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PART II

Statutory Notifications (S.R.O)

GOVERNMENT OF PAKISTAN

OIL AND GAS REGULATORY AUTHORITY

NOTIFICATION

Islamabad, the 2nd July, 2009

S.R.O. 624(I)/2009.- In exercise of the powers conferred by Section 42 of Oil and Gas Regulatory Authority Ordinance, 2002 (Ordinance XVII of 2002) the Oil and Gas Regulatory Authority is pleased to make the following regulations namely:-

1. Short title and Commencement: (1) These Regulations may be called the Technical Standards for the Petroleum Industry (Depots for the Storage of Petroleum Products)

(2) They shall, come in force at once.

2. Applicability:- These regulations shall be applicable to all such licencees undertaking the regulated activity for storage of petroleum products .

CHAPTER 1 - GLOSSARY

3 Definition of General terms

For the purpose of this standard, the following terms shall be defined as follows:-

3.1 Articulated Vehicle

A truck and trailer attached to each other.

3.2 Boiling Point

The temperature at which the vapour pressure of a liquid equals the surrounding pressure. For purposes of defining the boiling point, atmospheric pressure shall be considered to be 14.7 psia (760 mm of Hg). For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D 86, Standard Method of Test for Distillation of Petroleum Products, shall be considered to be the boiling point.

3.3 Bulk Plant depot or Terminal

That portion of a property where Flammable Liquids or Combustible Liquids are received by tank trucks, tank wagons or pipeline and are stored or blended in bulk for the purpose of distributing such liquids by tank trucks, tank wagons, pipeline, portable tank, or container

3.4 Classification of Fire

3.4.1 Class A Fires

Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

3.4.2 Class B Fires

Fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohol's, and flammable gases.

3.4.3 Class C Fires

Fires that involve energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance. (When electrical equipment is de-energized/ cut off from electrical circuit, fire extinguishers for Class A or Class B fires can be used safely.)

3.4.4 Class D Fires

Fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium.

3.4.5 Class K Fires

Fires in cooking appliances that involve combustible cooking media (vegetable or animal oils and fats).

3.5 Classification of Liquids

Any liquid within the scope of this standard and subject to the requirements of this standard shall be known generally either as a flammable liquid or as a combustible liquid, and shall be defined and classified in accordance with this sub-regulation.

3.5.1 Flammable Liquid

Any liquid that has a closed-cup flash point below 100ºF (37.8ºC), as determined by the test procedures and apparatus as in ASTM D 56, Standard Method of Test for Flash Point by the Tag Closed Cup Tester, ASTM D 93, Standard Test Method for Flash Point by the Pensky Martens Closed Tester, ASTM D 3278, Standard Method for Flash Point by Setaflash Closed Tester and ASTM D 3828, Standard Test for Flash Point by Small Scale Closed Tester. Flammable liquids shall comprise of Class I, that is, any liquid that has a closed-cup flash point below 100ºF (37.8ºC) and a Reid vapour pressure not exceeding 40 psia (2068.6 mm Hg) at 100ºF (37.8ºC), and includes:

(i) Class IA liquids:

Liquids that have flash points below 73ºF (22.8ºC) and boiling points below 100ºF (37.8ºC).

(ii) Class IB liquids:

Liquids that have flash points below 73ºF (22.8ºC) and boiling points at or above 100ºF (37.8ºC).

(iii) Class IC liquids:

Liquids that have flash points at or above 73ºF (22.8ºC), and below 100ºF (37.8ºC).

3.5.2 Combustible Liquid

Any liquid that has a closed-cup flash point at or above 100ºF (37.8ºC) as determined by the test procedures set forth in ASTM D 56, Standard Method of Test for Flash Point by the Tag Closed Cup Tester, ASTM D 93, Standard Test Method for Flash Point by the Pensky Martens Closed Tester, ASTM D 3278, Standard Method for Flash Point by Setaflash Closed Tester and ASTM D 3828, Standard Test for Flash Point by Small Scale Closed Tester. Combustible liquids shall comprise of Class-II and Class-III liquids, that is:

(i) Class-II liquid:

Liquids that have flash points at or above 100ºF (37.8ºC) and below 140ºF (60ºC).

(ii) Class-IIIA liquid:

Liquids that have flash points at or above 140ºF (60ºC), and below 200ºF (93ºC).

(iii) Class-IIIB liquid:

Liquids that have flash points at or above 200ºF (93ºC).

3.6 Emergency Relief Venting

An opening, construction method, or device to prevent excessive vapour pressure rise in the event of an external fire

3.7 Foam Application Systems

3.7.1 Fixed Systems

A complete installation in which foam is supplied through piping system from a central foam station, discharging through fixed delivery outlets directly to the hazard locations, which is to be protected.

3.7.2 Semi-fixed Systems

An installation in which Foam lines runs from outside the tank bund to the tank inlet(s) & is fixes with suitable valves & an inlet manifold to which the foam generators can be connected, when needed.

3.7.3 Mobile Systems

A foam-producing unit that is mounted on wheels and that is self-propelled or towed by a vehicle.

3.7.4 Portable Systems

A foam-producing unit that is transported by hand.

3.8 Foam Concentrate

Foam concentrate is the foam in concentrated liquid form as received from the manufacturer. For the purpose of this standard, "foam concentrate" and "concentrate" are used interchangeably.

3.9 Foam Classification

Foams are classified (by expansion) into the following three groups:

(i) Low-expansion foam:

Expansion up to 20 times foam to solution volume

(ii) Medium-expansion foam:

Expansion from 20 to 200 times foam to solution volume.

(iii) High-expansion foam:

Expansion from 200 to 1000 times foam to solution volume.

3.10 Flash Point

The minimum temperature of a liquid at which sufficient vapour is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in ASTM D 56, Standard Method of Test for Flash Point by the Tag Closed Cup Tester, ASTM D 93, Standard Test Method for Flash Point by the Pensky Martens Closed Tester, ASTM D 3278, Standard Method for Flash Point by Setaflash Closed Tester and ASTM D 3828, Standard Test for Flash Point by Small Scale Closed Tester.

3.11 General - Purpose Warehouse

A separate, detached building or portion of a building used only for items other than petroleum/chemical products.

3.12 Hazardous Area Classification

3.12.1 Classes of Locations

(i) Class I:

Locations in which flammable gases or vapours are or may be present.

(ii) Class II:

Locations which are hazardous because of the presence of combustible dust.

(iii) Class III:

Locations where hazardous conditions exist because of the presence of ignitable fibers or suspended particles.

3.12.2 Divisions

Within each location class, two divisions are recognized. This standard addresses only Class I locations. The divisions within Class I are:

(i) Division 1:

An environment where flammable gases, vapours, liquids, combustible dust or ignitable fibres & flyings are likely to exist under normal operating conditions.

Installations for Division I locations require explosion proof equipment.

(ii) Division 2:

An environment where flammable gases, vapours, liquids, combustible dust or ignitable fibres & flyings are not likely to exist under normal operating conditions, such as those resulting from the failure or rupture of equipment from human error in operation..

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Installations for Division 2 locations require that operation of the electrical system (including arcing and similar devices) may occur without providing a source of ignition under normal conditions.

(iii) Non-classified:

Locations, which need not be classified as Division 1 or 2, are non-classified.

3.12.3 Classifications of Locations

(i) Class 1, Division 1 Locations:

An environment where ignitable concentration of flammable gases, vapours or liquids can exist all of the time or some of the time under normal operating conditions. For instance, the presence of flammable gases in the vicinity of open-dome loading of gasoline tank trucks is normal and requires a Division I classification. However, "normal" does not necessarily mean the situation that prevails when everything is working properly. For instance, a process procedure might be so sensitive to control that relief valves frequently open. This can be considered normal. If these valves release flammable liquids or gases to the atmosphere (highly unlikely with today's environmental constraints) the location adjacent to the point of release is classified Division 1. However, if the operation of the relief valves occurs infrequently under unusual conditions, it is not to be considered normal.

Zone 0: Where ignitable concentrations of flammable gases, vapours or liquids can exist all of the time or for long periods of time under normal operating conditions.

Example – Vapour space of closed process vessel, container or storage tank.

Zone 1: Where ignitable concentrations of flammable gases, vapours or liquids can exist some of the time under normal operating conditions.

Example – Vehicle/rail tank wagon loading gantries around open manholes; Class I product container filling around fill nozzles; pits, trenches or low spots closed to filling operations; unventilated building containing Class I, II(2), III(2) products; vents for Class I, II(2), III(2) products.

(ii) Class I, Division 2 Location:

An environment where ignitable concentration of flammable gases, vapours or liquids are not likely to exist all of the time or some of the time under normal operating conditions.

Zone 2: Where ignitable concentrations of flammable gases, vapours or liquids are not likely to exist under normal operating conditions.

Example: Vicinity of broken/leaking pump seals, valve pipes; overfill of bulk vehicles, rail tank wagons, containers.
The term abnormal is used here in a limited sense. It is intended to cover the type of accident for which there is practicable projection. It does not include a major catastrophe of the type against which protection is impracticable.
As an example, consider a process vessel containing hydrocarbons that releases flammable material only under abnormal conditions. In this case, there is no division I location because the vessel is normally tight. To release a gas, the vessel would have to leak, and that would not be normal. Thus, the vessel is surrounded by a Division 2 zone. Everything outside that zone is non-classified.

(iii) Non-classified Locations:

Experience has shown that the occurrence of flammable material liberation from some operations and apparatus is so infrequent that it is not necessary to classify the surrounding locations. For example, it has not been found generally necessary to classify the following areas surrounding locations where flammable petroleum gases and volatile liquids are processed, stored, or handled:

(a) Adequately ventilated locations where flammable substances are contained in suitable, well-maintained, closed piping systems that include only the pipe, valves, fittings, flanges and meters.

(b) Locations that are not adequately ventilated where flammable substances are contained in piping systems without valves, fittings, flanges and similar accessories.

(c) Locations where the flammable liquids or gases are stored in suitable containers.

Equipment for Use in Hazardous Areas:

In addition to operational measures required to eliminate explosive hazards, certain constructional features are necessary to render equipment suitable for use in a hazardous area. Apart from the national or local regulations which must be adhered to, the following serves as a guide in selecting suitable equipment:

Zone 0: Only intrinsically safe certified apparatus and circuits.

Zone 1:

Intrinsically safe certified apparatus and circuits.

Flameproof equipment (Flameproof (explosion proof) electrical equipment is NOT normally weatherproof by design, and must therefore be provided with protection from rain and snow)

Zone 2:

Special selected industrial, non sparking or restricted breathing (venting) equipment.

All types of equipment specified for use in Zone 0and Zone 1.

In addition, equipment with special protection classification may be used in a zone (or less hazardous zone) for which it is approved.

3.13 Inside Liquid Storage Area

A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies. Such areas include:

3.13.1 Inside Room

A room totally enclosed within a building and having no exterior walls.

3.13.2 Cut-off Room

A room within a building and having at least one exterior wall.

3.13.3 Attached Building

A building having only one common wall with another building having other types of occupancies.

3.13.4 Liquid Warehouse

A separate, detached building or attached building used for storing petroleum products.

3.14 Types Of Foam Concentrates

3.14.1 Protein-Foam Concentrates

Protein-foam concentrates consist primarily of products from a protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use under emergency conditions. They are diluted with water to form 3 percent to 6 percent solutions depending on the type. These concentrates are compatible with certain dry chemicals.

3.14.2 Fluoroprotein-Foam Concentrates

Fluoroprotein-foam concentrates are very similar to protein-foam concentrates but have a synthetic fluorinated surfactant additive. In addition to an air-excluding foam blanket, they also can deposit a vaporization-preventing film on the surface of a liquid fuel. They are diluted with water to form 3 percent to 6 percent solutions depending on the type. These concentrates are compatible with certain dry chemicals .

Fluoroprotein-foam has largely replaced standard protein foam for fighting hydrocarbon fires because of its better performance, higher fluidity & greater resistance to fuel entrainment – particularly valuable for sub-surface injection into storage tanks, for which standard protein foam is unsuitable. Fluoroprotein foam can be used with fresh or sea water.

3.14.3 Aqueous Film-Forming Foam (AFFF) Concentrates

Because of its high fluidity, AFFF gives a rapid knock down of fires. These concentrates are based on fluorinated surfactants plus foam stabilizers and usually are diluted with water to a 1 percent, 3 percent, or 6 percent solution. The foam formed acts as a barrier both to exclude air or oxygen and to develop an aqueous film on the fuel surface that is capable of suppressing the evolution of fuel vapours. The foam produced with AFFF concentrate is dry chemical compatible and thus is suitable for combined use with dry chemicals.

For high risk areas such as vehicle loading bays, the use of AFFF provides both rapid knock down and a sealing layer. AFFF is effective for covering a spillage to prevent a fire from occurring. It can be used for sub-surface injection in the same way as fluoroprotein foam. It can be used with fresh or sea water.

3.14.4 Film-Forming Fluoroprotein (FFFP) Foam Concentrates

These concentrates use fluorinated surfactants to produce a fluid aqueous film for suppressing hydrocarbon fuel vapours. This type of foam utilizes a protein base plus stabilizing additives and inhibitors to protect against freezing, corrosion, and bacterial decomposition, and it also resists fuel pickup. The foam is usually diluted with water to a 3 percent or 6 percent solution and is dry chemical compatible.

3.14.5 Alcohol-Resistant Foam Concentrates

These concentrates are used for fighting fires on water-soluble materials and other fuels destructive to regular, AFFF, or FFFP foams, as well as for fires involving hydrocarbons. There are three general types:

(i) Water-soluble natural polymers, such as protein or fluoroprotein concentrates, containing alcohol-insoluble materials that precipitate as an insoluble barrier in the bubble structure.

(ii) Synthetic concentrates containing a gelling agent that surrounds the foam bubbles and forms a protective raft on the surface of water-soluble fuels; these foams may also have film-forming characteristics on hydrocarbon fuels.

(iii) Water-soluble natural polymers, such as fluoroprotein, containing a gelling agent that protects the foam from water-soluble fuels; these foams may also have film-forming and fluoroprotein characteristics on hydrocarbon fuels.

3.15 Portable Fire Extinguisher

A Portable device carried manually or on wheels and operated by hand, containing an extinguishing agent that can be expelled under pressure for the purpose of suppressing or extinguishing fire.

3.16 Stable Liquid

Any liquid other than unstable liquids.

3.17 Storage Tank

Any vessel having a liquid capacity that exceeds 60 gal (227 L), is intended for fixed installation, and is not used for processing.

3.18 Tanks

3.18.1 Aboveground Tanks

A tank that is installed above grade, at grade or below grade without backfill.

3.18.2 Atmospheric Tank

"A storage tank that has been designed to operate at pressures from atmospheric through 0.5psig (760mmHg through 786mmHg) measured at the top of the tank."

3.18.3 Low-Pressure Tank

A storage tank designed to withstand an internal pressure above 1.0 psig (6.9 KPa) but not more than 15 psig (103.4 KPa) measured at the top of the tank.

3.19 Unstable Liquid

A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.

3.20 Vapour Pressure

The pressure measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D 323 *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method).*

CHAPTER 2 - SCOPE

4 Scope of this Standard

4.1 These Standards prescribe the technical standards relating to the design, materials, construction, testing and lay out of bulk plant depots and terminals used for the storage of petroleum products, and also includes safety distances and standards for product storage systems, fire fighting systems, plant/equipment layout, and electrical systems required for such storage plants and terminals.

4.2 All existing bulk plant depots and terminals used for the storage of petroleum products shall be up-graded to conform with the requirements of these Standards within 05 years from the date on which these Standards are made effective. These Standards shall however be applicable to all bulk plant depots and terminals put into use for the storage of petroleum products after the date on which these Standards are made effective.

4.3 These Standards do not apply to bulk plants or terminals used for the storage of Liquid Petroleum Gas (LPG), Liquefied Natural Gas (LNG), Compressed Natural Gas (CNG) or chemicals. Also, these Standards are not applicable to storage units connected with motor fuel dispensing facilities.

5 Measurements & Reference to International Standards and codes

5.1 In this Standard the following terms of measurement and other technical terms have been used:

AFFF	Aqueous Film Forming Foam
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society for Mechanical Engineers
ASTM	American Society for Testing and Materials
bars	unit of pressure
bbl	barrels
cm	centimeter
C	Centigrade
F	Fahrenheit
FFFP	Film Forming Fluoroprotein
FM	Factory Mutual
ft	feet
ft^2	square feet
ft/sec	feet per second
gpm	gallons per minute
in	inch
KPa	Kilo Pascals
L	Liters
L/min	Liters per minute
$L/min/m^2$	Liters per minute per square meter
m	meters
m^2	square meters
mm	millimeters
m/sec	meters per second
NFPA	National Fire Protection Association
psig	pounds per square inch (gauge)
psia	pounds per square inch (absolute)
UL	Underwriter's Laboratory

5.2 In this standard the following International Standards and Codes have been referred to and apply as mentioned:

API RI 1615	Installation of Underground Petroleum Storage System
API Standard 2000	Venting Atmospheric and low-pressure Storage Tanks
API 620	Design and Construction of Large, Welded, Low Pressure Storage Tanks
API Specification 12 B	Bolted Tank for Storage of Production Liquids
API Specification 12 D	Field Welded Tanks for Storage of Production Liquids
API Specification 12 F	Shop Welded Tanks for Storage of Production Liquids
API 650	Welded Steel Tanks for Oil Storage.
API 650	Welded Steel Tanks for Oil Storage , Appendix H, "Internal Floating Roofs"
ASME B 31	Code for pressure piping
NFPA-10	Standard for Portable Fire.
NFPA 13	Standard for the Installation of Sprinkler Systems.
NFPA 14	Standard for the installation of Standpipe and Hose Systems Standard for Water Spray
NFPA 15	Standard for Water Spray Fixed Systems for Fire Protection
NFPA 16	Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
NFPA 20	Standard for Centrifugal fire pumps
NFPA 30	Flammable and Combustible Code
NFPA 45	Standard on Fire Protection for Laboratories.
NFPA 51B	Standard for Fire Prevention in Use of Cutting and Welding Processes.
NFPA 70	National Electrical Code (NEC).

NFPA 1961 Standard for Fire Hose.
NFPA 1963 Standard for Fire Hose Connection

CHAPTER 3 – PLANT LAYOUT

6 Road System

6.1 The roadway system should be arranged to form a complete ring around the entire site area, with branch roads crossing through the various areas. This makes all parts of the site accessible from more than one direction.

6.2 The roads should have minimum width of 10 ft to permit easy maneuvering of vehicles, with corner radii to suit the turning circle of the largest vehicle (i.e. fire trucks, product tank trucks or any specialist vehicles carrying special loads applicable to the plant.)

6.3 Pedestrian pathways adjacent to roads should be allowed in areas of high personnel concentration and traffic movement only.

6.4 There should be adequate parking space for vehicles to load or unload, or to receive clearance to enter or leave the site. Car parks for personnel and visitors should be in a safe area (minimum 50 feet from product handling/loading areas) The Installation/ depot shall have sufficient space for maneuvering/face out parking of vehicles for easy exit in case of an emergency situation.

7 Loading/ Unloading System

7.1 Product Tank Trucks Loading/Unloading System

7.1.1 For product loading and unloading, the required area will consist of the platform and associated equipment, plus the area for parking the tankers. Also adequate parking space should be provided for vehicles waiting to be loaded. It should be noted that access platforms are required for loading the product in tank trucks.

7.1.2 A loading or unloading facility shall have the canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and also does not restrict fire -fighting access and control.

7.1.3 The loading facilities for Tank Trucks filling shall be provided with loading arms. Moreover suitable metering equipment shall be used for measuring the quantity of product to be filled or decanted.

7.1.4 The loading gantries / unloading points shall be so arranged that vehicles enter from one side and leave from the other without any need for reversing/ repositioning.

7.1.5 Front end (Driver end) of tank truck shall be faced to main exit so that in case of any emergency, vehicle shall drive out of the installation. The corner radii should have the minimum value of 12.5 meters to suit

turning circle of the fixed/ articulated vehicles having length of about 15 meters.

7.1.6 Loading area should be fully paved, curbed and drained so that all spills from trucks and equipment would flow quickly to adequately sized and suitably located catch pits and drains. These catch pits and drains shall be connected with oily/water drains system

7.1.7 Loading and un-loading facilities shall be provided with a means for electrically bonding to protect against static electricity hazards.

7.2 Railway Wagons Loading System

7.2.1 Loading area should be paved, curbed and drained so that all spills from railway wagons and equipment would flow quickly to adequately sized and suitably located catch pits and drains. These catch pits and drains shall be connected with oily/water drains system.

7.2.2 Minimum headroom clearance to be:

Over roadways	6,000 mm (19.6 ft)
Over access-ways/ pipe racks	5,000 mm (16.4ft)

7.2.3 Loading facilities shall be provided with a means for electrically bonding to protect against static electricity hazards.

8 Buildings and Protective Boundaries

8.1 The major plant buildings administration, central workshops, warehouse etc, should be located as per minimum spacing requirements. The Installation/ depot shall be protected on all sides by concrete/ brick wall having a minimum height of 7 ft. The wall should also have 3 ft high barbed wire fencing on the top. The administration building should be separated from the product storage and handling areas through fencing etc.

CHAPTER 4 - DIKING AROUND TANK(S)

9 Diking around Tanks

9.1 Diking Requirements

The diking around tanks is required to protect the adjoining property or waterways from accidental oil spills. Such systems shall comply with the following:

(i) A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) or to the dike base, whichever is less.

(ii) The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank

within the diked area assuming a full tank. To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike.

(iii) To permit access, the outside base of the dike, at ground level, shall be no closer than 10 ft (3 m) to any property line that is or can be built upon.

(iv) Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquid tight and to withstand a full hydrostatic head. Earthen wall 3 ft (0.9 m) or more in height shall have a flat section at the top not less than 2 ft (0.6 m) wide. The slope of an earthen wall shall be cons istent with the angle of repose of the material of which the wall is constructed.

(v) The walls of the diked area shall be restricted to an average interior height of 6 ft. (1.8 m) above interior grade. Dikes shall be permitted to exceed this height where provisions are made for normal access and necessary emergency access to tanks, valves, and other equipment, and safe egress from the diked enclosure and where the following requirements are met:

(a) Where the average height of the dike containing Class I liquids is over 12 ft (3.6 m) high, measured from interior grade, or where the distance between any tank and the top inside edge of the dike wall is less than the height of the dike wall, provisions shall be made for normal operation of valves and for access to tank roof(s) without entering below the top of the dike. These provisions shall be permitted to be met through the use of remote-operated valves, elevated walkways, or similar arrangements.

(b) Piping passing through dike walls shall be liquid tight and be designed to prevent excessive stresses (e.g. pipe supports etc.) as a result of settlement or fire exposure.

(c) The minimum distance between tanks and toe of the interior dike walls shall be 5 ft (1.5 m).

(vi) Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes, in order to prevent spills from endangering adjacent tanks within the diked area as follows:

(a) One subdivision for each group of tanks having an aggregate capacity not exceeding 15,000 bbl (2,385,000 L).

(b) Where storing normally stable liquids in tanks not covered in regulation 9.1(vi)(a) above, one subdivision for each tank

greater than 2380 bbl (378,500 L) capacity. In addition, one subdivision for each group of tanks [no tank exceeding 2380 bbl (378,500 L) capacity] having an aggregate capacity not exceeding 3570 bbl (567,750 L).

(c) Whenever two or more tanks storing Class I liquids, any one of which is over 150 ft (45 m) in diameter, are located in a common diked area, intermediate dikes shall be provided between adjacent tanks to hold at least 10 percent of the capacity of the tank so enclosed, not including the volume displaced by the tank.

(d) The drainage channels or intermediate dikes shall be located between tanks so as to take full advantage of the available space with due regard for the individual tank capacities. Intermediate dikes, where used, shall be not less than 18 in. (45 cm) in height.

(vii) The provision for draining water from diked areas shall be controlled to prevent flammable or combustible liquids from entering natural watercourses, public sewers, or public drains. Control of drainage through block valves shall be accessible under fire conditions from outside the dike.

(viii) Storage of combustible materials, empty or full drums, or barrels, shall not be permitted within the diked area.

CHAPTER 5 - INSTALLATION OF UNDERGROUND TANKS

10 Installation of Underground Tanks

10.1 Location

Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of tank storing Class I liquids to the nearest wall of any basement or pit shall not be less than 1 ft. (0.3 m), and to any property line that can be built upon, not less than 3 ft (0.9 m). The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit, or property line shall not be less than 1 ft (0.3 m).

10.2 Burial Depth and Cover

10.2.1 All underground tanks shall be installed in accordance with the manufacturer's/designer's instruction, where available, and shall be set on firm foundations, concrete/sand pad as required by soil condition, and surrounded with at least 6 in. (15 cm) of noncorrosive inert material such as clean sand or gravel well tamped in place. The tank shall be placed in the

hole with care, since dropping or rolling the tank into the hole can break a weld, puncture or damage the tank, or scrape off the protective coating of coated tanks.

10.2.2 Underground tanks shall be covered with not less than 2 ft (0.6 m) of earth, or with not less than 1 ft (0.3 m) of earth on top of which shall be placed a slab of reinforced concrete not less than 4 in. (10 cm) thick. Where they are, or are likely to be, subjected to traffic, they shall be protected against damage from vehicles passing over them by at least 3 ft (0.9 m) of earth cover, or 18 in. (450 mm) of well tamped earth plus 6 in. (150 mm) of reinforced concrete or 8 in. (200 mm) of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 1 ft (0.3 m) horizontally beyond the outline of the tank in all directions.

10.2.3 When the depth of cover is greater than the diameter of the tank, or if the pressure at the bottom of the tank can exceed 10 psig (69Kpa), the designer/ recognized consultant should be consulted to determine if reinforcement of the tank is required. The specific gravity of the liquid to be stored shall be a design factor.

10.3 Other Applicable Standard

API RI 1615 *Installation of Underground Petroleum Storage System* should be used for the installation of underground tanks.

CHAPTER 6 - VENTING REQUIREMENTS

11 Venting Requirements

Venting for above ground Storage Vessel:

11.1 Venting of Atmospheric Storage Tanks

Atmospheric storage tanks shall be adequately vented to prevent the development of vacuum or pressure sufficient to distort the roof of a cone roof tank or exceeding the design pressure in the case of other atmospheric tanks, as a result of filling or emptying, and atmospheric temperature changes.

11.2 Sizing of Vents

Normal vents/ambient emergency vents shall be sized in accordance with API Standard 2000, *Venting Atmospheric and low-pressure Storage Tanks*.

11.3 Venting of Low-pressure and pressure Vessels

Low-pressure tanks and pressure vessels shall be adequately vented to prevent the development of pressure or vacuum that exceeds the design pressure of the tank or vessel when filling or emptying the tank or vessel or because of atmospheric temperature changes. Means shall also be provided to prevent overpressure from any pump discharging into the tank or vessel

when the pump discharge pressure can exceed the design pressure of the tank or vessel.

11.4 Venting of Class IA liquids Storage Vessels

Tanks and pressure vessels storing Class IA liquids shall be equipped with venting devices that shall be normally closed except when venting to pressure or vacuum conditions. Tanks and pressure vessels storing Class IB Liquids and Class IC liquids shall be equipped with venting devices or with flame arrestors. When used, vent devices shall be normally closed except when venting under pressure or vacuum conditions. Tanks of 3000 bbl (476,910 L) capacity or less containing crude petroleum in crude-producing areas, and outside aboveground atmospheric tanks under 23.8 bbl (3785 L) capacity containing other than Class IA liquids, shall be permitted to have open vents. (See exception to Regulation 11.6).

11.5 Class IB liquids and Class IC liquids Storage Vessels

Flame arrestors or venting devices required in Regulation 9.4 above may be omitted for Class IB liquids and Class IC liquids where conditions are such that their use can, in case of obstruction, result in tank damage.

11.6 Emergency Relief Venting of above ground storage vessels"

Except as provided in Regulation 11.7 below, every aboveground storage tank storing Class I liquids and Class II liquids shall have emergency relief venting in the form of construction or a device or devices that will relieve excessive internal pressure caused by the effects of an adjacent fire (exposure fire). This requirement shall also apply to each compartment of a compartmented tank, the interstitial space (annulus) of a secondary containment-type tank, and the enclosed space of tanks of closed top dike construction. This requirement shall also apply to spaces or enclosed volumes, such as those intended for insulation, membranes or weather shields, that can contain liquid because of a leak from the primary vessel and can inhibit venting during fire exposure. The insulation, membrane, or weather shield shall not interfere with emergency venting.

11.7 Large Vessels for Class IIIB Liquids do not require venting

Tanks larger than 285 bbl (45,306 L) capacity storing Class IIIB liquids and not within the diked area or the drainage path of Class I liquids or Class II liquids shall not require emergency relief venting.

11.8 Vertical Tank Construction

In a vertical tank, the construction referred to in Regulation 11.6 shall be a floating roof, a lifter roof or a weak roof-to-shell seam. The weak roof-to-shell seam shall be constructed to fail preferential to any other seam. Design methods that will provide a weak roof to shell seam construction are contained in API 650, *Welded Steel Tanks for Oil Storage.*

Venting for Underground Storage Vessel:

11.9 Normal Venting for Underground Storage Tanks

Tank venting systems shall be provided with sufficient capacity to prevent blowback of vapour or liquid at the fill opening while the tank is being filled. Vent pipes shall be sized according to design methods contained in NFPA 30, Flammable and Combustible Liquid Code.

CHAPTER 7 - PREVENTION OF OVERFILLING OF TANKS

12 Prevention of Overfilling of Tanks

12.1 Aboveground Storage Tank

Aboveground storage tanks receiving Class I liquids from mainline pipelines or marine vessels shall utilize one of the following methods of protection to prevent overfilling of tanks:

(i) Tanks gauged at frequent intervals by personnel continuously on the premises during product receipt with two way communication maintained with the supplier so that product in-flow in a tank can be promptly shut down or diverted

(ii) Tanks equipped with a high level detection device (alarms etc.) that is independent of any tank gauging equipment. Alarms shall be located where personnel who are on duty throughout product transfer can promptly arrange for flow stoppage or diversion;

(iii) Tanks equipped with an independent high-level detection and control system that will automatically shut down or divert flow when the pre-defined high level limit is reached.

12.2 Underground Storage Tank

An underground storage tank shall be equipped with overfill prevention equipment that will:

(i) Automatically shut off the flow of liquid into the tank when the tank is no more than 95 percent full; or

(ii) Alert the transfer operator when the tank is no more than 90 percent full by restricting the flow of liquid into the tank and triggering a high-level alarm.

(iii) Tanks gauged at frequent intervals by personnel continuously on the premises during product receipt with two way communication maintained with the supplier so that product in-flow in a tank can be promptly shut down or diverted.

CHAPTER 8 - FIRE FIGHTING SYSTEM

13 Fire Fighting - Water System

13.1 Single Fire Concept

In a hydrocarbon processing and handling facility, the capacity and extent of the fire fighting equipment to be provided is based on the assumption that only one major fire will occur at any one time. Thus the requirements of the largest single fire possibility shall govern the design of the major fire fighting facilities.

13.2 Application Rates for Water and Foam

The rates of application of fire fighting agents given below shall be used in conjunction with equipment spacing mentioned in section 4.3 of NFPA 30, *Flammable and Combustible Code*. Tables 2A to 2F specifying spacing/ distances are attached as appendix A.

13.2.1 Equipment Protection

Minimum recommended water spray application rates for fire fighting at petroleum installations are as follows:

(i) Uninsulated Equipment Enveloped in Flame:

Vessels, equipment, structural steel, pipe racks, fin-fan coolers etc.	**10 L/min/m^2**
Pumps handling flammable liquids in isolated areas	**10 L/min/m^2**
Pumps handling flammable liquids adjacent to cable runs, fin-fans, pressure equipment, pipe racks etc.	**20 L/min/m^2**
Compressors handling flammable gases	**10 L/min/m^2***
Electrical and instrument cable trays, transformers, switchgear etc.	**10 L/min/m^2**

Reference 1

*per square meter of horizontal area extending 0.6 m from the pump and driver's periphery.

Note: The above rates are not additional to any water which may be applied to the equipment for extinguishment or control. The rates assume a 25% loss of water due to wind deflection, splash etc. The above rates may be increased if there is a possibility of jet flame impingement.

(ii) Equipment Not Enveloped in Flame:

Equipment close to and exposed to radiation from a fire, and tanks or vessels within two tank diameters distance downwind of a tank fire, or one tank diameter distance in the other directions, shall be protected

by application of water spray at minimum recommended rates shown in the table below:

Miscellaneous process equipment	**2 L/min/m^2**
Fixed and floating roof tanks containing Class I liquids, Class II liquids and Class III liquids	**2 L/min/m^2**
Pressurized tanks (general)	**5-12 L/min/m^2**
Buildings such as warehouses, offices and laboratories	**2 L/min/m^2**

Reference 2

Water spray shall not be applied to the roof of a floating roof tank.

Structure may be protected from fire radiation by the application of fire proof coating.

13.2.2 Storage Areas

In the event of fire, water protection shall be applied to crude oil and product storage tanks exposed to radiation as follows:

(i) To tanks downwind of the fire and within 2 tank diameters separation distance.

(ii) To other tanks within one tank diameter separation distance.

Only the surfaces exposed to radiation need to be protected.

13.2.2.1 Tank Fires

A primary aim of fire fighting in storage areas is to prevent the spread of fire from the tank which is being controlled to adjacent tanks or the neighbourhood.

13.2.2.2 Floating Roof Rim Fires

With this type of fire the outside of the tank heated by flames may be cooled with water whilst attempts are made to achieve and maintain an effective foam blanket, and to avoid re-ignition from hot surfaces. The recommended application rate of water is 10 L/min/m2 of vertical tank surface in contact with the fire. For the calculation of water requirements, the area should be assumed to be that based on a nominal half of the vertical height of the tank. Water shall not be applied to the tank roof but foam shall be used at a rate specified in this regulation.

13.2.2.3 Tank on Fire

For the fixed roof tank on fire, water shall be available for vertical or inclined surfaces at the rate of 10 L/min/m^2 of exposed un-insulated surface. For planning water requirements it shall be assumed that half the vertical height of the tank is exposed. Water may be applied at a similar rate to the shells of floating roof tanks on fire.

13.2.2.4 Adjacent Tank

For adjacent tank cooling, the flow of water required is dependent on the distance from the fire, the wind direction, the area exposed to radiation, the type of tank (e.g. fixed or floating roof) and the intensity of the fire.

Any tank or similar structure shall be considered to require cooling if it is within one tank diameter distance from the burning tank, or 30 m whichever is the greater.

The area of the adjacent tank used in the water provision calculation is as follows:

$$(\text{shell area} \times 0.25) + (\text{roof area} \times 0.4)\ m^2$$

Provision shall be made for water application at the rate of preferably not less than 2 L/min/m2 of this area, especially with close separations. Rates higher than 2 L/min/ m2 do not provide a proportionate increase in protection.

13.2.3 Water Capacity and Fire Pump Flow Rates

The total water capacity and fire pump flow rate for extinguishing the major fire must be adequate for the highest combination of both the foam making requirements and the cooling of tanks or other structures and it shall depend upon the capacity of the facilities to be protected.

13.2.4 Maximum Total Demand to be Determined

It must be noted that the highest foam demand for the tank fire may not coincide with the highest cooling demand for adjacent tanks. Therefore, the overall design will be based on the maximum total demand, which shall be determined by calculating the combination of tank foam plus adjacent cooling.

13.2.5 Vertical Atmospheric Fixed-Roof Tanks

A fire extinguishing system shall be provided or be available for vertical atmospheric fixed-roof storage tanks larger than 50,000 gal (189,250 L) capacity, storing Class I liquids. Fixed-roof tanks storing Class II liquids or Class III liquids at temperatures below their flash points and floating roof tanks storing any liquids generally shall not require protection when installed in compliance with section 4.3 of NFPA 30 *Flammable and Combustible Code.* Tables 2A to 2F specifying spacing/ distances are attached as appendix A.

The tank vehicle and tank car loading and un-loading facilities shall be separated from above ground tanks, warehouses, or plant buildings, or the nearest property line of adjoining property that can be build upon by a distance of 25 ft (7.6m) for Class I liquids and at least 15 ft (4.6 m) for Class

II liquids and Class III liquids, measured from nearest spout or transfer connection.

13.2.6 No Shut-Off Valve

There shall be no shut off valve in the fire department connection. An approved straightway check valve shall be installed in each fire department connection, located as near as practicable to the point where it joins the system.

13.2.7 Size of Fire Mains

Fire mains shall be of ample size, in no case smaller than 6 in. (152 mm).

13.2.8 Block Valves

All block valves shall be indicating type valves.

13.2.9 Hydrants

Each fire main shall be provided with a suitable number of hydrants spaced at appropriate distances and sized to give adequate cover to the appropriate area or process unit. Hydrants shall be sited in accessible positions, usually adjacent to fire roads. A typical spacing will be 50 m-100 m, giving maximum hose lengths from hydrant to nozzle of 30-50 m. Normally there shall be at least two hydrants per bund area. Each hydrant shall have at least two outlets. In planning the locations of hydrants, consideration should be given to permitting approach from two sides thus enabling approach to be made upwind of the incident. In addition, the sitting should ideally facilitate tackling fires or giving protection in adjacent areas.

If a hydrant is in close proximity to a potentially hazardous area, provide a heat and blast protection shield, such as brick or concrete wall.

13.2.10 Sectional Block Valves

Fire main systems shall have sectional block valves in order to permit sectionalizing the system in the event of a break, or for the making of repairs or extensions.

13.2.11 Check Valves

Where there is more than one source of water supply, a check valve shall be installed in each connection.

13.2.12 Size of Connection to Hydrants

Hydrants shall be of standard design and shall not have less than a 4-in. (100 mm) diameter connection with the main fire water circuit. A valve shall be installed in the hydrant connection.

13.2.13 Height of Hose Outlet

The centre of a hose outlet shall not be less than 18 in. (457 mm) above final grade, or when located in a hose house, 12 in. (305 mm) above the floor.

13.2.14 Standard for Hose

Hose shall conform to NFPA 1961, *Standard for Fire Hose*.

13.2.15 Standard for Hose Coupling

Hose coupling threads shall conform to the NH standard threads, as specified in NFPA 1963, *Standard for Fire Hose Connection.*

13.2.16 Testing of Fire Service Mains

All new fire service mains shall be tested hydrostatically at not less than 200 psi (13.8 bars) pressure for two hours, or at 50 psi (3.4 bars) in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psi (10.3 bars)

13.2.17 Minimum Supply Requirements

A minimum of 2 hours supply should be provided based on the potential use of water for extinguishment, cooling and foam production in a design-base fire assumed for the site Fire Plan, if no source for water replenishment is available. Consideration should be given to contingency arrangements in the event of the site supply being exhausted before the fire is under control. Water containment and its recycling are options, which might also be considered.

13.2.18 Electrical Equipment Fires

In general, water and foams should not be used on fires involving live electrical equipment. For such applications, electrically non-conductive media including carbon dioxide and dry chemical powders shall be used.

14 Fire Fighting - Foam System

14.1 Operation of System

Systems can be actuated automatically or manually. All systems shall have provisions for manual actuation.

14.2 Foam Application System Design

This regulation covers design information for the use of foam to protect the following outdoor storage tanks, interior flammable liquid hazards, loading racks, diked areas, and non-diked spill areas.

14.2.1 Outdoor-Fixed Roof (Cone/ Dome) Tanks

Fixed cone roof/ dome tanks are defined as vertical and cylindrical tanks with a fixed roof designed as a conical section, and they comply with the requirements set forth in NFPA-30, *Flammable and Combustible Code,* API 650, *Welded Steel Tanks for Oil Storage* and API 620 *Design and Construction of Large, Welded, Low Pressure Storage Tanks.*

14.2.1.1 System Design

System design shall be based on protecting the tank (primary protection) requiring the largest foam solution flow, including supplementary hose streams.

(i) Method of Primary Protection

The following methods for protecting exterior fixed-roof tanks are included within this regulation:

(a) Surface application with fixed foam discharge outlets

(b) Subsurface application

(c) Foam monitors and hand-lines

(ii) Supplementary Protection

In addition to the primary means of protection, there shall be provisions for supplementary protection in accordance with the requirements in Regulation 14.2.8.

14.2.1.2 Details of Primary Protection Methods

(i) Surface Application with Fixed Foam Discharge Outlets

(a) Design Criteria for Surface Application with Fixed Foam Discharge Outlet:

Discharge outlets shall be attached to the tank, in case of protection of a flammable liquid contained in a vertical tank. Where two or more discharge outlets are required, the outlets shall be spaced equally around the tank periphery, and each outlet shall be sized to deliver foam at approximately the same rate. Fixed foam discharge outlets shall be attached securely at the top of the shell and shall be located or connected such that

there is no possibility of the tank contents overflowing into the foam lines. In order to prevent entrance of vapors into foam outlets and pipelines, fixed foam discharge outlets shall be provided with an effective and durable seal, frangible under low pressure. Fixed foam discharge outlets shall be provided with suitable inspection means to permit proper maintenance and for inspection and replacement of vapour seals.

(b) Foam Discharge Outlets

Fixed-roof (cone) tanks shall be provided with fixed foam discharge outlets as indicated in Table-14(1).

Table – 14(1)

(Number of Fixed Foam Discharge Outlets for Fixed-Roof Tanks Containing Hydrocarbons or Flammable and Combustible Liquids)

Tank Diameter (or equivalent area)		Minimum Number of Discharge Outlets
(ft)	(m)	
Up to 80	Up to 24	1
Over 80 to 120	Over 24 to 36	2
Over 120 to 140	Over 36 to 42	3
Over 140 to 160	Over 42 to 48	4
Over 160 to 180	Over 48 to 54	5
Over 180 to 200	Over 54 to 60	6

Reference 3

It is recommended that, for tanks greater than 200 ft (60 m) in diameter, at least one additional discharge outlet should be added for each additional 5,000 ft^2 (465 m^2) of liquid surface or fractional part thereof.

(c) Minimum Discharge Times and Application Rates

When fixed foam discharge outlets are used for fixed-roof (cone) tanks containing hydrocarbons, Table-14(2) below shall be used for the minimum discharge times and application rates.

Table – 14(2)

(Minimum Discharge Times and Application Rate for Fixed Foam Discharge Outlets on Fixed-Roof (Cone) Storage Tanks Containing Hydrocarbons and Flammable & Combustible Liquid Requiring Alcohol-Resistant Foams)

Hydrocarbon Type	Minimum Application Rate		Min Discharge Time (min)
	(gpm/ft2)	(L/minxm2)	
Flash point between 100.F and 140.F (37.8.C and 93.3.C)	0.10	4.1	30

Flash point below 100.F (37.8.C) or liquids heated above their flash points	0.10	4.1	55
Crude petroleum	0.10	4.1	55
For Flammable & Combustible Liquids requiring Alcohol-Resistant Foams ***Reference4***	Consult Manufacturer for listings on specific products		55

(ii) Subsurface Application Design Criteria

(a) Subsurface Application Design Criteria

Subsurface foam injection systems are appropriate for protection of liquid hydrocarbons in vertical fixed-roof atmospheric storage tanks. Subsurface injection systems shall not be used for protection of Class I hydrocarbon liquids or for the protection of alcohols, esters, ketones, aldehydes, anhydrides, or other products requiring the use of alcohol-resistant foams. The expansion ratios of Fluoroprotein foam, AFFF, and FFFP for subsurface injection shall be between 2 and 4.

(b) Foam Discharge Outlets

The discharge outlet into the tank can be the open end of a foam delivery line or product line. Outlets shall be sized so that foam generator discharge pressure does not exceed the design capacity for the generator. The foam velocity at the point of discharge into the tank contents shall not exceed 10 ft/sec (3 m/sec) for Class I liquids or 20 ft/sec (6 m/sec) for other classes of liquids. Where two or more outlets are required, they shall be located so that the foam travel on the surface cannot exceed 100 ft (30 m). Each outlet shall be sized to deliver foam at approximately the same rate. To provide even distribution of foam, outlets can be shell connections or can be fed through a pipe manifold within the tank from a single shell connection. Shell connections for foam discharge outlets can be made in man-way covers to prevent installing additional tank nozzles. Tanks shall be provided with subsurface foam discharge outlets as shown in Table-14(3).

Table – 14(3)

(Minimum Number of Subsurface Foam Discharge Outlets
for Fixed-Roof Tanks Containing Hydrocarbons)

Tank Diameter		Minimum Number of Discharge Outlets	
(ft)	(m)	Flash Point Below 100.F (37.8.C)	Flash Point 100.F (37.8.C) or Higher
Up to 80	Up to 24	1	1
Over 80 upto 120	Over 24 upto 36	2	1
Over 120 upto 140	Over 36 upto 42	3	2
Over 140 upto 160	Over 42 upto 48	4	2
Over 160 upto 180	Over 48 upto 54	5	2
Over 180 upto 200	Over 54 upto 60	6	3
Over 200	Over 60	6 Plus 1 outlet for each Additional 5000 ft^2 (465 m^2)	3 Plus 1 outlet for each additional 7500 ft^2 (697 m^2)

Reference 5

Note: The elevation of foam discharge outlets shall be such that the foam does not discharge into a water bottom. For this purpose, the outlets shall be located at least 1 ft (0.3 m) above the highest water level to prevent destruction of the foam.

(c) Minimum Discharge Times and Application Rates

The minimum discharge times and application rates for subsurface application on fixed-roof storage tanks shall be in accordance with Table-14(4).

Table – 14(4)

(Minimum Discharge Times and Application Rates for Subsurface
Application on Fixed-Roof Storage Tanks)

Hydrocarbon Type	Minimum Discharge Time	Minimum Application Rate	
	(min)	(gpm/ft^2)	(L/minxm^2)
Flash point between 100.F and 140.F (37.8.C and 93.3.C)	30	0.1	4.1
Flash point below 100.F (37.8.C) or liquids heated above their flash points	55	0.1	4.1
Crude petroleum	55	0.1	4.1

Reference 6

(iii) Foam Monitors and Hand-lines

(a) Design Criteria for Foam Monitors and Hand-lines

Monitor nozzles shall not be considered as the primary means of protection for fixed-roof tanks over 60 ft (18 m) in diameter. Foam hand-lines shall not be considered as the primary means of protection for fixed-roof tanks over 30 ft (9 m) in diameter or those over 20 ft (6 m) in height.

(b) Minimum Discharge Time and Application Rates

The design parameters for the use of monitors and handline nozzles to protect tanks containing hydrocarbons shall be in accordance with Table-14(5).

(c) Tanks Containing Flammable and Combustible Liquids Requiring Alcohol-Resistant Foams

In general, alcohol-resistant foams can be effectively applied through foam monitor or foam hose streams to spill fires of these liquids when the liquid depth does not exceed 1 in. (25.4 mm). For liquids of greater depth, monitor and foam hose streams shall be limited for use with special alcohol-resistant foams designed for the purpose.

Where monitors and hand-line nozzles are used to protect tanks containing flammable and combustible liquids requiring alcohol-resistant foams, the operation time shall be 65 minutes at listed application rates.

Table – 14(5)

(Foam Hand-line and Monitor Protection for Fixed-Roof Storage Tanks Containing Hydrocarbons)

Hydrocarbons Type	Minimum Application Rate		Minimum Discharge Time
	(gpm/ft²)	(L/minxm²)	(min)
Flash point between 100°F and 140°F (37.8°C and 93.3°C)	0.16	6.5	50
Flash point below 100°F (37.8°C) or liquids heated above their flash points	0.16	6.5	65
Crude petroleum	0.16	6.5	65

Reference 7

Note 1: Included in this table are gasoils and unleaded gasoline containing no more than 10 percent oxygenated additives by volume. Where oxygenated additives content exceeds 10 percent by volume, protection is normally in accordance with regulation 14.2.1.2 (iii) c. Certain non-alcohol-resistant foams

might be suitable for use with fuels containing oxygenated additives of more than 10 percent by volume. The manufacturer should be consulted for specific listings or approvals.

Note 2: Flammable liquids having a boiling point of less than 100°F (37.8°C) might require higher rates of application. Suitable rates of application should be determined by test. Flammable liquids with a wide range of boiling points might develop a heat layer after prolonged burning and then can require application rates of 0.2 gpm/ft^2 (8.1 L/min×m^2) or more.

Note 3: Care should be taken in applying portable foam streams to high-viscosity materials heated above 200°F (93.3°C), such as hot oils, burning asphalts, or burning liquids that have a boiling point above the boiling point of water. Although the comparatively low water content for foams can beneficially cool such fuels at a slow rate, it can also cause violent frothing and "slop over" of the tank's contents.

14.2.2 Outdoor Open-top (External) Floating Roof Tanks

Vertical cylindrical tanks without fixed-roofs that have double-deck or pontoon-type floating roofs are known as open-top floating roof tanks and are constructed in accordance with the requirement of API 650, (Appendix-C), *Welded Steel Tanks for Oil Storage* and NFPA 30, *Flammable and Combustible Liquids Code*. The seal can be a mechanical shoe seal or tube seal. The tube seal can be equipped with a metal weather shield. Secondary seals of combustible or non-combustible materials can also be installed.

14.2.2.1 System Design

System design shall be based on protecting the tank (primary protection) requiring the largest foam solution flow, including supplementary hose streams.

(i) Method of Primary (Seal Fire) Protection

The basis of system design shall be to protect the tank requiring the largest foam solution flow, including supplementary hose streams.

The only method used for fire protection of seals in open-top floating roof tanks is the “Fixed Discharge Outlets” Method.

(ii) Supplementary Protection

In addition to the primary means of protection, there shall be provisions for supplementary protection in accordance with the requirements of Regulation 14.2.8

(iii) Types of Fires anticipated

Two distinct types of fires can occur in open-top floating roof tanks:

(a) a seal fire.

(b) full surface area fire (as a result of the floating roof sinking).

Experience indicates that the most frequent type of fire involves only the seal of the floating roof tank

14.2.2.2 Details of Fixed Discharge Outlets for Seal Area Protection (Top of the Seal Method)

(i) Fixed foam discharge outlets located above a mechanical shoe seal, above a tube seal, weather shield, or above a secondary seal shall be used in conjunction with a foam dam. See Regulation 14.2.2.3 for foam dam design criteria. The following arrangement can be employed when utilizing fixed foam discharge outlets:

- Fixed foam discharge outlets mounted above the top of the tank shell
- Fixed foam discharge outlets mounted on the periphery of the floating roof.

(ii) Design Criteria for Top-of-Seal Method with Foam Dam

The design parameters for the application of fixed foam discharge outlets on top of the seal to protect open-top floating roof tanks shall be in accordance with Table-14(6). The requirements specified in the table apply to tanks containing hydrocarbons or flammable and combustible materials requiring alcohol-resistant foams. The required minimum application rates specified in Table-14(6) apply, unless listings for specific products require higher application rates where fixed foam discharge outlets are used.

Table – 14(6)

(Top-of-Seal Fixed Foam Discharge Protection for Open-Top Floating Roof Tanks)

Seal Type	Minimum Application Rate		Minimum Discharge Time	Maximum Spacing Between Discharge Outlets with	
				12-in. (305-mm) Foam-Dam	24-in. (610-mm) Foam Dam
	(gpm/ft²)	(L/min×m²)	(min)	ft (m)	ft (m)
Mechanical shoe Seal	0.3	12.2	20	40 (12.2)	80 (24.4)
Tube seal with Metal Weather Shield	0.3	12.2	20	40 (12.2)	80 (24.4)

Fully or partly combustible Secondary Seal	0.3	12.2	20	40 (12.2)	80 (24.4)
All metal Secondary Seal	0.3	12.2	20	40 (12.2)	80 (24.4)

Reference 8

Note: Where the fixed foam discharge outlets are mounted above the top of the tank shell, a foam splashboard is necessary due to the effect of winds.

(iii) Foam Dam

A foam dam shall be installed if a tube seal is used and the top of the tube seal is less than 6 in. (152 mm) below the top of the pontoon.

(iv) Minimum Discharge Times and application Rates

If the application rate is higher than the minimum rate specified in Table-6, the discharge time can be reduced proportionately, but not less than 70 percent of the minimum discharge times specified.

14.2.2.3 Foam Dam Design Criteria

The foam dam shall be circular and constructed of at least No. 10 U.S. standard gauge thickness [0.134-in. (3.4-mm)] steel plate.

The foam dam shall be welded or otherwise securely fastened to the floating roof.

The foam dam shall be designed to retain foam at the seal area while causing the foam to flow laterally to the point of seal rupture. Dam height shall be at least 12 in. (305 mm). The dam shall extend at least 2 in. (51 mm) above a metal secondary seal or a combustible secondary seal using a plastic-foam log. Dam height shall be at least 2 in. (51 mm) higher than any burnout panels in metal secondary seals.

The foam dam shall be at least 1 ft (0.3 m), but not more than 2 ft (0.6 m), from the tank shell.

To allow drainage of rain water, the foam dam bottom shall be slotted on the basis of 0.04 $in.^2$ of slot area per ft^2 of dammed area (278 mm^2 of slot area per m^2 of dammed area) restricting drain slots to a maximum 3/8 in. (9.5 mm) in height. Additional openings for drainage shall be avoided to prevent loss of foam through the drainage slots.

14.2.3 Outdoor Covered (Internal) Floating Roof Tanks

Covered (internal) floating roof tanks are defined as vertical cylindrical tanks with a fixed metal roof (cone or geodesic dome) equipped with ventilation at the top and containing a metal double-deck or pontoon-type floating roof or a

metal floating cover supported by liquid-tight metal flotation devices, constructed in accordance with the requirements of NFPA 30, *Flammable and Combustible Liquids Code* and API 650 (Appendix-H), *Welded Steel Tanks for Oil Storage.*

14.2.3.1 System Design

System design shall be based on protecting the tank requiring the largest foam water solution flow, including supplementary hose streams.

(i) Method of Primary Protection

The following methods for protecting internal floating roof tanks are included within this regulation:

(a) Full Surface Area Fire.

(b) Seal Area Fire.

(ii) Supplementary Protection

In addition to the primary means of protection, there shall be provisions for supplementary protection in accordance with the requirements of Regulation 14.2.8.

14.2.3.2 Details of Methods for Primary Protection

(i) Design for Full Surface Fire

Where the basis for design is a full surface fire (Class I liquids), the covered (internal) floating roof tank shall be considered as equivalent to a fixed-roof (cone) tank of the same diameter for the purpose of foam system design. For a full surface fire, the foam facilities shall be designed in accordance with Regulation 14.2.1 and Regulation 14.2.8, except that separately valved laterals for each foam discharge shall not be required. For this application, fixed foam discharge outlets shall not be fitted with a frangible vapour seal device.

(ii) Design for Seal Area Fire

For a seal fire design system, the covered (internal) floating roof tank shall be considered as equivalent to an open-top floating roof tank of the same diameter for the purpose of foam system design. For a seal fire, the foam discharge system shall be designed in accordance with the requirements specified in Table-14(6) utilizing fixed foam discharge outlets.

The following types of roof construction shall be considered suitable for seal area protection systems:

(a) Steel double deck.

(b) Steel pontoon.

(c) Full liquid surface contact, closed cell honeycomb, of metal construction conforming to API 650, *Welded Steel Tanks for Oil Storage*, Appendix H, "Internal Floating Roofs" requirements.

All other types of roof construction shall require full surface protection.

Note: Subsurface and semi-subsurface injection shall not be used because of the possibility of improper distribution of foam.

(iii) Minimum Discharge Time and application Rate

If the application rate is higher than the minimum rate specified in Table-2, the discharge time shall be permitted to be reduced proportionately, but shall not be less than 70 percent of the minimum discharge times specified.

14.2.4 Indoor Hazards

This regulation deals with foam fire-extinguishing systems, which are intended to protect indoor storage tanks that have liquid surface areas of 400 ft^2 (37.2 m^2) or greater.

14.2.4.1 Design Criteria for Indoor Storage Tanks Containing Flammable or Combustible Liquids Requiring Alcohol-Resistant Foams

Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to non-alcohol-resistant foams require the use of alcohol-resistant foams. Systems using these foams require special engineering consideration. In all cases, the manufacturers of the foam concentrate and of the foam-making equipment shall be consulted as to limitations and for recommendations based on listings or specific fire tests.

(i) Discharge Outlets

Tanks for storing liquid hydrocarbons shall be fitted with tank-mounted fixed foam discharge outlets as specified in Table-14(1).

(ii) Minimum Discharge Time and Application Rates

The minimum application rate for indoor hydrocarbon storage tanks shall be 0.16 gpm/ft^2 (6.5 L/min×m^2) of liquid surface area. Minimum discharge time shall be as specified in Table-14(2) for fixed foam discharge outlets.

If the application rate is higher than the minimum rate specified above, the discharge time can be reduced proportionately, but not less than 70 percent of the minimum discharge times indicated.

14.2.5 Loading/Unloading Gantry

Loading racks are defined as truck or rail car types for the purpose of loading or unloading product. When designing a loading rack foam system, the total rack size, flammable or combustible products involved, proximity of other hazards and exposures, drainage facilities, wind conditions, ambient temperatures, and available staff all shall be considered.

14.2.5.1 Methods of Protection

The following are two acceptable methods of protecting loading racks:

(i) Foam-water sprinkler application utilizing air-aspirating foam-water sprinklers or nozzles or non-air-aspirating standard sprinklers.

(ii) Foam monitors (Fixed/ Portable).

14.2.5.2 Design Criteria for Foam-Water Sprinkler Systems

(For design criteria for sprinkler systems, see NFPA 16, *Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*.)

14.2.5.3 Design Criteria for Foam Monitor Protection Systems

(i) Areas to Be Protected by Monitor Nozzles

Monitor nozzle system design shall be based on the total ground area. The intent of the design shall be to protect the canopy, pumps, meters, vehicles, and miscellaneous equipment associated with the loading and unloading operation in the event of a spill fire. Systems shall be designed to protect the canopy area as well as total curbed area around the loading gantry or the entire length of the truck or rail car.

(ii) Minimum Application Rates and Discharge Times

Minimum foam application rates and discharge times for loading gantry protected by monitor nozzles shall be as specified in Table-14(7).

Table – 14(7)

(Minimum Application Rates and Discharge Times for Loading Racks Protected by Foam Monitor Nozzle Systems)

Foam Type	Minimum Application Rate		Minimum Discharge Time	Product Being Loaded
	(gpm/ft^2)	(L/min/m^2)	(min)	
Protein and fluoroprotein	0.16	6.5	15	Hydrocarbons
AFFF, FFFP, and alcohol-resistant AFFF or FFFP Alcohol-resistant foams	0.10*	4.1*	15	Hydrocarbons
	Consult manufacturer for listings on specific products		15	Flammable and Combustible liquids requiring alcohol-resistant foam

Reference 9

* If a fuel depth of more than 1 in. (25.4 mm) can accumulate within the protected area, the application rate shall be increased to 0.16 gpm/ft^2 (6.5 L/minxm^2).

14.2.6 Diked Areas - Outdoor

Diked areas are areas bounded by contours of land or physical barriers that retain a fuel to a depth greater than 1 in. (25.4 mm). For protection of these areas, fixed discharge outlets, fixed or portable monitors, or foam hose-lines should be employed.

In order to obtain maximum flexibility due to the uncertainty of location and the extent of a possible spill in process areas and tank farms, portable or trailer-mounted monitors are more practical than fixed foam systems in covering the area involved. The procedure for fighting diked area spill fires is to extinguish and secure one area and then move on to extinguish the next section within the dike. This technique should be continued until the complete dike area has been extinguished.

14.2.6.1 Methods of Application

Where foam protection is considered for a diked area, it can be accomplished by any of the following methods:

(a) Low-level foam discharge outlets.

(b) Foam monitors or foam hose-lines.

(c) Foam-water sprinklers or nozzles.

14.2.6.2 Minimum Application Rates and Discharge Times for Fixed Discharge Outlets on Diked Areas Involving Liquid Hydrocarbons

The minimum application rates and discharge times for fixed foam application on diked areas shall be as specified in Table-14(8).

Table – 14(8)

(Minimum Application Rates and Discharge Times for Fixed Foam Application on Diked Areas Involving Hydrocarbon Liquids)

Type of Foam Discharge Outlets	Minimum Application Rate		Minimum Discharge Time (min)	
	(gpm/ft²)	(L/minxm²)	Class I HC	Class II HC
Low-level foam discharge outlets	0.10	4.1	30	20
Foam monitors	0.16	6.5	30	20

Reference 10

To keep the total design solution within practical limits, large dike areas shall be permitted to be subdivided

14.2.6.3 Fixed Foam Discharge Outlets

Fixed foam discharge outlets vary considerably in capacity and range area of coverage. Fixed foam discharge outlets shall be sized and located to apply foam uniformly over the dike area at the application rate specified in Table-14(8). Large dike areas shall be permitted to be subdivided to keep the total design solution within practical limits

14.2.6.4 Fixed Foam-Water Sprinklers or Nozzles

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems* shall be used for the design of systems where fixed foam-water sprinklers or nozzles are used.

14.2.6.5 Fixed Low-Level Foam Discharge Outlets

These outlets shall be permitted to be open pipe fittings or directional flow nozzles designed to discharge a compact, low-velocity foam stream onto the inner wall of the dike or where necessary directly onto the dike floor. They shall be located around the dike wall, and where necessary inside the dike area, to apply foam uniformly over the dike area. Where fixed discharge outlets installed at a low level are used as the primary protection, they shall be located so that no point in the dike area is more than 30 ft (9 m) from a discharge outlet where the discharge per outlet is 60 gpm (225 L/min) or less. For outlets having discharge rates higher than 60 gpm (225 L/min) the maximum distance between discharge outlets shall be 60 ft (18 m). Low-level foam discharge outlets might need supplementary overhead foam spray

application to provide coverage or cooling for overhead structures or for tank surfaces.

14.2.6.6 Foam Monitors or Foam Hose-lines

Where monitors are used to discharge foam in the diked area, they shall be located outside the dike area. Application rates and discharge times shall be as specified in Table 14(8).

14.2.6.7 Diked Areas Involving Flammable or Combustible Liquids Requiring Alcohol-Resistant Foams

Water-soluble and certain flammable and combustible liquids and polar solvents that are destructive to non-alcohol-resistant foams require the use of alcohol-resistant foams. Systems using these foams require special engineering consideration.

14.2.6.8 Design Criteria for Diked Areas Involving Flammable or Combustible Liquids Requiring Alcohol-Resistant Foams

The design criteria shall be as follows:

(i) Methods of fixed protection shall be the same as those described in Regulation 14.2.6.3 for hydrocarbon hazards.

(ii) Application rates shall be in accordance with manufacturer recommendations for specific products and corresponding foam-making devices.

(iii) The minimum discharge time shall be 30 minutes.

14.2.7 Non-diked Spill Areas

Non-diked spill areas are areas where a flammable or combustible liquid spill might occur, uncontained by curbing, dike walls, or walls of a room or building. In such cases it is assumed that any fire would be classified as a spill fire [i.e., one in which the flammable liquid spill has an average depth not exceeding 1 in. (25.4 mm) and is bounded only by the contour of the surface on which it is lying].

14.2.7.1 Design Criteria for Protection of Spill Fires Involving Hydrocarbons or Flammable and Combustible Liquids Requiring Alcohol-Resistant Foams

To determine protection for spill fires, it is necessary to estimate the potential spill area. Once this has been determined, Table-14(9) shall be used to calculate requirements to be used as design criteria for portable nozzles or monitors.

Table - 14(9)

(Minimum Application Rate and Discharge Times for Non-diked Spill Fire Protection Using Portable Foam Nozzles or Monitors)

Foam Type	Min. Application Rate Min.		Discharge Time	Anticipated Product Spill
	(gpm/ft²)	(L/minxm²)	(min)	
Protein and fluoroprotein	0.16	6.5	15	Hydrocarbon
AFFF, FFFP, and alcohol-resistant AFFF or FFFP	0.10	4.1	15	Hydrocarbon
Alcohol-resistant foams	Consult manufacturer for listings on specific products		15	Flammable and combustible liquids requiring alcohol-resistant foam

Reference 11

14.2.8 Supplementary Protection

Besides the primary means of protection, some types of hazards require provisions for supplemental means of protection as well. The supplemental protection requirements are described in this regulation.

14.2.8.1 Supplemental Foam Hose Stream Requirements

In addition to tank foam installations, approved foam hose stream equipment shall be provided, as supplementary protection for small spill fires. The minimum number of fixed or portable hose streams required shall be as specified in Table-14(10) and shall be available to provide protection to the area. The equipment for producing each foam stream shall have a solution application rate of at least 50 gpm (189 L/min), with the minimum number of hose streams shown in Table-14(10).

Table – 14(10)

(Supplemental Foam Hose Stream Requirements)

Diameter of Largest Tank	Minimum Number of Hose Streams Required
Up to 65 ft (19.5 m)	1
Over 65 to 120 ft (19.5 to 36 m)	2
Over 120 ft (36 m)	3

Reference 12

14.2.8.2
Additional foam-producing materials shall be provided to permit operation of the hose stream equipment simultaneously with tank foam installations as specified in Table-14(11).

Table – 14(11)

(Hose Stream Operating Times, Supplementing Tank Foam Installations)

Diameter of Largest Tank	Minimum Operating Time*
Up to 35 ft (10.5 m)	10 min
Over 35 to 95 ft (10.5 to 28.5 m)	20 min
Over 95 ft (28.5 m)	30 min

Reference1 3

* Based on simultaneous operation of the required minimum number of hose streams discharging at a rate of 50 gpm (189 L/min).

14.3 Reserve Supply of Foam Concentrate

There shall be a readily available reserve supply of foam concentrate sufficient to meet design requirements in order to put the system back into service after operation. This supply can be in separate tanks or compartments, in drums or cans on the premises, or available from an approved outside source within 24 hours.

15 Testing

15.1 Pressure Tests

All piping, except piping handling expanded foam for other than subsurface application, shall be subject to a 2-hour hydrostatic pressure gauge test at 200 psi (1379 kPa) or 50 psi (345 kPa) in excess of the maximum pressure anticipated, whichever is greater, in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems. All normally dry horizontal piping shall be inspected for drainage pitch.

15.2 Operating Tests

Before approval, all operating devices and equipment shall be tested for proper function.

16 Fire Water Pumps

16.1 General

16.1.1 Pumps and Drivers

Centrifugal fire pumps shall be designed as per NFPA 20.

16.1.2 Water Supplies

The water storage requirement shall be as per regulation 13.2.17.

16.1.3 Pressure Gauges

16.1.3.1 Pressure Gauge

A pressure gauge having a dial not less than 31/2 in. (89 mm) in diameter shall be connected near the discharge casting with a 1/4-in. (6.25-mm) gauge valve. The dial shall indicate pressure to at least twice the rated working pressure of the pump but not less than 200 psi (13.8 bars). The face of the dial shall read in pounds per square inch or bars or both with the manufacturer's standard graduations.

16.1.3.2 Compound Pressure and Vacuum Gauge

A compound pressure and vacuum gauge having a dial not less than 31/2 in. (89 mm) in diameter shall be connected to the suction pipe near the pump with a 1/4-in. (6.25-mm) gauge valve. Provision of compound gauge and vacuum gauge shall not be required for vertical shaft turbine-type pumps taking suction from a well or open wet pit.

The face of the dial shall read in inches (mm) of mercury (Hg) or pounds per square inch (bars) for the suction range. The gauge shall have a pressure range two times the rated maximum suction pressure of the pump, but not less than 100 psi (7 bars).

16.1.4 Circulation Relief Valve

Each pump(s) shall have an automatic relief valve listed for the fire pump service installed and set below the shutoff pressure at minimum expected suction pressure.

Provisions shall be made for discharge to a drain. Circulating relief valves shall not be tied in with the packing box or drip rim drains. Minimum size of the automatic relief valve shall be ¾ in. (19.0 mm) for pumps with a rated capacity not exceeding 2500 gpm (9462 L/min), and 1 in. (25.4 mm) for pumps with a rated capacity of 3000 to 5000 gpm (11,355 to 18,925 L/min).

16.1.5 Pipe and Fittings

16.1.5.1 Placement of Steel Pipes

Steel pipe shall be used aboveground except for connection to underground suction and underground discharge piping. Where corrosive water conditions exist, steel suction pipe shall be galvanized or painted on the inside prior to installation with a paint recommended for submerged surfaces. Thick bituminous linings shall not be used.

16.1.5.2 Joining of Steel Pipes

Sections of steel piping shall be joined by means of screwed, flanged (flanges welded to pipe are preferred), mechanical grooved joints.

16.1.5.3 Standard for Welded Pipe

All provisions for welded pipe shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

16.1.5.4 Standard for Torch-Cutting and Welding in Pump House

Torch-cutting or welding in the pump house shall be permitted as a means of modifying or repairing pump house piping when it is performed in accordance with NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes.*

16.2 Types of Fire Water Pumps

16.2.1 Horizontal and In-Line Pumps

16.2.1.1 Types

Horizontal pumps shall be of the split-case, end-suction, or in-line design.

16.2.1.2 Application

The horizontal split-case pump in horizontal or vertical position, and end-suction and in-line pumps shall not be used where a static suction lift is involved.

16.2.1.3 Characteristics

Pumps shall furnish not less than 150 percent (150%) of rated capacity at not less than 65 percent (65%) of total rated head. The shutoff head shall not exceed 140 percent (140%) of rated head for any type pump.

16.2.2 Vertical Shaft Turbine-Type Pumps

16.2.2.1 Suitability

The vertical shaft turbine-type pump is particularly suitable for fire pump service where the water source is located below ground and where it would be difficult to install any other type of pump below the minimum water level.

16.2.2.2 Characteristics

Pumps shall furnish not less than 150 percent (150%) of rated capacity at a total head of not less than 65 percent of the rated head. The total shut-off head shall not exceed 140 percent (140%) of the total rated head on vertical turbine pumps.

16.3 Standby arrangement

There should be at-least two fire pumps of similar capacity installed at the location, one acting as the main fire pump and other as the back-up.

17 Personnel Protection

Use PPE's (Personnel Protective Equipments) such as helmet, safety shoes, goggles, dangri, face shield, safety belt, mask, dust mask, rubber shoes, gloves (cotton, rubber, leather), ear plugs and ear muffs where required.

17.1 Breathing Apparatus

Self-contained breathing apparatus should be available for fire fighting and rescue. Arrangements should be made for a supply of cylinders sufficient for the scale and duration of incidents that may be envisaged. The use of breathing apparatus at an incident shall be strictly controlled.

17.2 Protective Clothing

Fire fighting personnel shall be provided with appropriate clothing to counter the effects of radiant heat and water. Synthetic materials such as nylon shall not be worn. Details may be obtained from NFPA 45 *Standard on Fire Protection for Laboratories*.

Special clothing and equipment may be necessary for dealing with certain specific hazards on the plant in an emergency (e.g., Acids and hydrogen fluoride).

17.3 Wind Socks

Wind Socks shall be provided at appropriate locations inside installation.

18 Fire Extinguishers

18.1 Standard for Fire Extinguishers

Fire extinguisher selection/distribution shall conform to NFPA-10, Standard for Portable Fire.

18.2 Fire Extinguishers Installation

Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor. Fire extinguishers having a gross weight greater than 40 lb (18.14 kg) (except wheeled types) shall be so installed that the top of the fire extinguisher is not more than 31/2 ft (1.07 m) above the floor. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 4 in. (10.2 cm).

18.3 Selection of Fire Extinguisher

The selection of fire extinguishers for a given situation shall be determined by the character of the fires anticipated, the construction and occupancy of the individual property, the vehicle or hazard to be protected, ambient-temperature conditions, and other factors like horizontal range, time of discharge, etc. The number, size, placement, and limitations of use of fire extinguishers required shall meet the requirements as specified in NFPA-10, *Standard for Portable Fire*.

Fire extinguishers shall be selected for the classes of hazards to be protected in accordance with the following subdivisions.

Fire extinguishers for protecting Class A hazards shall be selected from the following:

(i) Water type.

(ii) Multipurpose dry chemical type and wet chemical type.

Fire extinguishers for protection of Class B hazards shall be selected from the following:

(i) Aqueous film-forming foam (AFFF).

(ii) Film-forming fluoroprotein foam (FFFP).

(iii) Carbon dioxide.

(iv) Dry chemical type.

Fire extinguishers for protection of Class C hazards shall be selected from types that are designated for use on Class C hazards.

NOTE: Carbon dioxide fire extinguishers equipped with metal horns are not considered safe for use on fires in energized electrical equipment and, therefore, are not classified for use on Class C hazards.

Fire extinguishers and extinguishing agents for the protection of Class D hazards shall be of types designated for use on the specific combustible-metal hazard.

Fire extinguishers and extinguishing agents for the protection of Class K hazards shall be selected from either a wet chemical type or dry chemical type.

Periodic inspection and maintenance of fire fighting extinguishers to be carried out.

19 Plant Building Protection

19.1 Standard for Protection of Other Buildings and Structures

Plant Buildings like warehouse, container storage, workshops, administration blocks, etc. shall be protected with smoke detectors/water sprinkler system (automatic/manual) or hose reel system or both, based on the nature of structure/material/equipment to be protected. The water sprinkler/hose reel system shall be designed as per NFPA 30, *Flammable and Combustible Liquids Code*, NFPA 14, *Standard for the installation of Standpipe and Hose Systems,* NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA 13, *Standard for the Installation of Sprinkler Systems*.

CHAPTER 9 - TANKAGE SYSTEM

20 Tankage System

The storage of flammable and combustible liquids shall be stored in fixed aboveground, underground and mounded tanks

Tanks shall be permitted to be of any shape, size, or type consistent with sound engineering design standard.

All tanks shall be provided with a means for electrically bonding to protect against static electricity hazards.

20.1 Design Standards for Atmospheric Tanks

20.1.1 Standard for Atmospheric Vessels

Atmospheric tanks, including those incorporating secondary containment, shall be designed and constructed in accordance with the following engineering design standards:

(i) API Specification 12 B, *Bolted Tank for Storage of Production Liquids*
(ii) API Specification 12 D, *Field Welded Tanks for Storage of Production Liquids*
(iii) API Specification 12 F, Shop Welded Tanks for Storage of Production Liquids
(iv) API Standard 650, *Welded Steel Tanks for Oil Storage*.
(v) EEMUA Publication for Mounded Tanks

20.1.2 Standard for Construction of Atmospheric Vessels

Atmospheric tanks designed and constructed in accordance with Appendix F of API Standard 650, *Welded Steel Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to 1.0 psig (gauge pressure of 6.9

KPa). All other tanks shall be limited to operation from atmospheric to 0.5 psig (gauge pressure of 3.5 KPa).

20.1.3 Use of Welded Steel Vessels

Atmospheric tanks that are not designed and constructed in accordance with Appendix F of API Standard 650, *Welded Steel Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to 1.0 psig (gauge pressure of 6.9 KPa) only if an engineering analysis determines that the tank can withstand the elevated pressure.

20.1.4 Horizontal Cylindrical and Rectangular Vessels

Horizontal cylindrical and rectangular tanks built according to any of the standards specified above shall be permitted to operate at pressures from atmospheric to 1 psig (gauge pressure of 6.9 KPa) and shall be limited to 2.5 psig (gauge pressure of 17.2 KPa) under emergency venting conditions.

20.1.5 Use of Low-Pressure and Pressure Vessels as Atmospheric Vessels

Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks.

20.1.6 Temperature of liquids in Atmospheric Vessels

Atmospheric tanks shall not be used to store a liquid at a temperature at or above its boiling point.

20.1.7 Height of Vertical Tanks

The height of the vertical tanks shall not exceed 64 ft

20.2 Design Standards for Low-Pressure Tanks

20.2.1 Standard for Low-Pressure Vessels

Low-pressure tanks shall be designed and constructed in accordance with engineering design standard API 620, *Design and Construction of Large, Welded, Low Pressure Storage Tanks.*

20.2.2 Operation of Low-Pressure Vessels

Low Pressure Vessels shall not be operated above their design pressure.

20.2.3 Use of Pressure Vessels as Low-Pressure Vessels

Pressure Vessels shall permitted to be used as low-pressure tanks.

20.2.4 Height of Vertical Vessels

The height of the vertical tanks shall not exceed 64 ft (from bottom to top of curb angle).

CHAPTER 10 – PIPING

21 Piping

21.1 Standard for Piping

The design, fabrication, assembly, test and inspection of piping systems shall be suitable for the expected working pressures and structural stresses and must follow the applicable sections of ASME B 31, *Code for pressure piping*.

21.2 Standard for Materials used in Pipes, Values, etc.

Pipe, valves, faucets, couplings, fittings and other pressure containing parts shall meet the material specifications and pressure and temperature limitations of ASME B 31, *Code for pressure piping*.

21.3 Protection of Above-Ground Piping

Above ground piping systems shall be protected against external corrosion by application of paints/ epoxies, whereas Underground systems shall be protected against corrosion by using protective coatings or cathodic protection systems.

CHAPTER 11 – EFFLUENT

22 Effluent

22.1 Effluent Discharge

Effluent Discharge Oily-Water must run in closed sewers wherever possible. Gravity sewers should have adequate gradient for self-cleaning. They should be interconnected by means of sewer boxes or manholes, each having a liquid seal to prevent transmission of hazardous gases from one sewer box to another. In cases where gases could collect, sewer box covers should be sealed and sewer box vented to a safe location. These vents should terminate a minimum of 3 meters above grade, 5 meters from operating platforms and 15 meters from furnaces.

22.2 Collection of Oily Water

Effluent, i.e., oily water collection system shall run through the entire operations area covering tank farms, loading and un-loading facilities, pump house, etc.

22.3 Design of Drainage System

Drainage system shall be designed to minimize fire exposure to other tanks and adjacent properties or waterways. A facility shall be designed and operated to prevent the normal discharge of flammable or combustible liquids to public waterways, public sewers, or adjoining property.

22.4 Emergency Drains

Emergency drainage systems if connected to public sewers or discharged into public waterways shall be equipped with traps.

22.5 Treatment of Oily Water

All the oily water mixture should be collected at a single location and processed through a suitable system before discharging the same through any means. Requirements specified in the National Environment Quality Standards (NEQS) for Municipals & Liquid Industrial Effluent shall be followed.

22.6 Combustible Waste

Combustible waste material in operating areas shall be kept to a minimum, stored in covered metal containers and disposed of at proper location as soon as possible.

22.7 Drainage of Diked Area

Each diked area must be graded so as to avoid collection of rain water. All gravity flow is directed towards the catch basin. Coming from the catch basin a line (minimum size 6 inch dia.) is routed through the dike to a block valve which is normally closed. This valve discharges to the storm drain system. The valve is kept closed to contain the oil within the diked area in case of tank leak/rupture. Operator must ensure that oil or any oil traces shall not go to storm water drain. If oil or oil traces are present in the drain, it must go to oil/water separator for treatment.

CHAPTER 12 – ELECTRICAL

23 Electrical Equipment and Operations

Any electrical equipment provided should not constitute a source of ignition for the flammable vapour that might be present under normal operation or during a spill. This includes all areas where Class I liquids, Class II liquids or Class III liquids are stored or handled at or above their flash points.

All electrical equipment and wiring shall be of a type specified by and installed in accordance with any internationally accredited standard.

APPENDIX A – TABLES

Table 1 – Electrical Area Classifications

(The area classifications listed in this Table are based on the premise that the installation shall meet the applicable requirements in all respects)

[SI units: 1 in. = 25.4 mm; 1 ft = 0.3048 m]

Location	NEC Class 1		Extent of Classified Area
	Division	Zone	
Indoor equipment installed in accordance with Section 5.3 of NFPA 30, Edition 2000, (i.e. Facility Design) where flammable vapour-air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapours are present continuously or for long periods of time
	1	1	Area within 5 ft of any edge of such equipment, extending in all directions
	2	2	Area between 5 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 5 ft to 25 ft horizontally from any edge of such equipment[7]
Outdoor equipment of the type covered in Section 5.3 of NFPA 30, Edition 2000, (i.e. Facility Design) where flammable vapour-air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapours are present continuously or for long periods of time
	1	1	Area within 3 ft of any edge of such equipment, extending in all directions
	2	2	Area between 3 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 3 ft to 10 ft horizontally from any edge of such equipment
Tank storage installations inside buildings	1	1	All equipment located below grade level
	2	2	Any equipment located at or above grade level
Tank - aboveground	1	0	Inside fixed-roof tank

[7] The release of Class I liquids can generate vapours to the extent that the entire building, and possibly an area surrounding it, should be considered a Class I, Division 2, or Zone 2 location.

Location	NEC Class 1		Extent of Classified Area
	Division	Zone	
	1	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference
Shell, ends, or roof and dike area	2	2	Within 10 ft from shell, ends, or roof of tank; also, area inside dikes to level of top of tank
Vent	1	0	Area inside of vent piping or opening
	1	1	Within 5 ft of open end of vent, extending in all directions
	2	2	Area between 5 ft and 10 ft from open end of vent, extending in all directions
Floating roof With fixed outer roof	1	0	Area between the floating and fixed-roof sections and within the shell
With no fixed outer roof	1	1	Area above the floating roof and within the shell
Underground tank fill opening	1	1	Any pit, box, or space below grade level, if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
	2	2	Up to 18 in. above grade level within a horizontal radius of 10 ft from a loose fill connection and within a horizontal radius of 5 ft from a tight fill connection
Vent - discharging upward	1	0	Area inside of vent piping or opening
	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Up to 18 in. above grade level within a horizontal radius of 10 ft from a loose fill connection and within a horizontal radius of 5 ft from a tight fill connection
Drum and container filling - outdoors or indoors	1	0	Area inside the drum or container
	1	1	Within 3 ft of vent and fill openings, extending in all directions
	2	2	Area between 3 ft and 5 ft from vent or fill opening, extending in all directions; also, up to 18 in. above floor or grade level within a horizontal radius of 10 ft from vent or fill opening
Pumps, bleeders, withdrawal fittings Indoor	2	2	Within 5 ft of any edge of such devices, extending in all directions ; also, up to 3

Location	NEC Class 1		Extent of Classified Area
	Division	Zone	
			ft above floor or grade level within 25 ft horizontally from any edge of such devices
Outdoor	2	2	Within 3 ft of any edge of such devices, extending in all directions; also, up to 18 in. above grade level within 10 ft horizontally from any edge of such devices
Pits and sumps:			
Without mechanical ventilation	1	1	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
With adequate mechanical ventilation	2	2	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
Containing valves, fittings, or piping, and not within a Division 1 or 2 or Zone 1 or 2 classified location	2	2	Entire pit or sump
Drainage ditches, separators, impounding basins:			
Outdoor	2	2	Area up to 18 in. above ditch, separator, or basin; also, area up to 18 in. above grade within 15 ft horizontally from any edge
Indoor			Same classified area as pits
Tank vehicle and tank car[8] loading through open dome	1	0	Area inside of the tank
	1	1	Within 3 ft of edge of dome, extending in all directions
	2	2	Area between 3 ft and 15 ft from edge of dome, extending in all directions
Loading through bottom connections with atmospheric venting	1	0	Area inside of the tank
	1	1	Within 3 ft of point of venting to atmosphere, extending in all directions
	2	2	Area between 3 ft and 15 ft from point of venting to atmosphere, extending in all directions; also, up to 18 in. above

[8] When classifying extent of area, consideration shall be given to the fact that tank cars or tank vehicles can be spotted at varying points. Therefore, the extremities of the loading or unloading positions shall be used.

Location	NEC Class 1		Extent of Classified Area
	Division	Zone	
			grade within a horizontal radius of 10 ft from point of loading connection
Office and rest rooms	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb, or partition did not exist
Loading through closed dome with atmospheric venting	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Area between 3 ft and 15 ft from open end of vent, extending in all directions; also, within 3 ft of edge of dome, extending in all directions
Loading through closed dome with vapour control	2	2	Within 3 ft of point of connection of both fill and vapour lines, extending in all directions
Bottom loading with vapour control or any bottom unloading	2	2	Within 3 ft of point of connections, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of connections
Storage and repair garage for tank vehicles	1	1	All pits or spaces below floor level
	2	2	Area up to 18 in. above floor or grade level for entire storage or repair garage
Garages for other than tank vehicles	Ordinary		If there is any opening to these rooms within the extent of an outdoor classified location, the entire room shall be classified the same as the area classification at the point of the opening
Outdoor drum storage	Ordinary		
Inside rooms or storage lockers used for the storage of Class I liquids	2	2	Entire room
Indoor warehousing where there is no flammable liquid transfer	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as the wall, curb, or partition did not exist

Reference 20

Table 2A - Stable Liquids Minimum Tank Spacing (Operating Pressure 2.5 psig (17.2 Kpa) or less)

[Tank Shell to Property Line/Nearest Building or Public Way]

[SI units: 1 ft = 0.3 m]

S. No.	Type of Tank	Protection	Minimum Distance (Feet) from property Line That is or Can be Built On, Including the opposite Side of a Public Way and shall be not less than 5 ft	Minimum Distance (Feet) from Nearest Side of Any Public Way or from Nearest Important Building on Same Property and shall be not less than 5 ft.
1	Floating Roof	Protection for exposures [1]	½ times diameter of tank	1/6 times diameter of tank
		No Protection	Diameter of tank but need not exceed 175 ft.	1/6 times diameter of tank
2	Vertical with weak roof to shell seam	Approved foam or inerting system on tanks not exceeding 150 ft. in diameter [2]	½ times diameter of tank	1/6 times diameter of tank
		Protection for exposures	Diameter of tank	1/3 times diameter of tank
		No Protection	Twice diameter of tank but need not exceed 350 ft.	1/3 times diameter of tank
3	Horizontal and vertical with emergency relief venting to limit pressures to 2.5 psig (guage pressure of 17.2 Kpa)	Approved inerting system on the tank or approved foam system on vertical tanks	½ times Table 2D	½ times Table 2D
		Protection for exposures [3]	Table 2D	Table 2D
		No Protection	Twice Table 2D	Table 2D

Reference 14

[1] Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located either within the jurisdiction of any public fire department or adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

[2] For tanks over 150 ft. in diameter, use "Protection for Exposures" or "No Protection" as applicable.

[3] Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located either within the jurisdiction of any public fire department or adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

Table 2B - Stable Liquids Minimum Tank Spacing (Operating Pressure greater than 2.5 psig (17.2 Kpa)

[Tank Shell to Property Line/Nearest Building or Public Way]

[SI units: 1 ft = 0.3 m]

S. No.	Type of Tank	Protection	Minimum Distance (Feet) from property Line That is or Can be Built On, Including the opposite Side of a Public Way	Minimum Distance (Feet) from Nearest Side of Any Public Way or from Nearest Important Building on Same Property
1	Any Type	Protection for exposures [4]	1½ times Table 2D but shall not be less than 25 ft.	1½ times Table 2D but not less than 25 ft.
		No Protection	3 times Table 2D but not less than 50 ft.	1½ times Table 2D but not less than 25 ft.

Reference 15

[4] Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located either within the jurisdiction of any public fire department or adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

Table 2C - Unstable Liquids Minimum Tank Spacing

[Tank Shell to Property Line/Nearest Building or Public Way]

[SI units: 1 ft = 0.3 m]

S. No.	Type of Tank	Protection	Minimum Distance (Feet) from property Line That is or Can be Built On, Including the opposite Side of a Public Way	Minimum Distance (Feet) from Nearest Side of Any Public Way or from Nearest Important Building on Same Property
1	Horizontal and vertical tanks with emergency relief venting to permit pressures not excess of 2.5 psig (gauge pressure of 17.2 KPa)	Tank protected with any one of the following: Approved water spray, Approved inerting. Approved insulation and refrigeration. Approved barricade	Table 2D but not less than 25 ft.	Not less than 25 ft.
		Protection for exposures [5]	2½ times Table 2D but not less than 50 ft.	Not less than 50 ft.
		No Protection	5 times Table 2D but not less than 100 ft.	Not less than 100 ft.
2	Horizontal and vertical tanks with emergency relief venting to permit pressures over 2.5 psig (gauge pressure of 17.2 KPa)	Tank protected with any one of the following: Approved water spray. Approved inerting. Approved insulation and refrigeration. Approved barricade	2 times Table 2D but not less than 50 ft.	Not less than 50 ft.
		Protection for exposures [5]	4 times Table 2D but not less than 100 ft.	Not less than 100 ft.
		No Protection	8 times Table 2D but not less than 150 ft.	Not less than 150 ft.

Reference 16

[5] Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located either within the jurisdiction of any public fire department or adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

Table 2D – References for use in Tables 2A to 2C Minimum Tank Spacing

[Tank Shell to Property Line/Nearest Building or Public Way]

[SI units: 1 ft = 0.3 m; 1 gal = 3.8L]

S. No.	Tank Capacity (gal)	Minimum Distance (Feet) from property Line That is or Can be Built On, Including the opposite Side of a Public Way	Minimum Distance (Feet) from Nearest Side of Any Public Way or from Nearest Important Building on Same Property
1	275 or less	5	5
2	276 to 750	10	5
3	751 to 12,000	15	5
4	12,001 to 30,000	20	5
5	30,001 to 50,000	30	10
6	50,001 to 100,000	50	15
7	100,001 to 500,000	80	25
8	500,001 to 1,000,000	100	35
9	1,000,000 to 2,000,000	135	45
10	2,000,001 to 3,000,000	165	55
11	3,000,001 or more	175	60

Reference 17

Table 2E – Class IIIB Liquids Minimum Tank Spacing

[Tank Shell to Property Line/Nearest Building or Public Way]

[SI units: 1 ft = 0.3 m; 1 gal = 3.8L]

S. No.	Tank Capacity (gal)	Minimum Distance (Feet) from property Line That is or Can be Built On, Including theopposite Side of a Public Way	Minimum Distance (Feet) from Nearest Side of Any Public Way or from Nearest Important Building on Same Property
1	12,000 or less	5	5
2	12,001 to 30,000	10	5
3	30,001 to 50,000	10	10
4	50,001 to 100,000	15	10
5	100,0 01 or more	15	15

Reference 18

Table 2F – Minimum Tank Spacing (Shell to Shell)

(1)

[SI units: 1 ft = 0.3 m]

S. No.	Tank Size	Floating Roof Ranks	Fixed or Horizontal Tanks	
			Class I or Class II Liquids	Class IIIA Liquids
1	All tanks not over 150 ft in diameter	1/6 sum of adjacent tank diameters but not less than 3 ft	1/6 sum of adjacent tank diameters but not less than 3 ft	1/6 sum of adjacent tank diameters but not less than 3 ft
2	Tanks larger than 150 ft in diameter. If impounding is around tanks as foot note no. (1).	1/4 sum of adjacent tank diameters	1/3 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters

(1) Tanks used only for storing Class IIIB liquids shall be permitted to be spaced no less than 3ft (0.9m) apart unless within a diked area or drainage path for a tank storing a Class I or II liquid, in which case the provisions of above table shall apply".

Reference 19

APPENDIX – B
(LIST OF DRAWINGS / DOCUMENTS)

Following drawings/ documents shall be readily available at depots/ terminals:

1. Plot Plan
2. safety manual
3. Operating & Maintenance Manual
4. Training Documents
5. Piping & Equipment Drawings
6. Piping & Equipment Inspection and Testing documents/certificates
7. Oil Storage Tank Drawings
8. Oil Storage Tank Inspection and Testing documents/certificates
9. Electrical layout of the Installation
10. Hazardous area classification drawing
11. Layout locations of Fire Alarm Panel, Hooter/Alarm
12. Electrical and instrumentation equipment list and data sheets/specifications
13. Earth resistance test reports
14. Instrumentation calibration Test Certificates

REFERENCES

Reference 1	IP Code Oct. 1993, Table A-2.2.2.1
Reference 2	IP Code Oct. 1993, Table A-2.2.2.2
Reference 3	NFPA 11, 2002 Edition, Table 5.2.5.2.1
Reference 4	NFPA 11, 2002 Edition, Table 5.2.5.3.4 & 5.2.5.2.2
Reference 5	NFPA 11, 2002 Edition, Table 5.2.6.2.8
Reference 6	NFPA 11, 2002 Edition, Table 5.2.6.5.1
Reference 7	NFPA 11, 2002 Edition, Table 5.2.4.2.2
Reference 8	NFPA 11, 2002 Edition, Table 5.3.5.3.1
Reference 9	NFPA 11, 2002 Edition, Table 5.6.5.3
Reference 10	NFPA 11, 2002 Edition, Table 5.7.3.1
Reference 11	NFPA 11, 2002 Edition, Table 5.8.1.2
Reference 12	NFPA 11, 2002 Edition, Table 5.9.1.2
Reference 13	NFPA 11, 2002 Edition, Table 5.9.1.4
Reference 14	NFPA 30, 2003 Edition, Table 4.3.2.1.1
Reference 15	NFPA 30, 2003 Edition, Table 4.3.2.1.2
Reference 16	NFPA 30, 2003 Edition, Table 4.3.2.1.4
Reference 17	NFPA 30, 2003 Edition, Table 4.3.2.1.1(b)
Reference 18	NFPA 30, 2003 Edition, Table 4.3.2.1.5
Reference 19	NFPA 30, 2003 Edition, Table 4.3.2.2.1
Reference 20	NFPA 30, 2003 Edition, Table 8.2.2

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(Rashid Farooq)
Acting Chairman