigarette lighters.

d. *Equipment Maintenance.* Platform equipment should be maintained in good operating condition and kept free from external accumulation of dirt, hydrocarbons, and other extraneous substances. Particular attention should be given to items that could be potential fuel or ignition sources such as process components, drip pans, valves, flanges, and electrical equipment.

e. *Helicopter Fueling Facilities.* Where helicopter-fueling facilities are provided, procedures should be developed for receiving, storing, and dispensing fuel. These procedures should be developed in conjunction with the organization providing helicopter services.

f. *Diesel Fuel Storage Facilities.* Where diesel storage facilities are provided, procedures should be developed for receiving, storing, and dispensing fuel.

g. *Temporary Installations.* Occasionally, equipment may be placed on a platform for temporary use. Particular care should be taken to ensure that these temporary installations meet applicable safety standards and appropriate area classification requirements.

h. *Chemical Reactions.* Extreme care should be exercised in opening vessels or reintroducing hydrocarbons into vessels known to contain iron sulfide (see 2.3a).

i. *Purging.* Extreme care should be exercised in purging vessels and other equipment when the possibility of mixing oxygen and hydrocarbon vapors exists (see 2.3g).

4 Fire Detection and Alarms

4.1 GENERAL

The following sections are general guidelines for providing fire detection and alarm systems for offshore platforms. The systems should be designed to enable the detection of fires in their earliest stages.

4.2 FIRE DETECTION

Early detection of fires is essential if fire damage is to be minimized. Fires may be detected by personnel observation or by automatic devices.

a. *Personnel Observation.* Personnel may observe a fire and manually initiate fire control action before it is detected by automatic devices.

b. *Automatic Fire Detection Systems.* The primary function of an automatic fire detection system is to alert personnel of the existence of a fire condition and to allow rapid identification of the location of the fire. The detection system(s) may be used to automatically activate emergency alarms, initiate Emergency Shutdown (ESD), isolate fuel sources, start fire water pumps, shut-in ventilation systems, and activate fire extinguishing systems such as gaseous agents, dry chemical, foam or water. The types of fire detectors commonly used on offshore platforms are shown in Appendix A.

1. *Fusible Loop Systems.* Fusible loop systems consisting of pressured pneumatic lines with strategically located fusible elements are the most widely used automatic fire detection system. These systems are simple, reliable, and have received general industry acceptance. However, poorly designed systems may not detect fires in their earliest stages. Particular care should be given to the selection of the number, placement, and temperature rating of the fusible elements. As a minimum, fusible loop systems should be installed in accordance with API RP 14C.

2. *Electrical Systems.* Central type electrical fire detection systems consist of strategically located fire detectors connected to a central fire monitor point where alarms are annunciated to alert the entire platform. Self-contained electrical systems (frequently provided in temporary buildings) provide the detector alarm device and the power supply in an independent module. The electrical systems can offer automatic testing features. Rapid detection is the primary advantage of electrical systems. Electrical systems should be installed in accordance with API RP 14 for API RP 14FZ. Electrical fire detection components must be compatible and should be approved by a Nationally Recognized Testing Laboratory (NRTL).

3. In determining the type of detector to be used, factors such as the types of combustible material, electrical area classification, and sensor's speed of response and coverage should be considered. Also, equipment selection should consider the risk of spurious alarms caused by environmental factors such as lightning. All detectors should be installed in accordance with API RP 14C and suitably protected against physical damage. See NFPA 72 and NFPA 72E for further guidelines.

   (a.) Flame detectors can provide a high-speed response in the detection of fires. Flame detector installations should consider the likely source of flame, detector cone of vision, and physical obstructions. Flame detectors used in open areas should not be susceptible to false alarms due to sunlight. Single spectrum detectors are susceptible to spurious alarms;

therefore, it may be desirable to arrange them in groups using appropriate voting systems or to use devices that incorporate dual sensors of different types (e.g., UV/IR) to minimize unwarranted alarms.

(b.) Heat detectors normally require less maintenance than other types of detectors because of their basic nature of operation and simpler construction. These factors may result in fewer unwarranted alarms; however, since heat detectors are inherently slower in operation than other types of electrical detectors, they should be considered for installation in areas where high-speed detection is not required.

(c.) Products of combustion detectors are recommended where personnel regularly or occasionally sleep and in rooms containing heat sources such as space heaters, ovens, and clothes dryers or areas subject to electrical fires. Quarters buildings should contain products of combustion detectors within each bedroom, corridor, hallway and office.

4.3 INSTALLATION

Fire detection systems should be installed for process equipment and enclosed (unclassified, and classified) areas in accordance with API RP 14C and API RP 14F or API RP 14FZ. Using the above criteria may cause the designer to choose one detection system for a control building and another system for a building with a gas compressor.

a. *Process Equipment*. General protection for process equipment usually is accomplished utilizing fusible plugs. API RP 14C should be consulted for guidelines on the installation of fusible plugs. Since process equipment generally is located in open areas of the platform, smoke and heat detectors usually are not effective due to effects of weather and wind. If additional protection beyond fusible plugs is needed then flame detection (UV, IR, UV/IR) could be utilized. Flame detectors should be installed in accordance with manufacturer's recommendations and NFPA 72E.

b. *Permanent Enclosed Unclassified Buildings*. Permanent enclosed unclassified buildings (i.e., quarters, control rooms, offices), where personnel regularly or occasionally sleep, should be equipped with a central fire detection system. Fire detection systems for large, complex, or multi-story accommodations should be sufficiently zoned to allow rapid identification of the fire location. Activation of any detectors within these buildings should automatically actuate an audible fire alarm within the building as well as the remainder on the platform. Fire detectors and central fire detection systems should be installed to manufacturer's recommendations and NFPA 72 and NFPA 72E.

c. *Permanent Enclosed Classified Buildings*. Permanent enclosed classified buildings should be protected with fire and gas detection systems. In choosing a fire detection system consideration should be given to the following:

1. Response time of detectors.
2. Type of hazard protection and type of fire(s) that may occur.
3. Extinguishing system, which may be activated by the detection system.
4. Actions performed by the platform safety system (alarm, alarm with shut-in) when detection system activates.
5. Whether the building is occupied on a regular basis.

d. *Temporary Buildings*. Installation of temporary buildings may introduce a change from normal operations. Special consideration should be given to the impact this change may have on the existing facilities. As a minimum, temporary (typically, less than 90 days) and enclosed unclassified buildings should be equipped with self-contained battery powered products of combustion detection with audible alarms. Consideration should be given to automatically initiating a platform alarm or other alarm that would indicate that a fire condition exists in the temporary building.

Alternative fire detection devices may be used if they provide an equal or greater level of protection. Due to their relatively slow response time, thermal detectors are not recommended for use as a standalone fire detection device where personnel sleep.

4.4 ALARM SYSTEMS

Alarm systems should be installed on manned platforms in accordance with regulatory requirements.

a. *General Alarms*. Manned platforms should have a means of manually initiating a general alarm that is audible throughout the structure. In addition, visual alarms should be installed in high noise areas (e.g., machinery areas). Manual alarm stations should be strategically located near evacuation routes and consideration should be given to providing a means to initiate a general alarm at each ESD station. An alarm indicating an emergency situation should be distinguishable from an alarm requiring abandonment of platform.

b. *Alarm Provisions*. The platform safety system on manned platforms should include audible and visual (for high noise areas) fire alarm signals. The fire alarm signals should be activated by sensors detecting the presence of heat, flame, or smoke. The fire alarm signal should activate the platform general alarm.

c. *Emergency Shutdown System.* ESD may be activated by shutdown stations located per API RP 14C. Automatic ESD can be initiated by fire detectors, gas detectors, and/or process controls. Activation of the ESD system should sound an alarm.

5 Fire Control

5.1 GENERAL

A fire control strategy should be developed to establish the protection plans for all aspects of platform operations (drilling, production, wireline, workover, construction, etc.). This plan should consider fire hazards and detection, personnel protection and evacuation, and fire control. The fire control strategy should also consider the typical number of personnel on board and their abilities and training, and should contain specific guidance concerning the decision to fight a fire or evacuate the facility.

The designer and operator should consider the detrimental effects of the marine environment offshore in the selection of equipment, materials, and systems. Emergency equipment should be selected and designed to be ready for use at all times. The following sections are general guidelines for providing fire control equipment on a platform.

Table 5-1 provides a listing of the agents that may be employed on offshore facilities.

5.2 FIRE WATER SYSTEMS

Fire water systems are often installed on offshore platforms to provide exposure protection, control of burning, and/or extinguishment of fires. The system design must be based on good engineering design principles and may include coverage of platform equipment such as compressors, glycol regenerators, storage facilities, shipping and process pumps, wellhead, etc. The fire water pumping rate should be sufficient to perform all functions required by the fire control design.

The following guidelines describe a fire protection system which can be effectively operated by one or two persons. This system should provide these personnel with sufficient fire control equipment to respond quickly and effectively to a fire before it causes major damage.

The basic components of a fire water system are the fire water pump, the distribution piping, and the hose and nozzle. Additives such as foaming agents may be provided to aid in extinguishing flammable liquid fires.

a. *Fire Water Pumps.*

1. *Fire Water Pump Characteristics.*

(a.) Fire water pumps should be selected to deliver the pressure and flow requirements for the anticipated manual fire fighting demand (monitors or monitors plus hose streams) as well as operation of the largest deluge/water spray system if installed. The pump must be able to supply adequate pressure and flow, to the hydraulically most demanding area. As a minimum, the fire water pump should be sized to deliver 180 gpm (11.36 dm/s). The fire water system should deliver water at the pressure recommended by the nozzle manufacturer, or at least 75 psi (5.17 bar) when two hose streams are flowing.

(b.) Fire water pumps within the scope of this Recommended Practice, are not required to meet the criteria for NFPA 20 *Standard for the Installation of Centrifugal Fire Pumps*. However, it is recommended that this document be consulted as a guideline when designing or installing fire pumps. An NFPA 20 pump will meet the following performance criteria points:

- Rated pressure and flow.
- The pump should supply a minimum of 150% rated capacity at not less than 65% of the rated pressure.
- The "churn" or shut-off pressure will not exceed 140% of the rated pump pressure for vertical shaft pumps or 120% for horizontal shaft pumps.

In general, pumps used for fire water service should have a pump curve characteristic similar to that of an NFPA 20 pump.

(c.) The following "accessories" may be required to provide proper functioning of the fire water pump:

- Relief Valves—to prevent exceeding the pressure rating of the equipment (valves, piping, fittings, etc.).
- Test Header (Hose Valves)—to allow for flow testing (flow meters or portable pitot tubes can also be used).
- Automatic Air Release Valves—for pumps that automatically start and for pumps with the casing full of water.
- Circulation Relief Valves—to prevent over heating of the pump. Minimum flow orifices, pressure control valves or other devices may also be used.

(d.) Fire water pumps normally used are the vertical shaft turbine type or submersible centrifugal type. Other type pumps are acceptable providing they deliver the recommended water volume and head, and are otherwise suitable for the specific application.

(e.) Fire water pumps and all accessories exposed to sea water should be constructed of materials resistant to corrosion by sea water.

Table 5-1—Fire Extinguishing Agents

Agent	Class Fire	Mechanism	Application Method	Advantages	Disadvantages
Water	A or B	Cools fire below ignition temperature	Fire main (hoses) Deluge Sprinklers Hand portable	Rapid cooling; unlimited supply	System maintenance requirements are high; requires 2 or more personnel to properly manage hoses; requires proper training to effectively use on flammable liquids; equipment corrosion; freezing
Foam	B	Floats on flammable liquid and forms a cohesive boundary to isolate oxygen from the fuel	Can be premixed with water or injected using eductor	Excellent reflash protection when containment integrity is maintained	Requires water for application; different types of foam are required for certain flammables; premixed volumes must be periodically tested and replaced
Dry Chemical	A, B, or C	Chemically disrupts the fire reaction	Portable and semi-portable extinguishers; galley hoods; hose reel systems	Rapid extinguishment; ease of use	No reflash protection; different agents recommended for different class fires (ABC, or BC); leaves residue that can be corrosive, particularly to electrical components; effectiveness limited in exterior applications; limited volume
Carbon Dioxide (CO_2)		CO_2 gas displaces oxygen and smothers the fire	Fixed systems; portable and semi-portable	Effective in enclosed areas and electrical fires; does not harm electrical components	Fixed systems displace oxygen and will suffocate personnel in the protected space; no reflash protection; requires vapor tight integrity for space protected
Halon	B or C	Chemically disrupts the fire reaction	Primarily fixed systems in machinery or electrical equipment rooms or enclosures	Highly effective	No longer allowed in new applications due to ozone depletion potential; some authorities are limiting use in existing systems; minor health risk to personnel in the protected space; requires vapor tight integrity for space protected; continued use subject to availability of agent
FM-200 and FE-13	B or C	Chemically disrupts the fire reaction	Environmentally acceptable alternatives to halon	Highly effective; minimal ozone depletion potential	Minor health risks for personnel in the space protected; global warming potential may lead to future restrictions; proprietary products; requires vapor tight integrity for space protected
Inergen	B or C	Reduces oxygen in protected space below 18%, smothering the fire	Environmentally acceptable alternative to halon	No ozone depletion or global warming potential; non-proprietary mixture of CO_2, Argon and Nitrogen; no health risks	Requires vapor tight integrity for space protected
Watermist or Fine Waterspray	A, B, or C	Cooling; displacement of oxygen at fire interface	Fixed systems in machinery or electrical equipment rooms or enclosures, exterior skids, quarters, storerooms	Rapid cooling; uses less water than sprinklers; can operate from plant supplied or dedicated supply of water and compressed gas; safe for use on electrical equipment	Requires fresh or distilled water, which may result in limited supply

A backup fire water pump should be considered for manned platforms. The backup pump may have a different driver than the primary pump (e.g., 1 electric and 1 diesel). The backup pump should be able to supply minimum system demand (same sizing criteria as the primary pump).

2. *Fire Water Pump Location.*

   (a.) The fire water pump should be located to minimize possibility of damage in the event of a fire. It should be isolated as far as practical from external fuel and ignition sources. If more than one fire pump is installed, where feasible, they should be separated to minimize the possibility of a single fire damaging all pumps. This is especially critical if both pumps are located in the process or wellbay areas.

   (b.) Where practical, the lift column should be located where it will be protected by the platform framing to minimize damage from marine vessels.

(c.) Vertical shaft turbine type or submersible pumps should be located near platform hoisting equipment or provided with an alternate method of retrieving the pump for maintenance.

(d.) The pump driver controls should be easily accessible from at least two directions, and where practical, should be located near a stairwell to permit access from other platform levels.

(e.) Consideration should be given to the possibility of freezing temperatures when pumps are installed outdoors. Also, consideration should be given to mitigating the effect the low temperatures may have on pumps or internal combustion engines.

3. *Fire Water Pump Installation.*

(a.) The lift column assembly should be constructed from materials resistant to corrosion by sea water such as fiberglass pipe or internally-mated steel pipe.

(b.) The lift column should be encased in a steel pipe for protection against wave action and mechanical damage. The protective pipe should be securely attached to the platform to minimize wave action damage.

(c.) Fire water pumps should be equipped with a cone or basket type intake strainer constructed of corrosion resistant material.

(d.) Where marine growth may restrict water intake, anti-fouling paint or other control measures should be considered.

4. *Fire Water Pump Drivers.* Acceptable drivers include diesel engines, natural gas engines, and electric motors. It should be noted that only diesel and electric motors are recognized by NFPA 20. Fire water must be available to allow time for fire fighting or abandonment, consistent with the operator's fire fighting philosophy. Fuel or power should be available for at least 30 minutes of run time during platform shut-in. Additional time may be required, depending on abandonment and fire fighting philosophies of the operator.

(a.) *Diesel Engines.* Diesel engines should be NRTL listed for fire service. NFPA 20 outlines several cooling methods for the engine. Proper cooling systems are vital to the operation of an internal combustion engine. A listed engine will be rated by horsepower developed. If an engine outside the power range and type of listed engines is used, then that engine should have a rating of 10% greater than the maximum brake horsepower required by the pump throughout its operating range. Engine starters may be electric, hydraulic, or pneumatic. Electric starters should be energized by storage batteries equipped with a trickle charger to maintain adequate power. Electric starters should be approved for the area in which they are installed. Hydraulic starters are often manually charged and activated. Hydraulic reservoirs for hydraulic starters may be pressurized by manually operated pumps or the pressure may be maintained in the reservoir by automatic pumps. Pneumatic systems may be used if adequate volume is provided to permit starting during platform shut-in. Starter systems should be sized to provide a minimum of three crank cycles. The fuel tank, fuel line, and start system should be located so that it is protected as far as practical against fire or other damage. Also, the exhaust piping should be equipped with spark arrestors. Other safety equipment may be required by the authorities having jurisdiction, such as shutdown devices to prevent engine overspeed.

(b.) *Natural Gas Engines.* Starters for natural gas fueled engines are similar to those for diesel fueled engines. Fuel lines to the engine should be routed so they are protected, as far as practical, against fire or other damage.

(c.) *Electric Motors.* API RP 500 should be observed when installing an electric motor driver and controls. Power cables to the motor should be routed or otherwise protected, as far as practicable, from fire or other damage. It is recommended that NFPA 20 and NFPA 70 (NEV) be consulted for information on power supply arrangement.

5. *Fire Water Pump Controllers.*

(a.) Controllers should be equipped for automatic and manual starting. Automatic starting should be accomplished using pressure switches for on/off operation or automatic start upon activation of the ESD, fusible loop, or other fire detection system.

(b.) For electric fire pumps, proper sizing of the circuit breaker is important. NFPA 20 and NFPA 70 contain useful information addressing circuit breaker sizing. It is recommended that these documents be consulted during the design of these units. If electric fire pumps are to switch to emergency generators upon loss of primary power, then an automatic transfer switch should be provided.

(c.) For engine-driven fire pumps, various alarm conditions should be monitored. Alarms should indicate low oil pressure, high engine jacket water temperature, failure of engine to start, and shut down from overspeed. Alarms are usually arranged to shut down the pump during manual (maintenance) starts. However, during starts from the ESD, fusible loop, or other systems, the alarms should not shut down the pump. Activation of the ESD should not shut down the fire water pump.

(d.) Alarms should be annunciated so that operations and maintenance personnel can respond.

b. *Piping.*

1. Fire water piping should be designed in accordance with API RP 14E. Fire water piping should be designed to deliver the required volume and pressure for all systems, hose streams, and monitors that are reasonably expected to operate simultaneously. Design considerations should include, but are not limited to, the following: pump output, safety factors for pump

output, fire hose diameter and lengths, deluge/water spray demands, flow restrictions such as marine growth or corrosion, and monitor or hose station nozzle pressure requirements.

2. The piping should be properly supported and routed under or behind main structural members, where possible, for protection from explosion or fire. If fire water piping and appurtenances are installed in the immediate area of hydrocarbon processing equipment, the use of a fire retardant insulation material should be considered. See Section 9 for guidance on passive fire protection systems. The design should also include a method to protect piping from freezing. Consideration should be given the use of sectionalizing valves where system integrity would be compromised by a failure in other portions of the system.

3. Selection of piping and valving materials and their proper installation is critical to the integrity and dependability of a fire water system.

Consideration should be given to several significant factors for materials such as: corrosion resistance, fire endurance, service life compatibility with other components in the system, and cost. There may be reasons for installing more than one kind of material in the same fire water system. The designer/user should evaluate the advantages and disadvantages of materials very carefully when specifying a fire water system. See Appendix D for guidance on the selection of materials for fire water systems.

c. *Fire Water Hose Stations.*

1. Hose stations should be located considering accessibility from other decks (near a stairway), possibility of damage from a fire, coordination with other stations, and interference from other platform activities. Where hose stations are provided, they should be arranged to provide coverage of the target area from two different directions.

2. Fire hoses should be stored on reels or other suitable devices designed for rapid deployment and for protection of the hose. These storage devices should be corrosion resistant.

3. Fire hoses of 1 in. (25 mm) or $1^1/2$ in. (38.1 mm) diameter are recommended for effective handling by one person. Hose lengths of not more than 100 ft (30.5 m) are recommended.

4. Fire hoses should be selected that are resistant to oil, chemical deterioration, mildew, rot, and exposure to offshore environment.

5. Hose test pressure should meet NFPA 1961 or NFPA 1962.

d. *Fire Water Hose Nozzles.* Most nozzles used are either combination (fog pattern 90°, 60°, 30°, straight) or straight stream nozzles. Combination nozzles are usually recommended to have a 100 psi (6.89 bar) pressure at the nozzle for proper streams. Straight stream nozzles are usually recommended to have a 50 psi (3.45 bar) nozzle pressure. Manufacturers' literature should be consulted for actual design requirements. Nozzles should be constructed of materials resistant to corrosion from sea water.

e. *Water Spray Systems and Monitors.* Fixed water spray systems and fixed monitor nozzles can be useful to protect areas that cannot adequately be reached by hand-held hose streams. These systems can be used in combination or separately. Both must be connected to a reliable and adequately sized supply of water and may be applied for one or more of the following reasons:

1. *Exposure Protection (Cooling).* Most common application. The system should be able to function effectively for the duration of the fire (depends on quantities of fuel) at an application rate that prevents failure of process equipment, piping, structural steel, etc.

2. *Control of Burning.* This system affords protection until all flammable materials have been consumed. The system functions by heat absorption, dilution, emulsification, or reduction of fuel vaporization rate.

3. *Extinguishment.* This system is dependent on the physical properties of the fuel. Extinguishment can be accomplished by cooling, smothering with steam, emulsification, or dilution.

Note: By extinguishing certain fires, a more hazardous situation may be created. This is especially true for gas fires. If the source cannot be controlled and the fire is extinguished, a vapor cloud could form and lead to an explosion.

Water Spray Systems. A water spray system should be designed for a specific design density which will achieve one of the above desired effects. Open water spray nozzles rather than fusible link type sprinklers are used to achieve specific water discharge and distribution on the surface to be protected. Nozzle orientation is a critical factor in design of the system. Water spray systems can be designed to activate manually or automatically in conjunction with an automatic detection system. NFPA 13 *Standard for the Installation of Sprinkler Systems*, NFPA 15 *Standard for Water Spray Systems for Fire Protection*, and API Publ 2030 *Application of Fixed Water Spray Systems for Fire Protection in the Petroleum and Petrochemical Industries* should be consulted for specific design densities and installation recommendations. The general span of application ranges from 0.2 gpm/sq. ft (0.00014 m/s) – 0.5 gpm/ sq. ft (0.00034 m/s) of protected surface. Design densities may also be obtained by testing.

Monitor Nozzles. Monitor nozzles are fixed nozzles used for delivering large quantities of water (greater than 250 gpm [15.77 dm/s]). They are fixed in place and have levers or gears for changing the position of the nozzle. They may be located to cover specific vessels or certain locations inaccessible to manual fire fighting. Some design factors to consider are location, size of supply piping, arrangement of control valves, etc. NFPA 24 *Private Fire Service Mains and their Appurtenances* should be consulted for further guidance.

A water system should deliver water to the protected area from at least two sides with 360° coverage preferred. The control system design should not allow all deluge zones to inadvertently open simultaneously unless it is considered in the fire water supply design.

Consideration should be given to simultaneous operation of devices when sizing fire mains and fire pumps. Several water spray systems may be in operation while hose stations and monitors are being used.

5.3 FOAM SYSTEMS

Foam forming additives increase the effectiveness of water in controlling pooled liquid-hydrocarbon fires. A fire fighting foam is a stable aggregation of small bubbles of lower density than water or oil having a tenacious quality for covering and clinging to horizontal or inclined surfaces. It has the capability of flowing freely over a burning liquid surface, cooling the liquid, and forming a tough, air-excluding, continuous blanket to seal combustible vapors from access to air. Foam systems are not effective on gas pressure fires or grated areas. NFPA 11 *Foam Extinguishing Systems* should be consulted when planning, designing, or installing foam systems.

Foams may be employed using (1) hose stations, (2) fixed systems, or (3) portable extinguishers and should capable of being actuated manually. The foaming agent may be applied by directly introducing foam concentrate into the fire water system or may be applied as a premixed solution of concentrate and water.

Foam may be stored in a tank or in the vendor's shipping container. The storage location(s) of foam concentrate and premixed solutions should be selected considering the difficulty to replenish the system during an emergency, and the minimum ambient temperature because foam concentrates and premixed solutions are subject to freezing. The foam concentrate must be kept in adequate supply and not contaminated or diluted and the operator should follow the manufacturer's recommendation for testing. When dry chemical and foam extinguishing agents can be used at the same location, compatibility of the two products should be confirmed with the manufacturer(s).

a. *Concentrate Proportioning*. Foam concentrates are available for mixing with water in fixed proportions; commonly, one through 6% mixtures with water. The correct amount of concentrate may be introduced directly into the fire water system by use of either eductor stations or diaphragm tanks.

1. *Eductor Stations*. A simple means to supply foam to a hose station is through the use of an eductor to pick up the foam and proportion it into the water stream. The main disadvantage of an eductor is the pressure loss across it (on the order of one-third). This loss must be taken into account in the design of a system. Conventional fire hose nozzles are available that will provide sufficient aeration to form a foam. Because eductors are sensitive to back pressure, fixed rate nozzle gallonage rating and eductor ratings must match. Manufacturers' data should be consulted for maximum lengths of hose that can be used. Actual length of hose used should not exceed the manufacturers' recommendation less equivalent lengths of fittings, etc., downstream of the eductor. Eductor concentrate hose stations can be provided in a package containing all the components pre-assembled, including a concentrate storage tank.

b. *Premix Systems*. Premix systems may be used when a self-contained fire fighting system is desired. A means of storing the solution is required along with a means to expel the solution. Commercial equipment is available for this purpose and must be tailored to fit a particular application. Premixed foam-water solutions should be periodically tested and replaced to ensure their proper concentration and chemical integrity.

5.4 DRY CHEMICAL SYSTEMS

Dry chemicals extinguish by interrupting the chemical reaction of the fire. Dry chemical is very effective at reducing flame, but does not cool or provide reflash protection. Dry chemical is most commonly used in portable or semi-portable extinguishers, but may be used in hose reel or fixed system applications. Fixed systems are typically employed over cooking surfaces or deep fat fryers. Dry chemical is deployed as a powder driven by a compressed gas propellant. The powder poses risk of injury if inhaled, and can be dissipated by wind, reducing its effectiveness in exterior applications. The powder can be corrosive to electrical components. The nature of potential fires should be carefully considered in selecting and sizing the type of dry chemical and equipment. NFPA 17 *Dry Chemical Systems* should be consulted when planning, designing, or installing dry chemical systems.

a. *Types of Dry Chemical Agents*. Dry chemical agents are available for all classes of fires. The terms "regular dry chemical" and "ordinary dry chemical" refer to powders that are listed for use on Class B and Class C fires. "Multipurpose dry chemical" refers to powders that are listed for use on Class A, Class B, and Class C fires, although its use may be detrimental to the electrical equipment. A multipurpose dry chemical system is recommended only for those areas that include substantial Class A exposure, such as quarters or storerooms containing dry goods.

b. *Portable Extinguisher Considerations.* Dry chemical is well suited for application by means of portable extinguishers. Portable extinguishers can be easily operated by personnel, facilitate rapid response to fires, and are frequently all that is needed to control and extinguish a fire. Proper labeling and placement of extinguishers is an important element in the system design. Section 6.2 provides guidelines for the placement of extinguishers on a facility.

c. *Fixed System Considerations.* To cover several areas with a single supply of agent, hose reels or a system of nozzles can be connected by rigid piping to a single dry chemical supply. A major disadvantage of using a single large supply unit is the loss of fire fighting capability if the unit malfunctions or is damaged. This disadvantage can be overcome by using several smaller units or redundancy through use of additional portable or semi-portable units. Regulatory bodies may impose certain requirements on the actuation and control of fixed systems, dependent on certain design considerations of the facility, size of the area protected and the availability of personnel. System control guidelines are provided under 5.6

1. *Piping.* The discharge of dry chemical and expellant gas is two-phase flow, and the flow characteristics are dependent on the particular dry chemical, propellant gas, distance, and equipment being used. Therefore, it is important to use the manufacturers' data, which has been established by investigation and tests.
2. *Quantity.* The minimum quantity of dry chemical on hand for use in remote hand hose systems should be enough to permit use of the system for 30 seconds for each hose that might be in use simultaneously.

d. *Combined Use of Dry Chemical and Foam.* Dual-agent, self-contained systems are available for simultaneous or sequential use of foam and dry chemical. Such systems offer the advantages of rapid extinguishment by dry chemical and the reflash protection of foam. When dry chemical and foam extinguishing agents are considered for use at the same location, compatibility of the two products should be confirmed by the manufacturer(s).

e. *Dry Chemical Systems in Lieu of Fire Water Systems.* The corrosive properties of seawater and resultant high maintenance required for water systems can result in these systems not being available for use in an emergency. Minimal, or intermittent attendance by personnel, and other risk factors may warrant consideration of using additional chemical systems in lieu of fire water. If a fire water system as described under 5.2 is not installed, the following additional measures are recommended:

1. Tanks that store hydrocarbons or other flammable or combustible liquids, and have a capacity of 100 bbl or greater, should be protected by a fixed fire protection system that delivers foam and/or inert gas to the tank interior.
2. Storerooms for paint or other flammable or combustible liquids and have an area of 200 ft^2 or greater should be protected by a fixed sprinkler, watermist or gaseous extinguishing system. Where permitted by the regulatory authority, the extinguishing system should be automatically activated.
3. Spaces or enclosures containing internal combustion engines in excess of 1,000 bhp should be protected by a fixed sprinkler, watermist or gaseous extinguishing system. Where permitted by the regulatory authority, the extinguishing system should be automatically activated.
4. For facilities with quarters and cooking facilities, cooking surfaces should be protected by a range hood and dry chemical extinguishing system while personnel are on board.
5. For manned facilities, additional portable and semi-portable extinguishers should be located throughout the facility at locations based on specific analysis of the fire risks present on the facility, possible fire scenarios, and the particular fire protection philosophy applicable to the facility. Hose reel, or fixed chemical extinguishing systems may be employed in lieu of additional portable extinguishers, as long as the quantities of portable extinguishers are not less than that recommended under 6.2.
6. For manned facilities, the operator should consider the inclusion of a structural fire boundary that can serve to isolate the quarters or mustering and abandonment areas from the production areas.

5.5 GASEOUS EXTINGUISHING AGENT SYSTEMS

Gaseous extinguishing agents extinguish fires using two principal mechanisms, depending on the agent. Gases such as Carbon Dioxide (CO_2) and Inergen displace or reduce the concentration of oxygen, smothering the fire. Halons and flurocarbon-based halon replacements interrupt the fire chemical reaction. Gaseous agents are especially suitable for Class C fires because they are electrically nonconductive. CO_2 and Inergen leave no residues, while the halons and similar agents leave residues that can be corrosive under certain circumstances. Gaseous agents are also suitable for fires involving flammable liquids and other special hazards where the use of water is undesirable.

a. *Types of Agents.* Common gaseous Extinguishing Agents include CO_2, Halon 1301 and 1211, FM-200, FE-13, and Inergen. Use of halons has been banned for new systems due to its detrimental effect on atmospheric ozone and global warming. FM-200 and FE-13 are flurocarbons that have some global warming potential, and can pose health risk to personnel exposed to concentrations used to extinguish fires. CO_2 displaces oxygen and will suffocate personnel within a space which it is deployed. Inergen is a mixture of CO_2, Argon and Nitrogen that reduces the oxygen content below a level that will support combustion, but not below that needed to support human life.

b. *Portable Extinguisher Considerations*. Gaseous agents may be applied by means of portable extinguishers. Portable extinguishers are commonly used to provide rapid response to fires and are addressed under Section 6. CO_2 is commonly used in portable extinguishers protecting electrical equipment.

c. *Fixed System Considerations*. Gaseous agents may be used for total flooding of an enclosed area or for local application. Like dry chemical systems, a single gaseous agent supply can be used to protect multiple areas connected to the agent supply by fixed piping. Fixed nozzles can be used to protect selected areas, particularly in enclosed areas. CO_2 is not generally used for protection of spaces that can be occupied by personnel due to the suffocation risk.

1. *Piping*. Piping design for fixed systems is critical and dependent on the agent used, volume to be deployed and distance. Piping pressure drop must be limited to prevent the formation of snow in CO_2 systems or to maintain the liquid state in halon systems. Therefore, these piping systems should be designed by experienced personnel familiar with gaseous fire system design.

2. *Fixed System Enclosures*. Enclosed spaces protected by a fixed gaseous system should be designed to achieve and maintain vapor-tight integrity during and following discharge of a gaseous agent. Doors to the space should be self-closing and open out from the space protected. Actuation of the extinguishing system should close ventilation openings and louvers, and activate installed alarms and time delays to alert personnel that could be in the space. When the regulating authority permits automatic deployment of the system, the controls should also ensure actuation of installed alarms, closure devices and delays.

d. *Personnel Safety*. The discharge of gaseous extinguishing agents may expose personnel to noise, turbulence, high velocity, low temperature, risk of suffocation, and exposure to toxic combustion products. A static electricity hazard may exist when discharging any gaseous extinguishing agent. Consideration should be given to grounding nozzles and objects exposed to the gaseous extinguishing agent. See ANSI/NFPA 77 *Recommended Practice on Static Electricity*. The use of CO_2 in enclosed areas can produce an oxygen deficient atmosphere that will not support human life. Such an atmosphere will quickly produce dizziness, unconsciousness, and death if personnel are not removed from the area. Large volume discharges of CO_2 may also seriously interfere with visibility because CO_2 produces fog when discharged. The designer should consider the published toxicity data for the agent being used and determine if the threshold limit values can be exceeded at the concentrations used for extinguishment. Appropriate warning signs, time delays and personnel warning alarms may be considered. The regulatory requirements for the installation should also be consulted to determine additional requirements that may apply.

e. Although halons and flurocarbons have low toxicity during fire, their decomposition products can be hazardous. For any use of CO_2 and/or other gases where there is a possibility that personnel could be trapped in or enter into atmospheres made hazardous by their discharge, suitable safeguards should be provided to ensure prompt evacuation of personnel and to prevent personnel entry into such atmospheres and also to provide means for prompt rescue of any trapped personnel. In addition to pre-discharge/discharge audible/visual alarms, suitable safeguards may include training, warning signs, and the availability of escape or rescue breathing apparatus.

5.6 WATERMIST SYSTEMS

Watermist, or fine water spray systems extinguish fires by rapid cooling effect, combined with localized displacement of oxygen at the flame source as the mist is flashed into steam. Watermist systems may be used in applications suitable for a fixed gaseous or sprinkler system. Watermist utilizes stored fresh or distilled water and leaves no residues. Electrical equipment should be de-energized before deployment of watermist, although it can be safely discharged while electrical equipment is energized.

a. *Types of Watermist Systems*. Watermist systems may be designed to protect a single location or multiple locations. The systems come in two basic configurations:

1. High-pressure systems provide fresh water propelled by Nitrogen or other compressed gas at pressures of 150 psi – 4,000 psi. Water is distributed by a single high-pressure piping system to nozzles, where the water is atomized into a fine mist as it passes through an orifice.

2. Low-pressure systems operate at under 150 psi. Water and compressed air are separately piped to each nozzle, where they mix to create a mist.

b. *Fixed System Considerations*. Watermist systems typically use far less water than sprinkling systems. The space and volume requirements for watermist systems are comparable to that for a fixed gaseous system.

1. Low-pressure systems require separate piping for the water and propellant to each nozzle, but the piping can be tubing or other low-pressure service. High-pressure watermist system requires high-pressure piping.
2. Watermist system controls are comparable to the controls for fixed gaseous systems. Some systems may be designed to apply the mist in an intermittent pattern to enhance extinguishment or provide some reflash protection.
3. Unlike fixed gaseous systems, watermist systems do not require vapor-tight integrity of the protected area.
4. Systems designed to operate using plant-supplied water and/or air in lieu of dedicated stored water/air should only be considered when the supply is considered reliable under emergency conditions.

5.7 FIRE EXTINGUISHING CONTROL SYSTEMS

Facilities should have appropriate fixed gaseous or watermist systems as described under 5.5 or 5.6 (respectively), a fire water system as described under 5.2 (or chemical system in lieu of fire water as described in 5.4), and portable fire fighting systems as described in Section 6, "Portable Fire Extinguishers." In addition to the hand-held portable fire extinguishers required per Section 6, unmanned platforms containing production facilities should have a minimum of one (1) 150 lb (68.04 kg) wheeled dry chemical unit per deck (excluding boat landing and sub-cellar deck), where practical. In lieu of wheeled units, a fire water system may be used. The controls of each of these systems are dependent on the specific facility arrangement and risks, personnel available, and fire protection strategy employed. Generally, equipment such as fire hoses, portable or semi-portable extinguishers, and certain fixed systems are manually controlled, requiring personnel to first recognize the fire or risk of fire and activate the system. Automatic systems are those where a condition such as heat or smoke activates a control sequence leading to the release of the extinguishing agent.

Automatic systems controls should be designed to prevent injury to personnel resulting from unexpected deployment of the agent while persons are in the space protected. Design features include time delays and alarms prior to the release of agent, warning signs, or use of appropriate lockout-tagout procedures while personnel are in protected spaces. Automatic discharge of gaseous systems is prohibited by some regulatory authorities, and should be considered within the appropriate jurisdictional context. Automatic fire control systems are best used in areas where quick response significantly reduces the extent of damage and/or increases the safety of personnel.

Typical systems used offshore and their control mechanisms are listed below:

a. *Well, Process, and Hydrocarbon Storage Areas*. Fire water systems (hose reels, monitors, and manual deluge systems) are effective in controlling fires in these areas. Water can be used with other agents such as foam to improve effectiveness in areas with drip pans or solid steel decking. Automatic fixed water spray systems capable of wetting critical surfaces may be used. Special consideration should be given to wellheads, pressure vessels, key structural members, and equipment that has the potential for developing high surface temperatures during operations (e.g., fired equipment). Coverage and water density should be in accordance with 5.2e. Dry chemical or gaseous systems are not recommended for automatic operation in these areas.

b. *Enclosed Well and Process Areas*. Automatic fixed water spray systems or dry chemical systems may be used in these areas. Automatic chemical system design is discussed in 5.4. In enclosed areas, the system should be designed for total flooding. Water type systems are preferred over dry chemical systems. Chemical extinguishing systems by their nature have a limited supply of chemical agent, and as such should have either a manual or automatic water system as backup. Gaseous systems are not recommended in these areas.

c. *Open Machinery Areas*. Manual fire water systems can be used in these areas on non-electric driven compressors and pumps. Water can be used with other agents such as foam to improve effectiveness in areas containing drip pans or solid steel decking. Automatic fixed water spray/foam or watermist systems may be used for hydrocarbon pumps located outside of buildings. Automatic gaseous and dry chemical fire control systems are not recommended for gas compressors or electrical generators mounted on skids or decks outside of buildings. Systems employing water should be designed to minimize hazards or damage resulting from impingement of water on hot surfaces.

d. *Enclosed Machinery Areas*. These areas should contain dry chemical extinguishers per Section 6. In addition, manual hose reels and foam systems can be installed near the enclosure, or the enclosed space may be protected by a fixed gaseous or watermist system. Gas compressors, hydrocarbon pumps, and generators in adequately ventilated enclosed areas are normally not protected by automatic fire control systems. Gas compressors, hydrocarbon pumps, and generators in inadequately ventilated enclosed areas may be protected by automatic water spray, watermist, dry chemical, or gaseous systems if permitted by the regulatory authority. Systems employing water should be designed to minimize hazards or damage resulting from impingement of water on hot surfaces.

e. *Electrical Equipment Areas.* Automatic gaseous fire control systems as described in 5.5 or watermist systems as described in 5.6 should be considered for electrical equipment in enclosed buildings. Consideration may be given to discharging gaseous agents in electrical equipment buildings upon gas detection and prior to automatic circuit breaker operation in order to reduce the possibility of gas ignition.

f. *Living Quarters.* Extinguishers should be located throughout the living quarters as described in Section 6. Water hose reels should be strategically located near or inside the living quarters and should be accessible at each level. Quarters may also be protected by a sprinkler or watermist system.

1. Automatic dry chemical, CO_2, or wet foam systems should be considered in stove and fat fryer areas. All systems should include coverage of exhaust ducting, and automatic isolation of power from stoves and fryers. Dry chemical system design should also consider time delays on removing power from exhaust fans.
2. Automatic water sprinkler or watermist systems should be considered in non-cooking areas of living quarters. Design of the system should consider coverage, type of release (individually activated spray heads or total system activation), dry vs. wet charged systems, and corrosion of pipe systems. Further information on the design of sprinkler systems is found in NFPA 13.
3. Total flooding automatic gaseous systems are not recommended for use inside living quarters.

5.8 EMERGENCY DEPRESSURIZING

Facility depressurizing is a procedure that may be used as a complement to other fire protection systems to reduce or eliminate pressure induced stresses during a time of potential heat weakening of vessels and piping, as well as a reduction of the inventory of fuel present on the facility. The designer should note that depressurizing may result in an increased frequency of discharging large volumes of gas in a short period of time, as well as the loss of facility process control if based on natural gas supply. Precautions must be taken to prevent air intrusion and the possibility of expelling hydrocarbon liquids into the depressurizing system. Depressurizing to zero has the potential hazard of introducing air into the hydrocarbon system. In addition, the operator should carefully review their fire-fighting philosophy, design of depressurizing system, dispersion calculations, etc., prior to electing to implement a depressurizing system.

a. *Design Philosophy.* Where installed, the design and function of the depressurizing system must fit into the overall scheme of fire protection for the facility. Consideration should be given to other fire protective measures present, such as deluge systems, hand held and wheeled chemical units, hose reels, and fixed water spray monitors. The effectiveness of these other protective measures and the length of time for which they are available, as well as their special needs (i.e., fuel gas for fire water system) should be considered.

The fire control philosophy will determine the design rate of depressurizing and the process/mechanical design. For example, a fire control philosophy which relies primarily on blowdown will require a fast acting, high rate system, whereas a philosophy that incorporates an extensive use of deluge for heat control could typically allow depressurizing at a slower rate without experiencing vessel failure.

See Appendix E, "Emergency Depressurizing Design Considerations," for additional information.

b. *Magnitude.* Facility depressurizing can be partial or total. Partial depressurizing is used to reduce hydrocarbon inventories in specific sections of the platform or facility, such as compressors or critical vessels and piping. Partial depressurizing allows a reserve of fuel gas to accommodate emergency operations, etc. Properly designed, total depressurizing may provide an additional measure of protection by essentially eliminating pressurized fuel sources on the platform.

c. *Control.* Depressurizing can be initiated automatically or manually. Automatic depressurizing is typically initiated upon activation of ESD or Temperature Safety Element (TSE) loop(s), and may be subject to a time delay. This time delay allows facility operators the option of canceling the depressurizing in the event of a false or accidental alarm. Once the sources of input (i.e., wells and pipelines) are shut-in, one or more actuated depressurizing valves automatically fail open, depressurizing the facility. Automatic depressurizing does not rely on human activation; it reduces the possibility of human error in valve sequence; and, in the case of unmanned platforms, may provide an additional level of fire protection.

Manual initiation of depressurizing requires human intervention, and reduces the possibility of accidental occurrences due to instrumentation malfunction. Manual depressurizing can give the operator the capability to manage the fire control effort by providing selective control of the depressurizing process over such parameters as depressurizing rate, number of components depressurized, depressurizing of specific platform sections, etc. The degree of manual intervention can vary. Depressurizing valve operation may be manual or actuated. If actuated, the controller may be located remotely at a central control point, or at the valves.

6 Portable Fire Extinguishers

6.1 GENERAL

Hand portable fire extinguishers are intended as a first line of defense against fires of limited size and should be provided even though other fire extinguishing equipment is available. A major advantage of chemical extinguishers is their self-contained feature, which provides for protection without reliance on an external source of energy. A disadvantage, of course, is that the amount of extinguishing agent is limited to the capacity of the unit selected. Wheeled dry chemical extinguishers provide more capacity and range than hand portable units. This factor and the nature of potential fires must be carefully considered in selecting the size and number of extinguishers. Hand portable fire extinguishers with less than a 40-B rating or multipurpose Class A, B, C extinguishers are not recommended for installation in the process areas of production platforms. Information on extinguisher types and ratings is presented in Appendix B. NFPA 10 *Portable Fire Extinguishers*, provides further information. USCG regulations should be reviewed for additional information on portable fire extinguishers used on OCS fixed platforms.

6.2 PLACEMENT OF EXTINGUISHERS

Portable fire extinguishers are most effectively utilized when they are readily available in sufficient number and with adequate extinguishing capacity for use by persons familiar with their operation. The actual placement of fire extinguishers should be based on a physical survey of the area to be protected.

a. *Mounting.*

1. Extinguishers should be accessible and available in the event of fire.
2. Extinguishers should be mounted where they can be seen and should not be obstructed.
3. Hand portable extinguishers should be installed on hangers or brackets, or set on shelves that permit easy removal.
4. All hand portable extinguishers should be installed so as to provide adequate clearance between the bottom of the extinguisher and the floor for protection from salt water corrosion.
5. Extinguishers should be kept in their designated places when not in use.

b. *Location.* Where a specific class fire extinguisher is recommended below, an extinguisher rated for two or more classes may be used, provided one rating is the specified class.

1. Extinguishers should be located to minimize the possibility of damage from a fire or explosion and be provided in sufficient number that the overall fire control capability is not seriously impaired by a single fire.
2. The maximum travel distance from any point on the platform deck area having a potential for fire to an extinguisher should not exceed 50 ft (15.2 m).
3. A Class B extinguisher should be located within 10 ft (3.0 m) of each stairway on each deck level which has a potential for fire.
4. A Class B extinguisher should be provided for each internal combustion or gas turbine engine installed in an enclosed area.
5. A Class B extinguisher should be provided for each three internal combustion or gas turbine engines installed in open areas.
6. A Class C extinguisher should be provided for each two electric generators and for each two electric motors of 5 horsepower (3.7 kW) or greater.
7. A Class B extinguisher should be provided for each gas or oil fired boiler or heater.
8. A Class A extinguisher should be installed in each main corridor of quarters buildings.
9. A Class A extinguisher should be installed in each sleeping accommodation space occupied by more than four persons.
10. A Class C extinguisher should be installed in radio rooms or other enclosed areas containing a significant concentration of electrical equipment or controls.
11. Each galley should have installed extinguishers rated for Class A, B, and C fires.
12. An extinguisher of the appropriate class for stored combustibles should be provided for each storeroom.
13. A Class B extinguisher should be provided on or in the vicinity of each crane.

6.3 RECHARGING

Procedures should be established so that expended extinguishers can be immediately recharged or replaced. (See Caution statement in 7.7c.) Reserve supplies of dry chemical should be stored in a dry area in containers designed to prevent entry of moisture.

7 Inspection, Testing, and Maintenance

7.1 GENERAL

Fire control systems should be maintained so that they are fully operable through periodic inspection of equipment, a maintenance program, recharging each extinguisher after discharge, and hydrostatically testing each hand portable extinguisher as required. All persons expected to inspect, test, or maintain fire extinguishing systems should be trained in the functions they are expected to perform.

a. *Inspection.*

1. At least annually, all systems should be thoroughly inspected for proper operation by experienced personnel, following an established procedure.
2. The goal of the inspection is to determine if remedial measures are needed to maximize the probability that the item inspected will function satisfactorily until the next inspection.
3. Appropriate discharge tests should be made when inspection indicates their advisability.
4. Between annual inspections, systems should be visually inspected, or otherwise, by qualified personnel, following an established schedule and procedure.

b. *Maintenance.*

1. Systems should be maintained in satisfactory condition at all times. Use, impairment, and restoration of fire control systems should be reported promptly to the appropriate supervisor.
2. Any troubles or impairments should be promptly corrected by experienced personnel.

c. *Recordkeeping.*

1. An inspection report should be prepared showing, as a minimum, the prior inspection date, the current inspection date, the scope of the inspection, any corrective action taken or required, and the name or initials of the person making the inspection.
2. The latest inspection report should be retained at a designated field location.

7.2 FIRE WATER PUMPS

a. *Inspection and Tests.*

1. At least weekly, drivers and pumps should be started and operated long enough to bring to normal operating temperature. They should start reliably and run smoothly at rated speed and load.
2. At least monthly, water should be discharged simultaneously from a minimum of two discharge points to qualitatively verify the pump and water delivery system integrity.
3. Pump performance (flow volume and delivery pressure) should be tested annually to ensure the pumping system satisfies the fire water system design requirements.

b. *Maintenance.*

1. Engines should be kept clean, lubricated, and in good operating condition. Proper oil and coolant levels should be maintained.
2. *Starting Batteries.*

    (a.) Storage batteries should be kept charged at all times. They should be tested at least quarterly to determine the condition of the battery cells.

    (b.) The automatic charge feature of a battery charger is not a substitute for proper maintenance of the battery and the charger. Periodic inspection is required to ensure that the charger is operating properly.

3. *Fuel Supply.*

    (a.) Diesel fuel tanks should be checked after each engine run to assure an adequate fuel supply exists to meet the requirements of 5.2a.(4).

    (b.) Fuel gas scrubber vessels on natural gas fuel engines should be drained before and after the weekly engine run. Pressure gauge readings on fuel gas lines should be checked at the weekly engine run to determine that fuel gas is available at the proper pressure.

4. *Pump.* At a frequency dictated by flow test and experience, submerged pumps should be pulled to impact for corrosion and/or wear which could muse failure during emergency conditions.

7.3 FIRE HOSES, NOZZLES, AND MONITORS

a. *Inspections.*

1. At least annually, all fire hoses should be tested by subjecting them to the maximum fire water system operating pressures.
2. At least monthly, the hose and nozzles should be function tested for proper orientation.

b. *Maintenance.*

1. After each use, fire hoses should be returned to their storage device.
2. Cotton-jacketed hoses should be carefully cleaned and dried after use.

7.4 DELUGE AND SPRINKLER SYSTEMS

a. *Deluge System.* Deluge systems may be susceptible to plugging due to corrosion, biological fouling, or other foreign objects. Each operator shall establish a suitable means (e.g., inspections, testing, etc.) to verify that the system has the capability to function as designed. It is recommended that the operator verify the integrity of the system annually. Particular attention should be given to preventing introduction of foreign materials into the fire water system during system modifications.

b. *Sprinkler Systems.* Where installed, sprinkler system water flow, alarms should be tested for proper operation at least monthly.

7.5 FIXED DRY CHEMICAL EXTINGUISHING SYSTEMS

a. *Inspection and Tests.*

1. At least annually, all dry chemical extinguishing systems and other associated equipment should be inspected and checked for proper operation by qualified personnel.
2. At least semi-annually, all expellant gas containers should be checked by pressure or weight against required minimums.
3. At least semi-annually, all stored pressure dry chemical containers should be checked by pressure and weight against specified minimums.
4. Except for stored pressure systems, at least annually the dry chemical in the system storage container should be sampled from the top center and also near the wall. Inherent lumps that will not be friable when dropped from a height of 4 in. (101.6 mm) shall cause replacement of chemical.

b. *Maintenance.* After use, hoses and piping should be cleared of residual dry chemical.

7.6 GASEOUS AND WATERMIST EXTINGUISHING SYSTEMS

a. *Inspection and Tests.* At least annually, qualified personnel should thoroughly inspect and test all systems for proper operation. Discharge of the system is not required.

b. *Weight and Pressure.* At least semi-annually, the weight and pressure of refillable containers should be checked. If a container shows a loss in net weight of more than 5%, or a less in pressure (adjusted for temperature) of more than 10%, it should be refilled or replaced.

c. *Records.* The weight and pressure of the container should be recorded on a tag attached to the container.

7.7 PORTABLE FIRE EXTINGUISHERS

a. *Inspections.* Extinguishers should be inspected monthly, or at more frequent intervals when circumstances require, to ensure they are in their designated places, to ensure they have not been actuated or tampered with, and to detect any obvious physical damage, corrosion, compaction of powder, or other impairments.

b. *Hydrostatic Test.*

1. Hand portable extinguishers should be hydrostatically tested per NFPA 10 at intervals not exceeding those specified in Appendix C with the following exceptions:

a. Extinguishers utilizing a cylinder fabricated to U.S. Department of Transportation (DOT) specifications should be hydrostatically tested or replaced, according to the requirements of DOT.

b. Any time a cylinder shows evidence of corrosion or mechanical damage, it should be hydrostatically tested. However, some instances of damage require that the cylinder not be tested but replaced.

2. Nitrogen cylinders used for inert gas storage and used as an expellant for wheeled extinguishers should be hydrostatically tested by qualified personnel.

3. The hydrostatic test date should be recorded on a record tag of metal or equally durable material, or a suitable metallized decal affixed (by a heatless process) to the shell of an extinguisher that favorably passes the hydrostatic test. The record tag should contain the following information: date of test, test pressure, and name or initials of person or firm making the test.

c. *Maintenance.*

1. At regular intervals, not more than one year apart, extinguishers should be thoroughly examined. Deficient extinguishers should be repaired, recharged, or replaced, as appropriate.
2. Extinguishers out-of-service for maintenance or recharging should be replaced by an extinguisher(s) having the same classification and at least equal rating.
3. Each extinguisher should have a durable tag securely attached to show the maintenance or recharge date, and the initials or signature of the person who performs this service.

CAUTION: Mixing of different powders can cause a corrosive mixture and abnormal pressures to develop which can cause extinguishers to explode (i.e., mixing multipurpose powder with other powders). Extinguishers should only be refilled with the same type powder originally contained in the unit.

7.8 FIRE AND GAS DETECTORS AND GENERAL ALARMS

a. *Fire and Gas Detector Panel.* At least quarterly (not to exceed 100 days), circuit interfaces should be verified ensuring that detectors annunciate proper zones and activate proper alarms or extinguishing systems.
b. *Detectors (Flame, Heat, Smoke).* At least quarterly (not to exceed 100 days), fire detectors should be tested for operation and recalibrated, if applicable. Fusible element (fire loop) systems should be inspected for conformance with API RP 14C.
c. *General Alarm.* At least once a month, general alarms (see 4.4a), should be tested for operation.

8 Personnel Safety and Orientation

8.1 PERSONNEL SAFETY

a. *General.* Platforms should have means and methods by which personnel can safely fight a fire and, if the need arises, escape the platform. See API RP 14J for additional information concerning evacuation. Facilities operating on the United States OCS must comply with the USCG emergency evacuation requirements.

b. *Response and Escape Plans.*

1. A response plan (station bill) should be developed for the occurrence of a fire on a platform. This plan should designate by title and in order of succession the persons on the platform who shall be the "person in charge" and any special duties or duty stations that are required to fight a fire.
2. An escape plan should be included in the fire control plan so that a platform may be abandoned in a safe manner. This plan should indicate the abandon platform signal, the location of both primary and secondary means of escape, and the location of means of egress.
3. Copies of the response and escape plans should be posted in a conspicuous location on platforms which are manned. A generalized plan should be developed by the operator to cover platforms which are not continuously manned.

c. *Fire Drills.* Fire drills should be conducted for each crew on a monthly basis by the person in charge on all platforms which are manned. The drill should be conducted as if an actual fire existed. All personnel should report to their respective stations and be prepared to perform the duties assigned to them by the response and escape plans.
d. *Escape from Platform.* All platforms should be provided with means of escape sufficient to permit the safe egress of personnel in case of fire or other emergency. Facilities operating on the United States OCS must comply with the United States Coast Guard (USCG) Regulations on "Means of Escape."

Means of escape should be located and arranged so they are accessible to platform personnel. When more than one primary means of escape is provided at a platform level, at least two of the primary means of escape should be remote from each other and so arranged and constructed as to minimize the possibility that both may be blocked by any one fire or other emergency condition.

When only one primary means of escape and one or more secondary means of escape are to be provided at a platform level, at least one of the secondary means of escape should be remote from the primary means of escape and so arranged and constructed as to minimize the possibility that both may be blocked by any one fire or other emergency condition.

e. *Means of Egress.* All platform areas should be provided with means of egress sufficient for personnel to escape from a fire or other emergency and to travel to a means of escape.

Means of egress should be so arranged and maintained to provide adequate headroom and width.

Means of egress should be arranged and maintained so as to be readily accessible to platform personnel. The means of egress should be provided for escape in two different directions.

8.2 PERSONNEL ORIENTATION

a. *New Employees.*

1. Minimum training of personnel going offshore for the first time should include an orientation per API RP T-1 *Orientation Programs for Personnel Going Offshore for the First Time.*
2. New employees should receive training in alarm recognition, fire protection, and soon after employment as is practical.
3. New employees should be instructed in the response and escape plans for platforms where they are working.

b. *Platform Visitors and Contractors.* Platform visitors and contractors should be instructed and trained upon boarding the platform in the response and escape plans they are expected to perform in an emergency. They should also be instructed as to the various alarms and to their meaning.

c. *Fire Training and Incipient Stage Fire Response.* All operating personnel and other personnel who are offshore frequently should have fire-fighting training. This training should include practice in combating staged gas and oil fires similar to what would be expected on an offshore platform. Each session should include defensive fire response and operation of all the equipment personnel are expected to use. Each employee should know the location of incipient stage fire equipment, how to use it, and how to report a fire alarm. They should be given actual experience in handling the equipment on small practice fires simulating actual situations as closely as possible. As a minimum, this training should be conducted during a four to eight hour session each year. Each session should include defensive fire response and operation of all the incipient stage equipment employees are expected to use.

d. *Refresher Training.* Personnel should repeat the fire fighting training at intervals sufficient to develop and maintain the employee's confidence. The employee's competence and confidence in his ability to fight an offshore fire depend on how much practice he has had in using the fire fighting equipment. Refresher training should include the use of equipment expected to be used and practice in combating staged fires similar to what may be expected.

e. *Scenario Drills.* Planned programs should be used to ensure that each employee is familiar with the alarm signal systems, and the escape or response plan at his work place, and that they know their assignment. The escape or response plan will set forth the special duties and duty stations of each member of the personnel in the event of an emergency. Practice scenario drills should be held including the announced walk-through type as well as the unannounced variety. Actual practice in abandoning the platform is desirable.

f. *Documentation.* Documentation covering fire drills, training, etc. should be maintained.

9 Passive Fire Protection

9.1 GENERAL

Passive fire protection is defined as any fire protection system that by its nature plays an inactive role in the protection of personnel and property from damage by fire. Appendix F contains additional information on passive fire protection maintenance, ratings, and penetrations. Passive fire protection is quite often generically referred to as Structural Fire Protection (SFP), particularly in governmental regulations. Examples of passive fire protection systems would be spray-on insulating materials or insulating blankets of fireproof materials. Conversely, examples of active fire protection systems would be fire water, AFFF, CO, or dry chemical systems. API Publ 2218 *Fireproofing Practices in Petroleum and Petrochemical Processing Plants* can provide useful information regarding fireproofing practices, materials, etc.

9.2 USES

Generally, passive fire protection is not used as the only means of fire protection, but rather it is used in concert with active fire protection systems. This is because passive fire protection does not, in and of itself, provide inherent protection and is normally effective only for a finite time period. Once passive fire protection is exhausted, the protected component is vulnerable to damage by fire. Examples of where passive fire protection is used are: critical structural steel, living quarters, firewalls, etc.

9.3 FIREPROOFING MATERIALS

Them are many types of fireproofing materials available and in use throughout the industry. These materials are lightweight concretes, preformed inorganic panels, masonry blocks and bricks, man-made mineral fibers, and subliming, intumescent, and ablative mastics. However, the fireproofing materials that have been most commonly used in the offshore petroleum industry, and which will be addressed here, can be broken down into two generic groups; active and inactive insulants. The active insulants undergo chemical and physical changes when exposed to fire and the inactive insulants do not.

a. *Active Insulants.* The active insulants are generally available as ceramic fiber (or similar fireproof materials) structures in an epoxy-based matrix which contains additional chemicals designed to cause some chemical or physical reaction upon exposure to heat. The active insulants typically are available in multiple-part mixtures which when mixed together form a slurry suitable for spray application. However, they can be purchased in pre-cast panels which can be bolted in place. Active insulants are also known as intumescent materials because when they are exposed to heat, they undergo a physical and chemical change which causes them to expand to several times their applied volumes, thereby providing enhanced insulation.

b. *Inactive Insulants.* The inactive insultants can be grouped into two general groups: cementitious materials and man-made fibers, such as ceramic fiber or mineral wool. The cementitious materials, as the name implies, are essentially cement-based materials of a fire brick refractory blend, which are normally mixed as a slurry and spray-applied; however, these materials are also available in precast slabs which can be bolted in place. Man-made fiber insulants come in many different forms: blankets, bulk, panels, etc. These systems are installed by mechanically supporting them in or on a wall or similar structure.

APPENDIX A—FIRE DETECTION SENSORS

Classification of Detectors	Type of Detector	Operating Principle	Remarks
1. Flame Detectors	(a) Infrared (IR) Detectors	Responds to radiant energy from a flame	Used when a very rapid response to a fire is desired. Generally used in conjunction with an extinguisher system
	(b) Ultraviolet (UV) Flame Detectors	Responds to wave length of light emitted from flame	
	(c) Combination IR/UV	Responds to both UV and IR	Eliminate some of the false alarm problems of the individual IR or UV flame detectors
2. Heat Detectors	(a) Fusible Plugs or links	Melts at predetermined temperature	Used in compressor and equipment buildings and areas around production equipment and wellheads
	(b) Heat-pneumatic or Theronistor Sensors	Detect a high temperature along a length of tubing	
	(c) Rate of Rise Detectors	Detect a rapid rare of temperature rise	Not recommended for use near outside doorways in heated or air conditioned buildings
	(d) Fixed Temperature Detectors	Detect temperature above a predetermined value	
3. Products of Combustion Detectors	(a) Ionization Detector	Products of combustion activate an ionization chamber	Normally used in living quarters and control rooms
	(b) Photoelectric Detector	Activated by interruption of a beam of light by smoke particles	

APPENDIX B—FIRE EXTINGUISHER TYPES AND RATINGS

B.1 Extinguisher Types

The type of extinguisher selected for the class of fire anticipated depends on an analysis of the advantages and disadvantages of the various types available.

a. *Dry Chemical Extinguishers.* Dry chemical extinguishers are available in two basic styles: stored pressure and cartridge operated.

1. *Stored Pressure.* Them are two types of stored pressure dry chemical extinguishers. One type has a disposable shell and the other type has a rechargeable shell.

   (a.) *Disposable Shell.* The agent and pressurizing gas are in a factory-sealed cylinder which is threaded into a valve and nozzle assembly. Following use, the spent cylinder is discarded and a new one attached to the valve nozzle assembly. Disposable shell extinguishers usually have a capacity of 5 lb (2.27 kg) or less.

   (b.) *Rechargeable Shell.* The propellant gas (usually Nitrogen) and the agent are stored in the extinguisher shell.

2. *Cartridge Operated.* The agent is stored at atmospheric pressure in a chamber with a large fill opening. An activating assembly consisting of a cylinder of propellant gas (CO_2 or Nitrogen) with a valve and gas tube assembly is connected to the chamber. Activating assemblies provide a means of releasing the propellant gas into the dry chemical chamber. The dry chemical agent is fluidized and flows from the tank to a hose and nozzle assembly.

b. *Gaseous Extinguishers.*

1. *Compressed Gas Units.* CO_2 extinguishers are intended for use on Class B-C fires. The extinguishers consist of a pressure cylinder, a siphon tube and valve for releasing the agent, and a discharge horn or horn-gas combination. Extinguishers with electrically non-conductive (plastic) horns are recommended.
2. *Liquefied Gas Units.* Liquefied gas extinguishers have features and characteristics similar to CO_2 extinguishers.

c. *Water-base Extinguishers.* Them are two common types of extinguishers that use water. They are stored pressure type and the pump type. The stored pressure type is preferred over the pump type because of its ease of operation. These extinguishers are suitable only for Class A fires, but may be more effective than other Class A extinguishers on deep seated (mattress) fires.

B.2 Fire Extinguisher Rating

Most currently manufactured extinguishers are labeled with a series of markings that indicate the suitability of an extinguisher for a particular class of fire and the volume of agent provided. Figure B-1 shows the markings which are recommended in NFPA 10. Descriptions of the various classes of fires may be found in 2.2 of this RP. Extinguishers that are effective on more than one class fire have multiple classifications and ratings. Typical markings on these types of extinguishers are shown in Figure B-2.

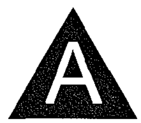
A NRTL will assign the extinguisher its rating on the basis of the size of standard test fires the device is able to extinguish successfully under reproducible laboratory conditions. Extinguishers produced by different manufacturers and having the same quantity and type of extinguishing agent sometimes get different ratings. Numerals are used with the identifying letters for extinguishers labeled for Class A or Class B fires. The numeral indicates the relative extinguishing effectiveness of the device. No rating numerals are used for extinguishers labeled for Class C fires. For example, the testing system used by Underwriters Laboratories, Inc., and Underwriters Laboratories of Canada might assign an extinguisher a rating of 4-A, 40-BC. This means the device is suitable for use on Class A, B or C fires, and that for Class A fires it is four times as effective as an extinguisher rated 1A, and for Class B fires it is forty times as effective as one rated 1-13. (A 4-A extinguisher is equivalent to 5 gallons [18.9 liters] of water in a Class A fire; a novice using a 40-BC extinguisher can normally be expected to extinguish a 40 sq. ft [3.7 m^2] fire of flammable liquid.) Extinguishers approved by the USCG for marine applications include marking of the fire class (A, B, C) and a number I, II, III, IV or V, which indicate the size of the extinguisher.

Appropriate labeling is done by the manufacturer. Labels will contain markings to indicate special instructions and extinguisher suitability. If appropriate, a NRTL approval label will be affixed. Care should be taken to maintain labels in good, legible condition because approval is voided if the label is lost.

The classification and rating system used in this RP is that used by Underwriters Laboratories, Inc. and Underwriters Laboratories of Canada. Full details are contained in UL 711 *Classification, Rating, and Fire Testing of Class AB and C Fire Extinguishers and for Class D Extinguishers or Agents for Use on Combustible Metals*. Other classification and rating systems are in use.

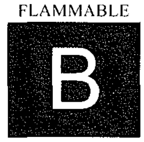
B.3 Quantity of Chemical Agent

The amount of chemical agent or extinguisher size required depends upon the size of fire that may be expected, the effectiveness of the extinguishing agent, and the skill of personnel expected to operate the equipment. Many sizes are available in the three basic configurations of hand portable, wheeled, and stationary units. Fire extinguisher unit size is expressed in terms of the weight, in pounds (kg), of the extinguishing agent. Tank capacities range from 1 lb to more than 3000 lb (0.45 kg – 1361 kg). Common sizes used are 20 lb – 30 lb (9.1 kg – 13.6 kg) hand portable units, 150 lb – 350 lb (68.0 kg – 158.8 kg) semi-portable units and 350 lb – 3000 lb (158.8 kg – 1361 kg) stationary units. Recognized testing laboratory ratings and NFPA 10 should be consulted for proper application of portable fire extinguishers.

ORDINARY


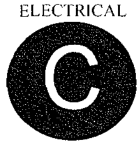
COMBUSTIBLES

1. Extinguishers suitable for "Class A" fires should be identified by a triangle containing the letter "A." If colored, the triangle shall be colored green.*

FLAMMABLE


LIQUIDS

2. Extinguishers suitable for "Class B" fires should be identified by a square containing the letter "B." If colored, the square shall be colored red.*

ELECTRICAL


EQUIPMENT

3. Extinguishers suitable for "Class C" fires should be identified by a circle containing the letter "C." If colored, the circle shall be colored blue.*

COMBUSTIBLE


METALS

4. Extinguishers suitable for fires involving metals should be identified by a five-pointed star containing the letter "D." If colored, the star shall be colored yellow.*

*NOTE: Recommended colors as described in the Federal Color Standard Number 595† are:

Green — No. 14260
Red — No. 11105
Blue — No. 15102
Yellow — No. 13655

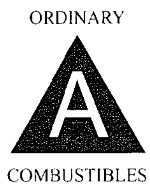
Extinguishers suitable for more than one class of fire may be identified by multiple symbols.

† Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Note 1: Reproduced with permission from Table B-1-3, *NFPA 10 Standard for Portable Fire Extinguishers*, Copyright ©1975, National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210

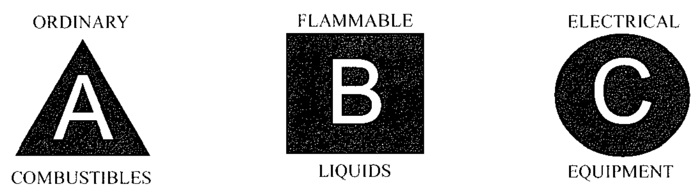
Note 2: Offshore environment may result in a need for more frequent inspection.

Figure B-1—Markings for Extinguisher Suitability

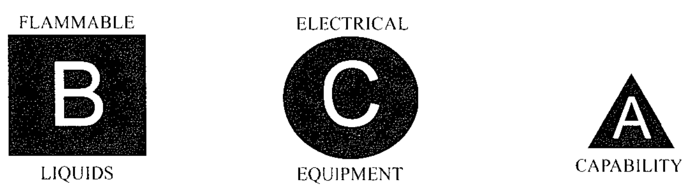


1. Water

2. Carbon Dioxide, Dry Chemical Bromochlorodifluromethane and Bromotrifluoromethane



3. Multipurpose Dry Chemical



4. Multipurpose Dry Chemical (Insufficient Agent for "A" Rating)

5. Dry Powder

Note 1: Reproduced with permission from Table B-1-4, *NFPA 10 Standard for Portable Fire Extinguishers*, Copyright © 1975, National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210

Note 2: Offshore environment may result in a need for more frequent inspection.

Figure B-2—Typical Extinguisher Markings

APPENDIX C—HYDROSTATIC TEST INTERVAL FOR PORTABLE EXTINGUISHERS

Extinguisher Type	Test Interval (Years)
Soda Acid	5
Cartridge-operated Water and/or Antifreeze	5
Stored Pressure Water and/or Antifreeze	5
Wetting Agent	5
Foam	5
Loaded Stream	5
Dry Chemical with Stainless Steel Shells or Soldered Brass Shells	5
Carbon Dioxide	5
Dry Chemical, Stored Pressure, with Mild Steel Shells, Brazed Brass Shells, or Aluminum Shells	12
Dry Chemical, Cartridge-operated, with Mild Steel Shells	12
Bromotrifluoromethame—Halon 1301	12
Bromochlorodifluoromethane—Halon 1211	12
Dry Powder, Cartridge-operated, with Mild Steel Shells	12

APPENDIX D—FIRE WATER PIPING MATERIAL SELECTION

D.1 Material Selection Considerations

a. *General.* In order to properly select fire water piping materials, consideration should be given to the following:

- Fire endurance.
- Mechanical strength.
- Erosion/corrosion resistance.
- Pitting susceptibility.
- Service life.
- Weight.
- Installation factors/cost.
- Pressure drop/flow velocities.
- UV degradation.
- Compatibility with other components.
- Marine growth resistance.

b. *Wet/Dry System.* A wet fire water piping system is continuously charged with water, to provide rapid delivery of fire water. A dry system is normally void of a water charge but is fed via deluge valves from the fire water supply. As a result, the system may not be as resistant to heat. However, circumstances may dictate the usage of a dry system. If a dry system is utilized, consideration should be given to the placement of the deluge valves such that they are sheltered from potential fire sources. If dry piping and appurtenances are installed in the immediate area of hydrocarbon processing equipment, a fire retardant insulating material or other means to ensure system integrity should be utilized.

D.2 Piping Systems

Special corrosion resistant alloys and nonmetallic materials should be installed by following manufacturers' recommendations and applicable standards.

a. *Metallic Piping.*

1. *Carbon Steel Pipe.* Carbon steel piping and valving materials have been the most commonly used materials for fire water systems in the offshore petroleum industry.

Carbon steel has good fire endurance, especially when filled with water, and it can withstand mechanical abuse. It is also more readily available than other material, craftsmen are familiar with welding and fitting it, cost of material is usually less, and no special warehousing is required.

The primary disadvantages of carbon steel fire water systems, regardless if the system is wet or dry, are short service life and plugging of the spray nozzles. Carbon steel offers the least resistance to seawater corrosion, and thereby experiences the shortest service life. In addition, internal products of corrosion in carbon steel systems can render a deluge system unreliable by plugging the spray nozzles. Therefore, a carbon steel fire water system should be routinely tested and inspected, as is other piping in corrosive services, so as to determine nozzle effectiveness, pipe wall thickness, and service life.

Internally-lined carbon steel pipe and fittings have been installed to reduce corrosion. Internally-lined components often require special handling and assembly with nonwelded connections. A lined system limits the possibility of tie-ins, makes revisions difficult, and increases the cost.

Galvanized carbon steel fire water systems withstand seawater better than plain carbon steel. Galvanized systems are also limited in types of connections and revisions that can be made without damage to the mating.

In general, carbon steel fire water systems will have the shortest service life of the commonly used materials due to corrosion (often less than 10 years life). Most carbon steel systems will be more dependable and have a longer life if the system is flushed thoroughly and regularly with fresh water to sweep the corrosion products from the system. The system should be inspected regularly in order to determine replacement requirements.

2. *Stainless Steel Pipe.* Stainless steel materials have the advantages of high heat resistance, ability to withstand mechanical abuse, freedom from internal corrosion products, and high external corrosion resistance. The primary disadvantages are susceptibility to pitting attack by seawater for lower grades (such as Grades 304 and 316) and increased cost for higher grades.

The proper selection of the type of stainless steel is important to avoid corrosion and pitting attack. The lower grades of stainless steel are susceptible to pitting attack, especially in stagnant seawater. Pitting attack in dry systems (i.e., deluge systems) may be within acceptable ranges (often greater than 10 years life); pitting attack in a wet system is usually too severe for an acceptable service life (often less than 5 years).

3. *Copper-Nickel Pipe.* Copper-Nickel (CuNi) materials have many advantages for a fire water system. The advantages are: long service life (often greater than 20 years), minimum corrosion, light weight, low friction factors, no products of corrosion, and minimal marine growth. Copper-Nickel piping has the disadvantages of: high initial cost, low tolerance to heat (for dry systems), low mechanical strength, limited flow velocities, susceptible to mechanical abuse, requires additional supports, and more difficult to install.

Flow velocities in CuNi piping should be controlled to prevent erosion in the softer material. The criteria of 11 fps (3.36 m/s) for continuous service and 22 fps (6.72 m/s) for intermittent service are often used. Criteria may be specified for certain CuNi alloys such as 10 fps (3.05 m/s) in 90-10 CuNi and 14 fps (4.28 m/s) in 70-30 CuNi for continuous flow. Higher flow rates e.g., 22 fps (6.72 m/s) may be appropriate for intermittent service. Consideration should be given to using welded joints in lieu of soldered joints. Specific design information and guidance may be obtained from the Copper Development Association located in New Haven, Connecticut.

4. *Fiberglass Piping.* The use of fiberglass pipe has the advantages of corrosion resistance, lighter weight, lower cost, and ease of installation. Fiberglass pipe is often called by various names (Glass Fiber Reinforced Pipe [GRP], Fiberglass Reinforced Pipe [FRPI, and Reinforced Thermosetting Resin Pipe [RTRP]). The disadvantages include low tolerance to heat (for dry systems), low mechanical strength, and susceptibility to UV degradation in unprotected systems. Service life data are limited, however, well designed and protected systems have a potential service life exceeding 30 years.

Fiberglass piping is a composite product containing glass fiber reinforcement embedded in, or surrounded by, cured thermosetting resins. The composite structure may contain pigment to prevent IN degradation with a minimum of filler. The pipe is manufactured under different processes; however, the filament wound process produces the highest strength characteristics in the pipe. Filament winding is the process of impregnating a number of glass reinforcing strands with a matrix resin, then applying the wetted fibers to a revolving mandrel under controlled tension in a predetermined pattern. The amount, type, and orientation of these glass fibers within the pipe provide the required mechanical strength. The second major component of fiberglass pipe is the resin system. Manufacturers choose a resin system for chemical, mechanical, and thermal properties. Fiberglass pipe uses only thermosetting resin systems. The two types of thermosets used in the manufacturing of fiberglass pipe are polyester and epoxy resins. Once cured, a thermoset is essentially infusible (cannot be remelted) and insoluble.

Specifications with regard to the mechanical properties of the pipe are outlined in ASTM D 2996 *Standard Specifications for Filament Wound Reinforced Thermosetting Resin Pipe*, and flanges in ASTM D 4024 *Standard Specification for Reinforced Thermosetting Resin (RTR) Flanges.*

Fire water systems should utilize pipe and fittings manufactured by a filament wound process with a high glass/resin ratio and increased wall thickness in the material for greater strength and fire resistant characteristics. To increase the fire endurance of the piping system, the designer may employ the use of insulation, passive fireproofing, or utilization of a double walled insulated pipe. Increasing the fire endurance of piping may not be required in areas not susceptible to flame impingement or on piping systems with continuous water circulation.

Connections between piping and fittings are generally done utilizing an adhesive bonded joint. It should be recognized that these joints are generally the "weak link" within the fiberglass piping system. Consideration should be given to using a "butt and wrap" joint design, which is more reliable than the adhesive bonded joint. Passive fire protection should be considered for joints, especially those subject to high heat or flame impingement. Additionally, connections with metallic systems should be with flanges rather than threaded or adhesive bonded connections. The piping system should be hydrostatically tested to 1.5 times the designed operating pressure of the system to ensure pipe and joint integrity. The entire system should be brought to test pressure and held a sufficient length of time, not less than 10 minutes, after all leaks have been detected and stopped.

The use of fiberglass pipe for fire water piping should be designed and installed utilizing a total system approach. Each manufacturer has its own specifications and practices with regard to the pipe, fittings, supports, and adhesives. It is recommended that the components of the piping system be obtained from the same manufacturer and installed in accordance with manufacturer's recommended practices.

APPENDIX E—EMERGENCY DEPRESSURING DESIGN CONSIDERATIONS

E.1 General

API RP 520, API RP 521, and API RP 14E should be used as guides in designing blowdown systems. Some specific items that should be considered when designing a blowdown system for fire protection and control are the following:

a. *Header Design.*

1. *Single.* A single blowdown header on facilities with both high and low-pressure systems could result in the initial blowdown of just the high-pressure system until sufficient pressure drop has occurred to allow gas from the low-pressure system to enter the header.
2. *Multiple.* Multiple pressure level headers allow the simultaneous blowdown of different pressure systems, providing immediate stress reduction to the entire facility. This is of particular importance if a fire is located near a low-pressure vessel.
3. *Pressure/Flow Rating.* A separate blowdown system (not intended to provide primary overpressure relief) can be designed to equal the highest pressure rating of the facility, allowing for a smaller diameter and more economical piping system; however, the system must be designed to prevent the overpressure of any interconnected low-pressure system.

The existing pressure relieving system may be used as a blowdown system if the blowdown rate is limited to the surplus capacity of the pressure relieving system, and the developed backpressure remains below the lowest MAWP of interconnected systems. Additionally, the allowable design pressure in the pressure relieving system must take into consideration the total buildup backpressure on the pressure relieving devices.

b. *Blowdown Rate.*

1. *Chilling.* Platform blowdown rate determination must consider system chilling due to depressurization and its effect on vessel and pressure piping ductility. The chilling rate will depend upon pressure drop, fluid composition, and rate of release. Vessel and piping material specifications must consider the minimum expected temperature and pressure during blowdown conditions. Design should also consider temperature and pressure during a subsequent repressurization of the vessel.
2. *Stress Reduction.* Depending upon the particular circumstances involved when flame is proximate to or impinging upon a pressure vessel, it may be difficult to design a blowdown system, which provides stress reduction rapidly enough to prevent catastrophic vessel failure. However, blowdown can benefit the overall fire protection scheme by reducing vessel stresses and the likelihood of failure due to fire exposure, and lowering the dependence on active deluge systems. This is especially important when considering that overpressure devices typically limit maximum pressure buildup in a vessel or system and do not depressurize.

c. *Vent Design.* Facility blowdown can result in the release of a much larger quantity of gas than would occur from the activation of a single pressure relief device. Vent design must take into account gas dispersion at the tip, gas composition and release rate, liquid carryover, and provide sufficient distance to keep ignitable or toxic concentrations away from the platform, as well as protect the facility and personnel from heat radiation in the event of ignition. Structural design of vent piping must include the thrust resulting at the vent tip. Mist extractors for vent scrubbers should be avoided to ensure trouble-free performance of the vent system.

d. *Hydrates.* Designer should consider the formation of hydrates during blowdown conditions, especially with high specific gravity gas, and with gas compositions containing HS or CO.

APPENDIX F—PASSIVE FIRE PROTECTION

F.1 Maintenance

Generally, passive fire protection systems are maintenance free. However, periodic visual inspections are recommended with repairs as warranted. The epoxy-based systems should receive a complete visual inspection at least every 24 months. This inspection should look for cracks or voids either in the topcoating or the fireproofing itself with repairs as recommended by the manufacturer. Cementitious coatings should be inspected more frequently, and any noted cracks or fissures repaired as recommended by the manufacturer. These periodic inspections are important in order to maintain the integrity of the fireproofing and also to provide early detection of substrate corrosion. If partial disbanding of the fireproofing coating has occurred and there are surface cracks in the area of the disbonding, moisture may migrate to the substrate, establish a corrosion cell and become a source of corrosion. This corrosion potential highlights the need to have a fireproofing coating application procedure, which ensures that a proper bond is established between the fireproofing coating and the substrate.

Insulating blankets, which are normally not installed in areas exposed to weather, require little, if any, maintenance other than routine repair of tears in the outer covering.

F.2 Fireproofing Ratings

The effectiveness of passive fire protection is generally expressed in terms of a given rating for a particular system or combination of systems. In this sense, use of the term rating means the length of time, expressed in minutes, that a given fireproofing system will provide a prescribed level of protection from a fire which has a specific rate of temperature rise (time-temperature).

a. *Performance Criteria.* For a system rating to have any meaning, there must be a performance criterion by which the system rating can be measured. Performance, as it is used in defining criteria for passive fire protection systems, means the period of resistance, expressed in time, to a fire exposure before the first critical point in behavior is observed. This critical point may be collapse or loss of strength of the materials comprising the fire barrier. Performance criteria usually require that the temperature of the unexposed surface of a test panel, subjected to a controlled fire test, not exceed a prestated temperature for a given number of minutes. For example, if the performance criteria for a given fireproofing system were 1000°F (538°C) at the end of 60 minutes and a test panel, protected with the system in question, did not exceed 1000°F (538°C) on its unexposed surface after 60 minutes of being exposed to a controlled fire test, then that system would be given a rating of 60 minutes. These ratings are achieved by taking credit for all of the insulating properties of the entire system: building materials, fireproofing material, air gaps, etc. Generally, empirical data is generated for a given system, and based on that data the performance of similar systems can be predicted for any change in the thickness of the various constituents.

When specifying performance criteria for a fire barrier, the following minimum should be identified: test furnace time-temperature curve, maximum time-temperature (average and single-point) relationship acceptable for the unexposed surface, as well as any other critical behavior limitations required by the design.

Quite often, one will see fire ratings expressed in alphanumeric terms (e.g., A-60). This nomenclature probably sprang from structural fire protection research associated with investigations of early ship fires. The investigations ultimately led the United States to issue Federal Regulations requiring structural fire protection on vessels seeking USCG certification. In 46 *CFR* 92.075, there are definitions of classes of bulkheads. "A" class bulkheads are defined as being steel or equivalent with the requirement that they be capable of preventing the passage of flame and smoke for one hour if subjected to a "standard fire test." A standard fire test is also defined in 46 *CFR* 92.075 and has a time-temperature curve identical to ASTM E 119. This regulation also defines "B" and "C" class bulkheads. 46 *CFR* 164.007 further defines the testing requirements and in fact makes specific reference to ASTM E 119. Additionally, in 46 *CFR* 164.008-2, the performance requirements for A, B, and C class construction are further defined. 46 *CFR* Part 108 contains definitions of, and requirements for, structural fire protection on Mobile Offshore Drilling Units (MODUs) and Tension Leg Platforms (TLPs), and the terminology is similar to the other parts of 46 *CFR*. Specific definitions of bulkheads meeting the requirements of the regulations are contained in Navigation and Inspection Circular (YV10 6-80) *Guide to Structural Fire Protection Aboard Merchant Vessels*.

Variations of this nomenclature have been used throughout the fireproofing industry to describe fireproofing systems. For example, a given system may have a described rating of A-60-H. The first letter (A) means that the system is made of steel, the second number (60) means that the system has a rating of 60 minutes, and the third letter (H) indicates the type of fire curve by which the rating was achieved; in this case, hydrocarbon. Unfortunately, there appears to be little formal standardization of the terminology used to describe fireproofing systems; therefore, descriptions and meanings may vary slightly from country to country or industry to industry.

b. *Applicable Test Standards*. There are two test standards which are in general use for providing criteria by which firewalls are tested: ASTM E 119 *Standard Test Methods for Fire Tests of Building Construction and Materials*, and UL 1709 *Rapid Rise Fire Tests of Protection Materials for Structural Steel*. Both standards contain a time-temperature curve, which dictates the rate or rise of the temperature in the test furnace to be used for rating fireproofing materials.

ASTM E 119 is a standard which was developed years ago in order to test assemblies of masonry units and composite assemblies of structural materials for buildings. The time-temperature curve in ASTM E 119 is based on a cellulosic fire which is the type of fire most commonly encountered in buildings; consequently, the rate of rise is relatively slow: 2000°F (1093°C) in 4 hours.

UL 1709 is a standard which was developed a few years ago in order to address the need to develop a method for measuring the resistance of fireproofing materials to rapid-temperature-rise fires, like a hydrocarbon fire. Therefore, the rate of rise required in UL 1709 is quite rapid: 2000°F (1093°C) in 5 minutes. For fireproofing on offshore structures, it may be more meaningful to require that fireproofing systems be rated in accordance with UL 1709.

UL 1709 requires that the temperature rise on the unexposed surface of the protected materials not exceed 1000°F (538°C) during the period of fire exposure. This temperature is based on the temperature at which most structural steels begin to yield and lose strength; this requirement primarily addresses the integrity of structural steel. While this may be suitable for structural steel, a much lower temperature (e.g., 250°F [121°C]) should be considered for fireproofing systems on buildings which house personnel (e.g., living quarters).

F.3 Penetrations

It is best to avoid penetrations in firewalls; however, this is not always possible, and therefore particular attention must be given to the design of the penetration. Quite often, it is necessary to make penetrations in firewalls in order to accommodate the passage of process piping, electrical cables, doors, etc. The designer of these penetrations must ensure that the penetration does not degrade the integrity and rating of the firewall that they penetrate. The designer should be aware that most commercially available penetrating devices currently on the market are not rated for the more severe hydrocarbon fire environment (UL 1709). If penetrations are to be made through firewalls designed to withstand hydrocarbon fires, it may be necessary to design purpose-built penetrations and subject them to performance "type-testing" in order to ensure that the penetration does, in fact, have the same performance rating as the wall through which it penetrates.

a. *Piping and Cables*. The typical approach to penetrating firewalls with process piping is to route the piping through a larger conduit with the annular space around the process piping filled with a fireproofing material, and the exterior of the conduit coated with an appropriate type and quantity of fireproofing material. Electrical cables are typically routed through fire rated multicable transits.

b. *Doors*. There are many manufacturers of fireproof doors, both in the United States and Europe. Most commercially available fireproof doors are fire rated to ASTM E 119 or a similar standard; however, there are some doors available which are rated to the more severe hydrocarbon fire curves.

c. *Applicable Standards*. There are several testing standards available which define the test requirements for piping/cable penetrations and doors. Some of the more pertinent standards are listed below:

1. ASTM E 163 *Standard Methods of Fire Tests of Window Assemblies*
2. ASTM E 152 *Standard Methods of Fire Tests of Door Assemblies*
3. ASTM E 814 *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*