FORMOSA PLASTICS CORPORATION, U.S.A.

General Design Guideline

for

Fire Fighting System

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Add definitions for Sect. 4 and update Sect. 5 per the latest edition of NFPA 24 and 15, and API RP2001-2012.
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General Design Guideline for Fire Fighting System

1. Purpose

This Guideline presents the basis of design and engineering for the fire fighting facilities such as fire water system, foam system, fixed water spray system and fixed dry chemical system.

2. Scope

This Guideline provides general design requirements for all projects of each unit/plant. The selected fire protection approaches shall be determined by the individual project after confirming with Operations and Licensor.

The following items are not covered in this Guideline: fire resistant construction, insulation or fireproofing, trenching or fire walling, electrical binding or grounding, or general regulations affecting personnel or equipment.

3. Organizations Affected:

Departments and Divisions involving operation, safety, maintenance, engineering and installation of unit/plant fire fighting facilities and systems.

4. Definitions

4.1 Aqueous Film Forming Foam (AFFF) means a fluorinated surfactant with a foam stabilizer which is diluted with water to act as a temporary barrier to exclude air from mixing with the fuel vapor by developing an aqueous film on the fuel surface of some hydrocarbons which is capable of suppressing the generation of fuel vapors.

4.2 Automatic Fire Detection Device means a device designed to automatically detect the presence of fire by heat, flame, light, smoke or other products of combustion.

4.3 Carbon Dioxide (CO2) means a colorless, odorless, electrically nonconductive inert gas that is a medium for extinguishing fires by reducing the concentration of oxygen or fuel vapor in the air to the point where combustion is impossible.

4.4 Class A Fire means a fire involving ordinary combustible materials such as paper, wood, cloth, and some rubber and plastics materials.

4.5 Class B Fire means a fire involving flammable or combustible liquids, flammable gases, greases and similar materials, and some rubber and plastic materials.

4.6 Class C Fire means a fire involving energized electrical equipment where safety to the employee requires the use of electrically nonconductive extinguishing media.

4.7 Class D Fire means a fire involving combustible metals such as magnesium, titanium, zirconium, sodium, lithium and potassium.

4.8 Catastrophic release means a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals, that presents serious danger to employees in the workplace.

4.9 Combined System: A system of piping that connects both sprinklers and water spray nozzles in a common fire area, and is supplied by a single riser and system actuation valve.
4.10 **Control of Burning:** Application of water spray to equipment or areas where a fire can occur to control the rate of burning and thereby limit the heat release from a fire until the fuel can be eliminated or extinguished effectuated.

4.11 **Density:** The unit rate of water application to an area or surface expressed in gpm/ft$^2$.

4.12 **Dry Chemical** means an extinguishing agent composed of very small particles of chemicals such as, but not limited to, sodium & potassium bicarbonates, urea-based potassium bicarbonate, potassium chloride, or monoammonium phosphate supplemented by special treatment to provide resistance to packing and moisture absorption as well as to provide proper flow capabilities. Dry chemical does not include dry powders.

4.13 **Dry Powder** means a compound used to extinguish or control Class D Fires.

4.14 **Enclosed Structure** means a structure with a roof or ceiling and at least two walls, which may be present fire hazards to employees, such as accumulations of smoke, toxic gases and heat, similar to those found in buildings.

4.15 **Exposure Protection:** Absorption of heat through application of water spray to structures or equipment exposed to a fire, to limit surface temperature to a level that will minimize damage and prevent failure.

4.16 **Facility** means the buildings, containers or equipment which contain a process.

4.17 **Fire Area:** A plant (surface) area where a sustained and intense fire is considered credible.

4.18 **Fire Brigade** means an organized group of employees who are knowledgeable, trained, and skilled in at least basic fire fighting operations.

4.19 **Fire Hazard Analysis (FHA)** - A study used to evaluate fire hazards in a specific potential fire area and evaluate consequences of the fire-related events.

4.20 **Fixed Extinguishing System** means a permanently installed system that either extinguishes or controls a fire at the location of the system.

4.21 **Foam** means a stable aggregation of small bubbles, which flow freely over a burning liquid surface and form a coherent blanket, which seals combustible vapors and thereby extinguishes fire.

4.22 **Gaseous Agent** is a fire-extinguishing agent which is in the gaseous state at normal room temperature and pressure. It has low viscosity, can expand or contract with changes in pressure and temperature, and has the ability to diffuse readily and to distribute itself uniformly throughout an enclosure.

4.23 **Hazard** are situations or properties of materials with the inherent ability to cause harm. Flammability, toxicity, corrosivity, and stored electrical, chemical, or mechanical energy all are hazards associated with various industrial materials or situations.

4.24 **Highly hazardous chemical** means a substance possessing toxic, reactive, flammable, or explosive properties and specified by Paragraph (a)(1) of 29CFR 1190.119.

4.25 **Local Application System** means a fixed fire suppression system which has a supply of...
extinguishing agent, with nozzles arranged to automatically discharge extinguishing agent directly on the burning material to extinguish or control a fire.

4.26 **Multipurpose Dry Chemical** means a dry chemical which is approved for use on Class A, B & C fires.

4.27 **Net Rate**: The total rate of water discharge density, less water wastage due to factors such as wind effects and inaccuracies in nozzle angles of spray.

4.28 **Process Hazard Analysis (PHA)** – An organized effort to identify and evaluate hazards associated with chemical processes and operations to enable their control. This review normally involves the use of qualitative techniques to identify and assess the significance of hazards. Conclusion and appropriate recommendations are developed. Occasionally, quantitative methods are used to help prioritize risk reduction.

4.29 **Sprinkler Alarm** means an approved device installed so that any water flow from a sprinkler system equal to or greater than that from a single automatic sprinkler will result in an audible alarm signal on the premises.

4.30 **Sprinkler System** means a system of piping designed in accordance with fire protection engineering standards and installed to control or extinguish fires. The system includes an adequate and reliable water supply, and a network of specially sized piping and sprinklers which are interconnected. The system also includes a control valve and a device for actuating an alarm when the system is in operation.

4.31 **Water Spray System**: An automatic or manually actuated fixed pipe system connected to a water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area.

5 Guidelines

5.1 **Process Hazardous Analysis (PHA) and Fire Hazardous Areas**

5.1.1 Process Hazardous Analysis

a. Employer/Operations Departments shall perform an initial process hazard analysis (hazard evaluation) on processes covered by 29 CFR 1190.119(e).

b. Process Hazard Analysis (PHA) shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. Employers/Operations shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process. The process hazard analysis shall be conducted as soon as possible, but not later than the schedules as listed in 29 CFR 1190.119(e)(1).

c. At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the
requirements in 29 CFR 1190.119(e)(4), to assure that the process hazard analysis is consistent with the current process.

d. Employers/Operations shall establish a system to promptly address the PHA Team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.


5.1.2 Fire Hazardous Areas

Based on the findings and recommendations provided by PHA Team, Operations Departments shall classify the major fire hazard areas in overall plant. Operations and Projects shall divide the unit/plant plot plan into the different hazardous areas, such as:

a. In the process area, the area that is surrounded by the main roads, open area and pipe rack is considered as a single fire risk area.

b. In the hydrocarbon storage area, the one tank is considered as a single fire risk area.

c. In the building area, such as catalyst activator building and finishing building of polyolefins, the independent room enclosed by non-combustible materials is considered as a single fire risk area.

5.2 Applicable Fire Fighting Facilities

5.2.1 The selection of applicable facilities shall be based on the process hazardous analysis and developed for each specific object. (See Procedure 3 and Attachments, FUESP003, FPC USA Process Safety/Risk Management Manual.)

5.2.2 Most facilities have the following three basic types of firefighting equipment ready for immediate use. (6.1, API RP 2001 -2012)

a. Fixed System: A fire protection system that is permanently installed and connected to a supply of extinguishing agent(s). These systems may be automatically or manually activated. A water spray system supplied directly by the plant fire water system or a gaseous clean agent system in a control room or computer room are examples of fixed systems found in refineries.

b. Semifixed System: A fire protection system that is permanently installed but not connected to a supply of extinguishing agent. These systems generally require personnel to manually connect an extinguishing agent supply to the system prior to use. One
example is a tank foam system that terminates at a connection located outside of the dike wall.

c. Portable Equipment: Fire suppression equipment that must be moved to the site of the fire, then assembled or positioned before being put into service. It is generally stored until needed at a location accessible to its intended users. Examples include fire trucks, portable pumps, fire hose, foam monitors, foam supplies, fire extinguishers, and most fire department equipment.

5.2.3 The following Attachments, except Attachment B, shall be filled out and completed by each plant operations per the unique plant process characteristics, and shall be used as a design basis.

a. Attachment A: List of Applicable Fire Fighting Facilities for the designated areas at each plant.

b. Attachment B: Quick Selector Guide of Extinguishing Approach, could be used as a reference.


d. Attachment D: List of Equipment/Area Requiring Protection by Fixed Foam System.

e. Attachment E: List of Equipment/Building Requiring Protection by Dry Chemical System.

5.3 Fire Control and Extinguishment Equipment

5.3.1 The goal of effective fire control is to extinguish a fire in the shortest possible time, with no loss of life and minimum loss of property. The primary objective of firefighting is to extinguish a small fire before it expands to become large or to control a large fire and protect adjacent exposures until emergency response resources and staffing are sufficient to safely mount an aggressive suppression effort. (6.1, API RP 2001 -2012)

5.3.2 Water Supply Flow Rate Ranges for Manual Fire-fighting

The minimum fire protection water supply should be capable of providing the flow rates, pressures, and duration determined from a preincident scenario analysis. The following provides broad general guidelines for determination by operations and projects. (6.2.2.2, API RP2001-2012)

a. The flow rate of water required for fire protection should be calculated separately for each considered fire area within the refinery. The fire protection water supply is normally sized to be capable of providing the largest calculated flow rate required for any single fire area within the refinery.

b. Specific design criteria for fire water flow rates depend on plant design, configuration, and process hazards. The actual design can be determined by:
1. Providing 0.1 gpm/ft\(^2\) to 0.5 gpm/ft\(^2\) of water to the fire area based on congestion and unit structures, or
2. Historical experience with similar facilities.

c. Where the fire protection water system is intended to supply only monitors and hose streams in support of manual firefighting and suppression, the sample flow rate ranges may be estimated using the values suggested in Table 1 – Example Water Flow Rates for Manual Firefighting, API RP 2001-2012.

5.3.3 Determining Water Flow Rates for Process Areas

Where the considered fire area is totally or partially protected by fixed water spray, sprinkler, or foam systems, the flow rate should be the sum of the flow rates required for proper operation of the fixed systems, plus an allowance for simultaneous operation of monitors and hose streams. Where there are multiple fixed systems within the fire area, the calculated flow rate should consider whether adjacent systems may need to operate concurrently (6.2.2.3, API RP 2001-2012).

5.3.4 Suggested Residual Pressure

The residual pressure required for common fire protection systems and equipment items should be the highest pressure required for any system or equipment at the delivery point where it would be operated during the fire scenario. The suggested residual pressures for common fire protection systems and equipment items are shown in Table 2 – Suggested Residual Pressure, API RP 2001-2012. (6.2.2.3)

5.3.5 Fire Water Flow Duration

The total water supply should be capable of supplying the maximum flow for a period of not less than four to six hours, consistent with projected fire scenario needs. (6.2.2.5, API RP 2001-2012).

5.3.6 Firewater Sources

a. Fire water is supplied from existing fire water line. Where the water system is supplied from a tank or reservoirs, the quantity of water required for fire protection should be reserved exclusively for fire protection.

b. Consideration can be given to using recycling firewater from effluent treatment basins, thus providing virtually limitless quantities of firewater.

5.3.7 An integrated system of hydrants, monitor nozzles and water spray systems should be installed to reach all each processing units, facilities, utility and off site areas to support both automatic and manual fire fighting efforts. This System must comply with NFPA 24-2013.

5.3.8 The fire water system should be designed such that the fire main sizing meets fire flow requirements throughout the refinery. Each important fire risk area should be looped with fire mains sized to supply the critical areas with water at the appropriate fire flow rate and
5.3.9 The fire water distribution system should be installed at close proximity to access facilities where fire-fighting equipment can be hooked up.

5.3.10 Water Requirements for Tank Fires

Full surface tank fires represent large water demands for fire suppression. Preincident planning should consider water sources and delivery to the fire. This may involve high-capacity foam monitors, large diameter hose (LDH) and high-capacity mobile pumps.

5.4 Fire Monitors

5.4.1 Fixed monitor coverage in the process areas, have adequate water spray protection range that can be reached by two monitor streams.

5.4.2 Minimum design requirement radius for monitor stream is 100 ft.

5.4.3 Monitors must be located at least 50 ft. from the nearest hazard or use motor-operated remote-controlled devices.

5.4.4 See Section 5, FEMX001 (Rev.4), FPC Specification for Fire Water Piping System for details.

5.5 Fire Water Network System

5.5.1 The fire water main shall be of closed loop underground design and shall be provided along the main roads. It should be fully reticulated with sectional isolation valves and be completely separated from process water systems.

5.5.2 Master Streams

a. Mater streams shall be delivered by monitor nozzles, hydrant monitor nozzles, and similar master stream equipment capable of delivering more than 250 gpm. (Chapter 9, NFPA 24-2013)

b. Application and special consideration shall be provided for the following:
   1. Large amounts of combustible materials located in yards
   2. Average amounts of combustible materials in inaccessible locations
   3. Occupancies presenting special hazards, as required by AHJ (the authority having jurisdiction)

5.5.3 Refer to Section 4, FEMX001 (Rev.4) for the details for spacing, specifications and installation of hydrants.

5.5.4 Fixed monitors should be located around process and storage areas. Process equipment should be within reach (Min. radius: 100 ft) of two monitors or one monitor where equipment is deluge protected.

5.5.5 The fire water distribution system shall be designed so that the flow velocity does not
5.5.6 See NFPA 24-2013 and the latest edition of FEMX001, FPC Specification for more details.

5.6 Hoses and Hose Reel System

5.6.1 See the details for hoses specifications and connections provided in Section 6, FPC FEMX001 (Rev. 4), FPC Specification for Fire Water Piping System.

5.6.2 Indoor Hose Reel System
   a. Hose reel shall be swinging recess wall-mounted type with 100 ft. of 1-1/2” hose and nozzle.
   b. Rack pivots on nipple connection. 1-1/2” Cast brass angle valve with 1-1/2” NPT female inlet.
   c. Hose nozzle shall be 1-1/2” and fully adjustable from shutoff to full fog.
   d. Hose reels are provided for the designated indoor building.
   e. Discharge quantity per hose nozzle shall be 100 gpm or more at nozzle tip pressure 100 psig or more.

5.6.3 Outdoor Hose Reel System
   a. Fire hose reels shall be located approximately 150 ft. apart in the process area.
   b. Hose reels shall be floor-mounted type with 100 ft. of 1-1/2” hose and nozzle.
   c. Inlet screwed 1-1/2” female BSPT, control valve and hose connection on center drum is screwed 1-1/2” BSPT.
   d. Discharge quantity per hose nozzle shall be 100 gpm or more at nozzle tip pressure 100 psig or more.

Note: Outdoor hose reel systems are not recommended by TX/EHS for the use at the site of FPC TX Point Comfort. Refer to AHJ/ TX/EHS for further details.

5.7 Fixed Water Spray System

5.7.1 Application
   Water spray is applicable for protection of specific hazards and equipment and shall be permitted to be installed independently of, or supplementary to, other forms of fire protection systems or equipment. (1.3.1, NFPA 15 – 2012)

5.7.2 Water spray protection is applicable for the protection of hazards involving each of the following groups: (1.3.2, NFPA 15 – 2012)
   a. Gaseous and liquid flammable materials
b. Ordinary combustibles such as paper, wood, and textiles

c. Certain hazardous solids such as propellants and pyrotechnics.

d. Vapor mitigation

5.7.3 Equipment such as vessels, pumps and compressors which serves at the following conditions normally requires the fixed water spray systems:

a. High Temperature: Flammable or combustible liquids service above 500 °F or their auto-ignition temperature;

b. High Pressure: Flammable or combustible liquids service greater than 500 psig;

c. Storage tanks for light hydrocarbons and liquefied flammable gases;

d. Critical equipment;

e. Hydrocarbon loading/unloading facilities including jetties; and

g. Large hold-up of hydrocarbons, warehouse & storage areas

5.7.4 Special Considerations

a. A study shall be made of the physical and chemical properties of the materials for which the water spray protection is being considered to determine the advisability of its use.

b. The flash point, specific gravity, viscosity, miscibility, and solubility and permeability of the material, temperature of the water spray, and the normal temperature of the hazard to be protected are among the factors that shall be given consideration.

c. Where water spray can encounter confined materials at a high temperature or with wide distillation range, the slop-over or frothing hazard shall be evaluated.

d. Water Soluble Materials

Each water soluble material shall be tested under the conditions of use to determine the applicability of a water spray system, unless design supportive data is available.

e. Water spray shall not be used for direct application to materials that react with water, such as metallic sodium or calcium carbide, which produce violent reactions or increase hazardous products as a result of heated vapor emission.

f. Water spray shall not be used for applications involving liquefied gases at cryogenic temperatures (such as liquefied natural gas), which boil violently when heated by water.

g. An evaluation shall be conducted, given the possibility of damage, distortion, or failure of equipment operating at high temperatures due to water spray application.

5.7.5 Design Objectives

In general, water spray shall be considered effective for any one of or a combination of the
following objectives: (4.1, NFPA 15-2012)

a. Extinguishment of fire
b. Control of burning
c. Exposure protection
d. Prevention of fire

5.7.6 System Design

a. Systems shall be arranged for automatic operation with supplementary manual tripping means provided.
b. Manual operation shall be permitted where automatic operation of the system presents a hazard to personnel.
c. Manual operation of the system shall be permitted where a system is isolated and attended by trained personnel at all times.
d. Systems shall be designed to accomplish at least one of the design objectives defined in above Para.5.7.5.

e. Minimum Pipe Size:
The minimum pipe size shall be 1 inch for steel piping and galvanized steel, and ¾ inch for copper and stainless steel. (5.3.8, NFPA 15-2012)
f. The design shall ensure that the nozzle spray patterns meet or overlap.
g. Nozzle spacing (vertically or horizontally) shall not exceed 10 ft.

5.7.7 Extinguishment of fires (7.2, NFPA 15-2012)

a. Systems shall be designed so that extinguishment shall be accomplished and all protected surfaces shall be cooled to prevent flashback occurring after the system is shut off.
b. Extinguishment of fires by water spray shall be accomplished by one or a combination of the following methods:
   1. Surface cooling
   2. Smothering by produced steam
   3. Emulsification
   4. Dilution
   5. Other Factors
c. Design Density

A general range of water spray application rates that shall apply to most ordinary combustible solids or liquids shall be from 0.15 gpm/ft² to 0.50 gpm/ft² of protected surface.
d. The specific design density for extinguishment shall be based on test data or knowledge concerning conditions similar to those that will apply in the actual installation.

e. Cable Trays and Cable Runs
   1. Where insulated wire and cable or nonmetallic tubing is to be protected by an automatic water spray (open nozzle) system designed for extinguishment of fire that originates within the cable or tube, the system shall be hydraulically designed to impinge water directly on each tray or group of cables or tubes at a net rate of 0.15 gpm/ft² on the projected plane containing the cable or tubing tray or run.
   2. Cable trays and cable runs shall be permitted to be protected by other water spray densities and methods of application where verified by tests and where acceptable to the authority having jurisdiction (AHJ).
   3. Where it is likely that spills of flammable liquids or molten materials will expose cables, nonmetallic tubing, and tray supports, the design of protection systems shall be in accordance with that specified for exposure protection. (See 5.7.9.).

f. Belt Conveyors
   1. Open nozzles shall be located to direct water spray onto the surfaces to extinguish fire in hydraulic oil, the belt, the contents on the belt, or the drive unit.
   2. Water spray impingement on structural elements shall provide exposure protection against radiant heat or impinging flame.
   3. Interlocks shall be provided between the detection system and the machinery to shut down belt conveyor operation, including upstream feed. (See Sections 6.5 and 7.7. NFPA 15-2012).
   4. The water supply shall be capable of supplying both the design flow rate and 250 gpm (946 L/min) for hose streams for a minimum duration of 1 hour.
   5. Drive Unit
      The water spray system shall be installed to protect the drive rolls, the take-up rolls, the power units, and the hydraulic-oil unit. The net rate of water application for the drive unit shall be not less than 0.25 gpm/ft² of roll and belt.
   6. Conveyor Belt
      The water spray system shall be installed to automatically wet the top belt, its contents, and the bottom return belt. Discharge patterns of water spray nozzles shall envelop, at a net rate of not less than 0.25 gpm/ft², the top and bottom belt surface area, conveyor surfaces where combustible materials are likely to accumulate, the structural parts, and the idler rolls supporting the belt.

5.7.8 Control of Burning (7.3, NFPA 15-2012)
   a. A system for the control of burning shall operate as intended until there has been time for the burning material to be consumed, for steps to be taken to shut off the flow of
leaking material, or until the burning material can be otherwise extinguished.

b. Nozzles shall be positioned to impinge water directly on the areas of the source of fire and where spills are likely to spread or accumulate.

c. The water application rate shall be at a net rate of not less than 0.50 gpm/ft$^2$ of protected area.

d. Pumps, Compressors, and Related Equipment. Pumps or other devices that handle flammable liquids or gases shall have the shafts, seals, and other critical parts enveloped by directed water spray at a net rate of not less than 0.50 gpm/ft$^2$ of projected surface area of the equipment.

e. Flammable and Combustible Liquid Pool Fires

Water spray systems designed to control pool fires resulting from a flammable or combustible liquid spill fire shall be designed to apply a net rate of not less than 0.30 gpm/ft$^2$ of protected area.

5.7.9 Exposure Protection. (7.4, NFPA 15-2012)

a. A system for exposure protection shall operate as intended for the anticipated duration of the exposure fire.

b. Vessels

Water spray shall be applied to vessel surfaces (including top and bottom surfaces of vertical vessels) at a net rate of not less than 0.25 gpm/ft$^2$ of exposed surface. All uninsulated vessel skirts and any uninsulated steel saddles greater than 12 in. high at the lowest point shall have water spray applied on one exposed (uninsulated) side, at a net rate of not less than 0.25 gpm/ft$^2$.

c. Structures and Miscellaneous Equipment

1. Horizontal stressed (primary) Steel structural steel members shall be protected by nozzles and piping of such size and arrangement to discharge a net rate of not less than 0.10 gpm/ft$^2$ over the wetted area, as per Figure 7.4.3.1, NFPA 15-2012.

2. Horizontal structural steel that has been encased in fire-resistant insulating material to provide a level of fire resistance acceptable to the authority having jurisdiction (AHJ) shall not require water spray protection.

3. Horizontal structural steel shall not require water spray exposure protection where all of items listed in 7.4.3.3, NFPA 15-2012 are met.

d. Vertical Structural Steel

7. Vertical structural steel members shall be protected by nozzles and piping of such size and arrangement as to discharge a net rate of not less than 0.25 gpm/ft$^2$ over the wetted area. See Figure 7.4.3.1, NFPA 15-2012.
8. Vertical structural steel that has been encased in fire-resistant insulating material to provide a level of fire resistance acceptable to the authority having jurisdiction (AHJ) shall not require water spray protection.

9. Refer to 7.4.3.6, NFPA 15-2012 for the details of vertical structural steel which shall not require water spray exposure protection.

e. Metal Pipe, Tubing, and Conduit

1. Water spray intended to protect metal pipe, tubing, and conduit in racks shall be directed toward the underside of the pipes, tubes, and conduit.

2. Water spray protection shall be permitted to be applied to the top of pipes on racks where water spray piping cannot be installed below the rack due to the potential of physical damage or where space is inadequate for proper installation.

3. The levels protected and the densities required shall be in accordance with Table 7.4.3.7.3, NFPA 15-2012.

4. Vertically stacked piping shall be protected by water spray directed at one side (vertical plane) of the piping at a net rate of not less than 0.15 gpm/ft².

f. Cable Trays and Cable Runs.

1. Where insulated wire, cable, or nonmetallic tubing in open trays or runs is to be protected by water spray from a spill fire exposure, a net rate of not less than 0.30 gpm/ft² of projected horizontal or vertical plane area containing the cables or tubes shall be provided.

2. Water spray nozzles shall be arranged to supply water at this rate both over and under (or to the front and rear of) cable or tubing runs and to the racks and supports.

3. Flame Shield Use

Where flame shields equivalent to 1/16 inch thick steel plate are mounted below cable or tubing runs, the water density requirements shall be permitted to be reduced to a net rate of not less than 0.15 gpm/ft² over the upper surface of the cable or rack.

4. Where other water spray nozzles are arranged to extinguish, control, or cool exposing liquid surfaces, the water spray density shall be permitted to be reduced to a net rate of not less than 0.15 gpm/ft² over the upper surface, front, or back of the cable or tubing tray or run.

5.7.10 Flammable Vapor Mitigation (7.5, NFPA 15-2012)

a. Design for Vapor Mitigation.

The water spray system shall be designed to operate within the necessary time and shall discharge water for the duration needed to dissolve, dilute, disperse, or cool the flammable vapors, gases, or hazardous materials.
b. The duration of the release of the flammable materials shall be included in the determination of the water spray duration time.

c. The minimum net rate of application shall be based on field experience with the product or on actual test data.

d. The design area of the water spray system shall cover the entire area of any potential spill anticipated, such as the area of a containment dike, pit, and so forth.

e. Nozzles of the water spray system shall be located to cover all potential leak points, such as fill and discharge connections, relief valves, flexible connections, flanges, pumps, valves, vessels, and so forth.

f. The water spray system shall be activated automatically by gas/vapor detection in accordance with 6.5.2.7 and manually from both the system area and remotely, such as from a control room.

g. It shall be permitted to have the vapor mitigation system activated by both gas/vapor detection and another detection system, such as flame or heat detection, but the gas/vapor detection system shall be capable of activating the water spray system alone.

h. Fire Risk Analysis

A fire risk analysis shall be conducted that considers additional items listed as 7.5.9, NFPA 15-2012 in the design of the water spray system for vapor mitigation.

5.7.11 Deluge valve will be automatic or manual activated by the following means

a. Manual release lever at the local deluge valve trim

b. Energizing of solenoid valve by the remote push button from fire alarm panel in control room without local control panel

c. Activation of pilot bulb detectors

Note: Dry pipe pilot system is recommended for all deluge systems.

5.7.12 Design of Water Spray System.

a. The deluge valve and manual operation valve for the fixed water spray system shall be located at least 50 ft. from the equipment to be protected and will be so grouped that the number of their manifolds may be the minimum.

b. The spray nozzle will be arranged so that the surface is directly impinged by spray water for the surface area.

c. Demand of firewater for fixed spray system must be evaluated to ensure hydraulic calculations, pipe sizing, and pump capacity meet requirements.

5.7.13 The water mist system, such as HI-FOG system, is a Class 1 water mist as defined by NFPA 750, and is recommended by Safety Department/TX for the fire protection system used for the outdoor transformers/electrical fires.
5.7.14 Control of Runoff

a. Water discharge from water spray systems shall be controlled or contained to prevent the spread of fire where flammable or combustible liquids are present.

b. Where flammable or combustible liquids are not present and the potential for water damage to adjacent areas is minimal, water discharged from water spray systems shall not be required to be controlled or contained.

c. The control or containment system shall utilize any one of the following:
   1. Curbing and grading.
   2. Underground or enclosed drains
   3. Open trenches or ditches
   4. Diking or impoundment
   5. Any combination of the above

d. Where the protected hazard involves the possible release of flammable or combustible liquids, the drainage system shall be designed to safely handle burning liquids.

e. Enclosed drain systems shall be fitted with traps or other means to prevent the entrance of flames or burning liquids into the system.

f. Open trenches and ditches shall be routed so as not to expose fire fighters, critical equipment and piping, other important structures, or property of others.

g. The control or containment system shall be designed to accommodate the total combined flow from all of the following:
   1. All water spray systems intended to operate simultaneously within the fire area (where the actual discharge will exceed the design flow rate, the actual flow rate shall be used).
   2. Supplemental hose streams and monitor nozzle devices likely to be used during the fire
   3. The largest anticipated spill or accidental release of process liquids where applicable
   4. Any normal discharge of process liquids or cooling water into the drainage system
   5. Rain water, provided local conditions warrant inclusion

h. The control or containment system shall be designed to accommodate the total combined flow for the fire’s expected duration.

i. Where approved, the system shall be permitted to be designed to accommodate the total combined flow for a period less than the fire’s expected duration.
j. The water and liquids drained from protected areas shall be collected and treated as required by local regulations.

k. Hazardous chemicals and contaminated water shall not be discharged to open waterways or onto the property of others.

5.7.15 See NFPA 15 -2012 and FEMX002, FPC Specification of Fire Spray Fixed System for the further details.

5.8 **Fixed Foam System**

5.8.3 Fixed foam system shall be provided for the designated equipment in accordance with NFPA 11 & 16 and consists mainly of foam tank, deluge valve, foam/water sprinkler head, and foam supply piping.

5.8.4 Minimum requirements are covered for flammable and combustible liquid hazards in local areas within buildings, for storage tanks, and for indoor and outdoor processing areas. (Para. 1-1, NFPA 11, 1998 edition.)

5.8.5 Fixed foam tank or semi-fixed systems should be installed for atmospheric fixed roof and floating roof storage tanks in accordance with NFPA 11.

5.8.6 If there is a full time (24 hours a day and 7 days a week) fire brigade on site then system can be semi-fixed with foam provided by the fire brigade fire trucks via laterals, extending outside dike walls. Foam connections outside dike walls should have barrier walls to protect firefighting personnel.

5.8.7 **Foam Application**

a. The automatic foam/water sprinkler system shall be applied for the designated equipment. The foam bladder tank type could be applicable for the proportioning system.

b. Foam Concentration depends on the foam liquid property. For example, the air foam liquid on Aqueous Film-Foaming (AFFF) basis is injected into a water stream at a rate of 3% volume to form an air foam solution.

c. Foam solution depends on the foam solution property. For example, the AFFF is sized for a foam solution rate of 0.25 gpm/ft² of horizontal projected surface area of a packaged hot-oil skids, plus a five-foot-wide parameter area around the skids.

d. Minimum Discharge Time: Foam supplying equipment must be capable of operating and comply with the NFPA-required minimum periods of time.

5.9 **Fixed Dry Chemical System**

5.9.3 Dry chemical systems are individually designed for local or total flooding, for automatic control, manual control or both, and for automatic selector operation where more than one hazard area is protected by a single supply unit. Doors, windows, ventilating equipment and related alarms and signals may be controlled simultaneously with the release of the dry
chemical, by the use of electrical controls.

5.9.4 The special hazards best handled with dry chemical are certain flammable liquids, flammable gases and electrical hazards where residual dry chemical powder will not interfere with the operation of delicate parts and contacts.

5.9.5 The dry chemical system shall consist of a dry chemical storage tank, a bank of nitrogen cylinders (for tank pressurization) and fixed discharge piping and nozzles to deliver the dry-powder-extinguishing agent to the designated area automatically upon a signal from a flame detector.

5.9.6 Each hazard section shall be protected individually by the selected valve. Manual actuation from a remote hand switch shall also be provided.

5.10 Activation System

For installed active fire protection systems, either manual or automatic activation provides the desired mitigation.

5.10.1 When evaluate a facility, a review must be made for the existing fire/gas detection system, occupancies and human activities. The decision for installing a manual vs. automatic activation system should be carefully selected to match the expected hazard, the location, surveillance capability, and the environment in which it will be installed.

5.10.2 Manual activation requires a person to activate the system by pushing a button or opening a valve in response to either an observation of a fire or a signal from a detection system. The advantage to this type of system is the reduction in nuisance activation, maintenance and testing costs, and less complexity. In facilities where human activities are frequent, manual activation may be feasible due to the availability of personnel. The disadvantage is the potential for delay in activation of the system if lack of human actions.

5.10.3 Automatic systems have the advantage of automatically activate fire protection systems, it may be feasible in a location where fewer operators available, but the disadvantage is the potential for nuisance or unwanted activation that may create potential problems for operations and higher cost. The second disadvantage is that if there is a failure of the detection system or the activation mechanism.

6 Applicable Codes and Reference Specifications

The latest edition of the following Codes, Standards and Specifications, referred to and designated herein, together with all addenda, appendixes, revisions and supplements, shall be considered as a part of this Guideline.

6.1 NFPA 11: Standard for Low-Expansion Foam and Combined Agent System

6.2 NFPA 13: Standard for the Installation of Sprinkler System

6.3 NFPA 14: Standard for the Installation of Standpipe and Hose System

6.4 NFPA 15: Standard for Water Spray Fixed System for Fire protection
6.5 NFPA 16: Standard on Deluge Foam-Water Sprinkler and Foam-Water Spray Systems
6.6 NFPA 17: Standard for Dry Chemical Extinguishing Systems
6.7 NFPA 20: Standard for the Installation of Centrifugal Fire Pumps
6.8 NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances
6.9 NFPA 70: National Electrical Code
6.10 API RP 2001: Fire Protection in Refineries

7. Attachments
   Attachment A: List of Applicable Fire Fighting Facilities
   Attachment B: Quick Selector Guide of Extinguishing Approach
   Attachment C: Equipment/Structure Requiring Fixed Water Spray System
   Attachment D: Equipment/Area Requiring Fixed Foam System
   Attachment E: Equipment/Building Requiring Dry Chemical System
## Attachment A: List of Applicable Fire Fighting Facilities

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<th>Plant:</th>
<th>Location:</th>
<th>Issued Date:</th>
<th>Rev. No.:</th>
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<td>Outdoor Water Hydrant</td>
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<td>Fixed Water Spray System</td>
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<td>Fixed Dry Chemical System</td>
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</tbody>
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Note: Plant Operations shall select the required fire fighting facilities by making a check under “Yes” or “No” column for each object area.

Prepared by Operations: _______________  Approved by Operations Manager: _______________
## Attachment B - Quick Selector Guide of Extinguishing Approach

Plant: ______________ Location: ___________       Issued Date: ___________ Rev. No.:_______

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<th>Special Fire Hazard</th>
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<td>LPG Storage</td>
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<td>Switchgear Rooms</td>
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<td>Transformers, Circuit Breakers</td>
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<td>Transformers, Circuit Breakers</td>
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**Note 1: Refer to Para. 5.7.13**
### Attachment C - Equipment / Structure Requiring Fixed Water Spray System

<table>
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<tr>
<th>Unit</th>
<th>Area</th>
<th>Equipment / Structure Tag No.</th>
<th>Equip. / Structure Description</th>
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Note: Plant Operations shall fill out this List completely for project design basis.

Prepared by Operations: _______________  Approved by Operations Manager _______________

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Engineering Center  Effective Date: 06/01/2014  Document Code: FEMX003

\FTPCNTSR\EC_V_Drive\Manuals\PrjManual\Vol.2\FEMX003\FEMX003.doc (05/20/2014)  Version No.: 2, May. 20, 14
Rev.1
## Attachment D - Equipment / Area Requiring Fixed Foam System

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Note: Plant Operations shall fill out this List completely for project design basis.

Prepared by Operations: ___________________  Approved by Operations Manager: ______________
## Attachment E - Equipment / Building Requiring Dry Chemical System

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Note: Plant Operations shall fill out this List completely for project design basis.

Prepared by Operations: _______________ Approved by Operations Manager: _______________