FIRE PROTECTION FACILITIES
FOR
PETROLEUM DEPOTS, TERMINALS, PIPELINE INSTALLATIONS
AND
LUBE OIL INSTALLATIONS

Prepared By

FUNCTIONAL COMMITTEE ON FIRE PROTECTION

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These documents are intended to supplement rather than replace the prevailing statutory requirements.
FOREWARD

The oil industry in India is nearly 100 years old. As such a variety of practices have been in vogue because of collaboration/association with different foreign companies and governments. Standardization in design philosophies and operating and maintenance practices at a national level was hardly in existence. This coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasized the need for the industry to review the existing state of art in designing, operating, and maintaining oil and gas installations.

With this in view, Oil Industry Safety Directorate (OISD) was established in 1986 staffed from within the industry in formulating and implementing a series of self regulatory measures aimed at removing obsolescence, standardizing and upgrading the existing standards to ensure safer operations. Accordingly, OISD constituted a number of functional committees comprising of experts nominated by the industry to draw up standards and guidelines on various subjects.

The present document on fire protection facilities for petroleum Depots, Terminals and Pipeline installations is the amended edition of the document prepared by the Functional Committee on "Fire Protection Facilities For Petroleum Depots, Terminals, Pipeline Installations And Lube Oil Installations" which was published in July, 1989. This document is prepared based on the accumulated knowledge and experience of industry members and the various national and international codes and practices. It is hoped that the provision of this document will go a long way to improve the safety and reduce accidents in the Oil and Gas Industry.

This document will be reviewed periodically for improvements based on the new experiences and better understanding. Suggestions may be addressed to:-

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(Complete Revision: August, 2007)

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ANNEXURE

I. Sample Calculation of Fire Water Flow Rate for Storage Tanks.
II. Sample Calculation of Fire Water Flow Rate for POL Tank Wagon Loading Gantry.
III. Sample Calculation of Foam Compound Requirement for Depot/Terminal
IV. Brief Description of Fire Fighting Foams.
V. System of automatic actuated rim seal fire detection and extinguishing system for external floating roof tanks storing Class- A petroleum
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FIRE PROTECTION FACILITIES
FOR
PETROLEUM DEPOTS, TERMINALS AND PIPELINE/LUBE OIL INSTALLATIONS

1.0 INTRODUCTION

The petroleum depots, terminals & pipeline/lube oil installations are generally located in the remote areas and near railway sidings. However, the experience shows that with the passage of time, these get surrounded by residential/industrial installations. The inventory of flammable materials stored therein necessitates inbuilt fire protection facilities.

It can be impractical and prohibitively costly to design fire protection facilities to control catastrophic fires. The usual requirement of a good system is to prevent emergencies from developing into major threat to the oil installation and surroundings.

2.0 SCOPE

2.1 This standard lays down the minimum requirement of fire protection facilities at Petroleum Depots, Terminals, Pipeline Installations with or without Storages, Central Tank Farms (CTF). Lube Oil Installations, Grease Manufacturing & Filling Facilities.

2.2 This standard does not cover the fire protection facilities for:-

i) Depots, Terminals/Installations inside the Refineries and/or Oil/Gas Processing Plants under the same management for which OISD-STD-116 shall be referred.

ii) Installations handling Liquefied Petroleum Gas (LPG) Storage, Handling and Bottling. The same are covered in OISD-STD-144, OISD-STD-150 or OISD-STD-169 as the case may be.

iii) Drilling rigs, Work over rigs and Production installations (GGS/OCS, GCP/GCS, EPS, QPS/WHI etc) which are covered in OISD-STD-189.

iv) Port Oil Terminals for which OISD-STD-156 shall be referred.

v) Control Room Building & Electrical Installations shall be provided as per OISD-STD-163 & 173 respectively.

2.3 It is intended that the provisions specified in this standard shall be implemented progressively for the existing facilities as given in Annexure-VI of this standard. For the new / upcoming locations, these shall be implemented with immediate effect.

3.0 DEFINITIONS

3.1 PETROLEUM DEPOTS & TERMINALS

A portion of the property, where combustible/flammable liquids are received by tanker, pipelines, tank wagons, tank trucks and are stored or blended in bulk for the purpose of distribution by tankers, pipelines, tank wagons, tank trucks, portable tanks or containers.
3.1.1 PIPELINE INSTALLATIONS

Pipeline Installations are those facilities on cross-country pipelines which have pumping and/or delivery station with or without storages.

3.1.2 LUBE OIL INSTALLATIONS

The facilities meant for receipt, storage and blending of base oils & additives into finished Lube products. It includes lube-blending plants, grease manufacturing plants & small can filling plants.

3.1.3 AVIATION FUELLING STATIONS

The facilities where ATF is received by tank wagons, tank trucks & pipeline and stored in bulk for dispatch of product by refuellers & pipeline. It also includes storage of Methanol/AVGAS & other additives in drums.

3.1.4 INFRASTRUCTURE/OTHER FACILITIES

These are the facilities such as Control Room Building, Sub-Station, Diesel Generator (with diesel storage tank), & Administrative Building, etc. provided in Petroleum Depots, Terminals and Pipeline Installations.

3.1.5 HARZARDOUS AREA

An area will be deemed to be hazardous where:-

Petroleum having flash point below 65°C or any flammable gas or vapor in a concentration capable of ignition is likely to be present.

Petroleum or any flammable liquid having flash point above 65°C is likely to be refined, blended or stored at above its flash point.

For classification and extent of hazardous area, refer “The Petroleum Rules - 2002”.

3.2 CLASSIFICATION OF PETROLEUM PRODUCTS

3.2.1 Petroleum means any liquid hydrocarbon or mixture of hydrocarbons and any inflammable mixture (liquid, viscous or solid) containing any liquid hydrocarbon.

3.2.2 General Classification

Petroleum products other than LPG which is a separate category are classified according to their closed cup Flash Point as follows:-

**Petroleum Class A** means petroleum having a flash point below 23°C.

**Petroleum Class B** means petroleum having a flash point of 23°C and above but below 65°C.

**Petroleum Class C** means petroleum having a flash point of 65°C and above but below 93°C.

**Excluded Petroleum** means petroleum having a flash point above 93°C and above.

**Flash Point** of any petroleum means the lowest temperature at which it yields a vapor which will give a momentary flash when ignited.

3.2.3 Classification for Heated Petroleum Products

The locations where product is handled by artificially heating it to above its flash point, Class C product shall be considered as Class B product and Class B product as Class A product.
3.3 GENERAL TERMINOLOGY

*Clean agent* electrically non-conductive, volatile or gaseous fire extinguishant that does not leave a residue upon evaporation and meets the requirements given in the latest NFPA 2001 on clean agent fire extinguishing systems in line with environmental considerations of Kyoto and Montreal Protocol & latest MoEF regulations.

*Shall* indicate that provision is mandatory.

*Should* indicate that provision is recommendatory as per good engineering practices.

GPM denotes US gallons (1GPM=3.785 LPM)

4.0 FIRE PROTECTION PHYLOSOPHY

The fire protection philosophy is based on loss prevention & control. It considers that a depot/terminal carries an inherent potential hazard due to flammable nature of petroleum products stored therein. A fire in one facility can endanger other facility of the depot/terminal, if not controlled/extinguished as quickly as possible to minimize the loss of life & property and prevent further spread of fire.

4.1 GENERAL CONSIDERATIONS

The size of product storage & handling facilities, their location and terrain determine the basic fire protection requirements.

4.1.1 Layout

Layout of a depot or terminal, pipeline installation, lube oil installation, grease manufacturing & filling facilities and handling/disposal system of blow down, drain from equipment handling flammable liquids shall be done in accordance with OISD-STD-118 & OISD-STD-109 as applicable.

Special consideration should be given in the plant layout & product line layout for heated products lines laid alongside the pipeline carrying lighter petroleum products.

4.1.2 FIRE PROTECTION

Depending on the nature of risk, following fire protection facilities shall be provided in the installation.

- Fire Water System.
- Foam System.
- Clean Agent Protection System.
- First Aid Fire Fighting Equipment.
- Mobile Fire Fighting Equipment.
- Carbon Dioxide System
- Dry Chemical Extinguishing System
- Portable fire fighting equipment
- Fire Detection, Alarm & Communication System.

4.2 DESIGN CRITERIA FOR FIRE PROTECTION SYSTEM

4.2.1 Facilities shall be designed on the basis that city fire water supply is not available close to the installation.

4.2.2 The fire water system shall be provided based on two largest fire contingencies simultaneously for all locations where total tankage in the terminal is more than 30,000 KL. Wherever water replenishment @ 50% is available, single fire contingency shall be considered for Fire water storage.

This clause shall not be applicable for location exclusively storing class C & excluded products.

(Refer Explanatory Note for implementation vide Annexure VI)
4.2.3 The hazardous areas shall be protected by a well laid combination of hydrants & monitors. The following installations are exempted from this provision:

i) The installation having aggregate above ground storage capacity of less than 1000 KL (Class A+B+C) other than AFS.
ii) Pipeline installation having only scrapper stations or sectionalizing valve stations.

4.2.4 Tank Wagon (TW)/Tank Truck (TT) loading/unloading facilities, Manifold area of product pump house & Exchange pit shall be fully covered with a well laid out combination of hydrants and UL/FM listed/approved variable flow type water-cum-foam monitors.

4.2.5 The installations storing Class A petroleum in above ground tanks shall have fixed water spray system.

However, installations above 1000 KL storage fulfilling the following both conditions are exempted from the provision of fixed water spray system

- Aggregate above ground storage of Class A & B petroleum up to 5000 KL.
- Floating roof tank storing Class A petroleum having diameter up to 9 m.

4.2.6 Class 'B' above ground Petroleum storage tanks (fixed roof or floating roof) of diameter larger than 30 m shall be provided with fixed water spray system.

4.2.7 When Class A & B above ground storage tanks are placed in a common dyke, the fixed water spray system shall be provided on all tanks except for small installations as mentioned in 4.2.5.

4.2.8 TW loading gantries shall be provided with manually operated fixed water spray system. In case automatic fixed water spray system is provided in TW gantry, the gantry shall be divided into suitable number of segments (each segment having min. length of 15 m length & width of 12 m) and three largest segments operating at a time shall be considered as single risk for calculating the water requirement.

Accordingly, a provision shall be made to actuate the water spray system from a safe approachable central location i.e. affected zone and adjoining zones.

4.2.9 The fixed water spray system shall also be provided on all tanks, irrespective of diameter in the installations constructed prior to publication of 1st Edition of OISD-STD-117 in July'1989, where inter distances between tanks in a dyke and/or within dykes are not meeting the requirements of OISD-STD-118.

4.2.10 Fixed foam system or Semi-fixed foam system shall be provided on tanks (floating roof or fixed roof) exceeding 18 m diameter storing Class A or Class B petroleum.

In the installations where inter distances between tanks within a dyke and/or within tank dykes are not conforming to the provisions of OISD-STD-118 and the tanks in the installation are constructed prior to publication of 1st Edition of OISD-STD-117 in July’1989, fixed foam or semi-fixed foam system shall also be provided on all tanks irrespective of diameter.

4.2.11 Portable foam and/or UL/FM listed/approved variable flow water-cum-foam monitors shall be provided for suppression of pool fire in tank farm area.
4.2.12 Automatic actuated rim seal fire detection and extinguishing system shall be provided on all existing as well as new external floating roof tanks storing Class petroleum.

Only those Rim seal protection systems, which use the linear heat hollow metallic tube type detectors with foam based extinguishing media, either for existing/ new or for replacements of existing detection system when due, shall be used. These detection systems shall be certified by any of the international certifying agencies like UL, FM, VdS or LPC to ensure that those systems are used which meet with highest international standards of safety certification. (Refer Explanatory Note for implementation vide Annexure VI)

The minimum requirement in design for the of automatic rim seal protection using foam system is given in Annexure V

This is in addition to the fixed water spray system and fixed foam system or Semi-fixed foam system on all floating roof tanks storing Class A & B petroleum.

4.2.13 Fixed water spray system shall also be provided in lube oil drum areas if located in hazardous area. (Refer Explanatory Note for implementation vide Annexure VI)

4.2.14 Clean Agent (Halon substitute) based flooding system should be provided for control rooms, computer rooms/ repeater station and pressurized rooms in major locations having automated pipeline receipt/dispatch and/or TW/TT loading facilities. Selection of clean agent and design of fire protection system for control rooms, computer rooms and pressurized rooms should follow the Standard on “Clean Agent Extinguishing systems NFPA Standard 2001 (2008 or Latest Edition) including its safety guidelines with respect to “Hazards to Personnel”, electrical clearance and environmental factors in line with environmental considerations of Kyoto and Montreal Protocol & latest MoEF regulations. Clean agent like Inert gas, Fluroketone can be used as fire suppressant in control rooms, computer rooms and pressurized rooms.

Combined POL and LPG facilities in the same premises

The fire protection and fire fighting requirement for the combined POL and LPG facilities in the same premises shall be based on the following:–

i. Each POL / LPG facility shall independently meet the design, layout & fire protection system requirements of corresponding OISD standards.

ii. The fire water requirement shall be based on two fire contingencies simultaneously in the combined facility and fire water storage capacity shall be fixed accordingly.

iii. The fire water system shall ensure availability of pressure of 7 kg/cm$^2$g at the farthest point.

iv. The entire fire water system shall remain pressurized and kept in auto mode as recommended for LPG installations.

v. The control of such facility shall remain with dedicated or LPG group.

4.3 FIRE WATER SYSTEM

Water is used for fire extinguishments, fire control, cooling of equipment, exposure protection of equipment and personnel from heat radiation.
The fire water ring main shall be provided all around perimeter of the installation with hydrants/monitors spaced at intervals not exceeding 30m when measured aerially.

4.3.1 Components of Fire Water System

The main components of the system are Fire Water Storage, Fire Water Pumps and Distribution Piping Network.

4.3.2 Basis

The fire water system shall be provided based on two largest fire contingencies simultaneously for all locations where total tankage in the terminal is more than 30,000 KL. Wherever water replenishment @ 50% is available, single fire contingency shall be considered for Fire water storage. This clause shall not be applicable for location exclusively storing class C & excluded products.

(Refer Explanatory Note for implementation vide Annexure VI)

4.3.2.1 Design Flow Rate

i) Fire water flow rate for a tank farm shall be aggregate of the following :-

- Water flow calculated for cooling a tank on fire at a rate of 3 lpm/m² of tank shell area.
- Water flow calculated for exposure protection for all other tanks falling within a radius of (R +30) m from centre of the tank on fire (R-Radius of tank on fire) and situated in the same dyke at a rate of 3 lpm/m² of tank shell area.
- Water flow calculated for exposure protection for all other tanks falling outside a radius of (R+30) m from centre of the tank on fire and situated in the same dyke at a rate of 1 lpm/m² of tank shell area.

- For water flow calculations, all tanks farms having class A or B petroleum storage shall be considered irrespective of diameter of tanks and whether fixed water spray system is provided or not.
- Water flow required for applying foam on a single largest tank by way of fixed foam system, where provided, or by use of water/foam monitors. (Refer section 4.4.8 for foam solution application rates.)
- Various combinations shall be considered in the tank farm for arriving at different fire water flow rate and the largest rate to be considered for design.

ii) Fire water flow for pump house shed at cross country pipeline installations shall be at a rate of 10.2 lpm/m².

iii) Fire water flow rate for TW loading gantry (Refer Annexure – II) and product pump house in a depot or terminal shall be calculated at a rate of @ 10.2 lpm/m².

iv) For Pump of volatile product/s located under pipe rack fire water flow rate shall be calculated at a rate of 20.4 lpm/ m².

v) Fire water flow rate for supplementary streams shall be based on using 4 single hydrant outlets and 1 monitor simultaneously. Capacity of each hydrant outlet as 36 m³/hr and of each high volume monitor as 228m³/hr minimum shall be considered at a pressure of 7 kg/cm² (g). The supplementary water stream requirement shall be in addition to design flow rates as calculated in (i), (ii), (iii) & (iv) above.

vi) The design fire water rate shall be the largest of [4.3.2.1 (i)], [4.3.2.1 (ii)], [4.3.2.1 (iii)], or [4.3.2.1 (iv)]. (Refer Annexure-I).
4.3.3 Header Pressure

Fire water system shall be designed for a minimum residual pressure of 7 kg/cm² (g) at hydraulically remotest point in the installation considering single largest risk scenario.

4.3.4 Storage

Water for the fire fighting shall be stored in easily accessible surface or underground or above ground tanks of steel, concrete or masonry.

The effective capacity of the reservoir/tank above the level of suction point shall be minimum 4 hours aggregate rated capacity of pumps. However, where reliable make up water supply is 50% or more of design flow rate, the storage capacity can be reduced to 3 hours aggregate rated capacity of pumps.

Fresh water should be used for fire fighting purposes. In case sea water or treated effluent water is used for fire fighting purposes, the material of the pipe selected shall be suitable for the service.

The installation shall have facilities for receiving and diverting all the water coming to the installation to fire water storage tanks in case of an emergency.

Storage reservoir shall be in two equal interconnected compartments to facilitate cleaning and repairs. In case of steel tanks there shall be minimum two tanks each having 50 % of required capacity.

Large natural reservoirs having water capacity exceeding 10 times the aggregate fire water requirement can be left unlined.

4.3.5 Fire Water Pumps

(i) Fire water pumps having flooded suction shall be installed to meet the design fire water flow rate and head.

If fire water is stored in underground tanks, an overhead water tank of sufficient capacity shall be provided for flooded suction and accounting for leakages in the network, if any.

(ii) The pumps shall be capable of discharging 150% of its rated discharge at a minimum of 65% of the rated head. The Shut-off head shall not exceed 120% of rated head for horizontal centrifugal pumps and 140% for vertical turbine pump.

(iii) At least one standby fire water pump shall be provided up to 2 nos. of main pumps. For main pumps 3 nos. and above, minimum 2 nos. standby pumps of the same type, capacity & head as the main pumps shall be provided.

(iv) The fire water pump(s) including the standby pump(s) shall be of diesel engine driven type. Where electric supply is reliable, 50% of the pumps can be electric driven. The diesel engines shall be quick starting type with the help of push buttons located on or near the pumps or located at a remote location. Each engine shall have an independent fuel tank adequately sized for 6 hours continuous running of the pump.

(v) Fire water pumps & storage shall be located far away from the potential leak sources / tankage are and shall be at least 30 m (minimum) away from equipment or where hydrocarbons are handled or stored.

(vi) Fire water pumps shall be exclusively used for fire fighting purpose only.

(vii) Suction and discharge valves of fire water pumps shall be kept full open all the times.

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(viii) The fire water network shall be kept pressurized by jockey pump(s).

(ix) A standby jockey pump of similar type, the capacity of the pump shall be sufficient to maintain system pressure in the event of leakages from valves etc. The capacity of jockey pumps shall be 5% minimum and maximum 10% of the design fire water rate. Its head shall be higher than the main fire water pumps. Auto cut-in / cut-off facility should be provided for jockey pumps capacity & head shall be provided.

(x) The fire water pumps shall be provided with auto cut in facility with pressure drop in fire water network

(Refer Explanatory Note for implementation vide Annexure VI)

4.3.6 Fire Water Network

(i) Looping

The fire water network shall be laid in closed loops as far as possible to ensure multi-directional flow in the system. Isolation valves shall be provided in the network to enable isolation of any section of the network without affecting the flow in the rest. The isolation valves shall be located normally near the loop junctions. Additional valves shall be provided in the segments where the length of the segment exceeds 300 m.

(ii) Above / Underground Network

The fire water network steel piping should normally be laid above ground at a height of at least 300 mm above finished ground level. Pipes made of composite material shall be laid underground.

However, the ring main shall be laid underground at the following places.

- Road crossings.
- Places where above ground piping is likely to cause obstruction to operation and vehicle movement.
- Places where above ground piping is likely to get damaged mechanically.
- Where frost conditions warrants and ambient temperature is likely to fall subzero, above ground piping shall be laid at least 1 m below the finished grade level to avoid freezing of water. Alternatively, water circulation should be carried out in the above ground pipelines or any other suitable means.

(iii) Protection of underground pipeline

If fire water ring mains are laid underground, the following shall be ensured:-

- The ring main shall have at least 1 m earth cushion in open ground, 1.5 m cushion under the road crossings and in case of crane movement area pipeline shall be protected with concrete/steel encasement as per design requirement.
- For rail crossing, provisions stipulated by Indian Railways shall be complied.
- The under ground ring main shall be protected against soil corrosion by suitable coating/wrapping with or without cathodic protection.
- Pipe supports under the pipe line shall be suitable for the soil conditions.

(iv) Support & Protection of above ground pipelines

The mains shall be supported at regular intervals not exceeding 6 m. For pipeline size less than 150 mm, support interval shall not exceed 3 m.

The pipe support shall have only point contact.
The system for above ground portion shall be analyzed for flexibility against thermal expansion and necessary expansion loops, guides/cross guides and supports provided.

(v) Sizing of pipeline

a) The hydraulic analysis of network shall be done at the design time. Also whenever fire water demand increases due to addition of facilities or extensive extension of network, fresh hydraulic analysis shall be carried out.

b) Fire water ring main shall be sized for 120% of the design water flow rate. Design flow rates shall be distributed at nodal points to give the most realistic way of water requirements in an emergency. It may be necessary to assume several combinations of flow requirement for design of network.

The stand post for hydrants and monitors shall be sized to meet the respective design water flow rates.

(vi) General

Connections for fixed water monitors on the network shall be provided with independent isolation valves.

Fire water mains shall not pass through buildings or dyke areas. In case of underground mains the isolation valves shall be located in RCC/brick masonry chamber of suitable size to facilitate operation during emergency & maintenance.

4.3.7 Hydrants & Monitors

i) Hydrants shall be located bearing in mind the fire hazards at different sections of the premises to be protected and to give most effective service. At least one hydrant post shall be provided for every 30 m of external wall measurement or perimeter of battery limit in case of high hazard areas. For non-hazardous area, they shall be spaced at 45 m intervals. The horizontal range & coverage of hydrants with hose connections shall not be considered beyond 45 m.

ii) Hydrants shall be located at a minimum distance of 15 m from the periphery of storage tank or equipment under protection. In case of buildings this distance shall not be less than 2 m and not more than 15 m from the face of building. Provision of hydrants within the building shall be provided in accordance with IS: 3844.

iii) Hydrant/Monitors shall be located along road side berms for easy accessibility.

iv) Double headed hydrants with two separate landing valves or monitor on suitably sized stand post shall be used. All hydrant outlets/monitor isolation valves shall be situated at workable height of 1.2 meter above ground or hydrant/monitor operating platform level.

v) Monitors shall be located to direct water on the object as well as to provide water shield to firemen approaching a fire. The requirement of monitors shall be established based on hazards involved and layout considerations. Monitors shall not be installed within 15 m of hazardous equipment.

vi) For marketing terminals & Petroleum Depots, the remote operated high volume long range water cum foam monitors (Capacity 1000 GPM) to fight tank fires shall be provided which shall
be of variable flow 1000/750/500GPM (with flow adjustable manually in the field). Foam induction to the monitor shall be possible from minimum 60 m distance from the monitor.

For Pipeline tank farms & Central Tank Farms, Remote operated high volume long range water cum foam monitors (capacity 1000 GPM and above) to fight tank fires shall be provided which shall be of variable flow type (with flow adjustable manually in the field). Foam induction to the monitor shall be possible from minimum 60m distance from the monitor.

These high volume long range monitors shall be located more than 45 m from the hazardous equipment. The basic water-cum-foam monitors shall be UL/FM listed/approved. The electrical or hydraulic remote control mechanism shall be in line with Hazardous Area Classification.

Following criteria shall be followed for installation of variable flow foam-cum-water monitors:
(a) Remote operated variable flow monitors shall be installed in such a way that all the tanks in the installation are within the horizontal range of foam throw.
(b) Minimum two nos. of monitors shall be installed for each tank farm having aggregate storage capacity up to 10,000 KL in the installation to meet the requirement as per S.No. (a) above.
(c) In tank farm having aggregate storage capacity more than 10,000 KL, additional monitor/s should be provided (depending on tank inter-distance & throw of the monitor).
(d) Number & Capacity of monitor shall be provided in such a way that the foam application rate from the monitors meets requirement of foam application rate (8.1 LPM/m²) for full surface tank fire as per NFPA-11.
(e) For determining the total foam solution requirement, potential foam loss from wind and other factors shall be considered.

(Refer Explanatory Note for implementation vide Annexure VI)

(vii) Hydrants and monitors shall not be installed inside the dyke areas. However, as an additional requirement, oscillating monitors shall be provided in inaccessible area within the dyke with isolation valve or ROV outside the tank farm, where inter distances between tanks in a dyke and/or within dykes are not meeting the requirements of OISD-STD-118.

(viii) TW/TT loading & unloading facilities shall be provided with alternate hydrant and UL/FM listed/approved variable flow water-cum-foam monitors having multipurpose combination nozzles for jet, spray & fog arrangement and located at a spacing of 30 m on both sides of the gantry. The hydrants & monitors shall be located at a minimum distance of 15 m from the hazard (e.g. TW & TT loading/unloading facilities) to be protected.

(ix) Hydrants/Monitors shall be located with branch connection.

4.3.8 Material Specifications

The materials used in fire water system shall be of approved type as indicated below:-

(i) Pipes
Carbon Steel as per IS: 3589/IS: 1239/IS: 1978 or Composite Material or its equivalent for fresh water service. In case saline, blackish or treated effluent water is used, the fire water ring main of steel pipes, internally cement mortar lines or glass reinforced epoxy coated or pipes made of material suitable for the quality of water shall be used. Alternately, pipes made of composite materials shall be used. The composite material to be used shall be as per API 15LR/API 15HR.
ii) **Isolation Valves**
Gate or butterfly type isolation valves made of Cast Steel having open/close indication shall be used. Other materials such as cupro-nickel for saline/blackish water can be used.

iii) **Hydrants**
- Stand post: Carbon Steel
- Outlet valves: Gunmetal/Aluminum/Stainless Steel/Al-Zn Alloy

iv) **Monitors**
As per UL/FM listed/approved.

v) **Fire Hoses**
Reinforced Rubber Lined Hose as per IS 636 (Type A)/Non-percolating Synthetic Hose (Type B)/UL or Equivalent Standard.

vi) Fire water mains, hydrant & monitor stand posts, risers of water spray system shall be painted with “Fire Red” paint as per IS: 5.

vii) Hose boxes, water monitors and hydrant outlets shall be painted with “Luminous Yellow” paint as per IS: 5.

viii) Corrosion resistant paint shall be used in corrosion prone areas.

4.3.9 **FIXED WATER SPRAY SYSTEM**

i) Fixed water spray system is a fixed pipe system connected to a reliable source of water supply and equipped with water spray nozzles for specific water discharge and distribution over the surface of area to be protected. The piping system is connected to the hydrant system water supply through an automatically or manually actuated valve which initiates the flow of water. In case the system is manually actuated, the isolation valve shall be located outside the dyke for ease of access & operation.

ii) Spray nozzles shall be directed radially to the tank at a distance not exceeding 0.6 m from the tank surface. Only one type and size of spray nozzle shall be used in a particular facility.

iii) While calculating the water rates for spray application for cases other than tanks/vessels, the area should be divided into suitable segments so that maximum water requirement can be optimized. (Refer Annexure-II for typical calculations).

4.4 **FOAM SYSTEMS**

4.4.1 **Types of Foam**
Foams are classified by producing action of generation and expansion. Foam concentrate to be used shall conform to IS: 4989 2006/UL-162 or Equivalent Standard (Annexure – IV)

4.4.2 **Types of Low Expansion Foam**
For combating large hydrocarbon fires particularly in a contained area like storage tank, foam has proved useful for its inherent blanketing ability, heat resistance and security against burn-back. Aqueous Film Forming Foam (AFFF) compound is technically superior and compatible with other fire fighting agents.

Efficient and effective foam delivery system is a vital tool for its usefulness in controlling the fire.

The process of adding or injecting the foam concentrate to water is called proportioning. The mixture of water and foam compound (foam solution) is then mixed with air in a foam maker for onward transmission to burning surface.
4.4.3 CONVEYING SYSTEMS

The system consists of an adequate water supply, supply of foam concentrate, suitable proportioning equipment, a proper piping system, foam makers and discharge devices designed to adequately distribute the foam over the hazard.

Conventional systems are of the open outlet type, in which foam discharges from all foam outlets at the same time, covering the entire hazard within the confines of the system. There are three types of systems:

(i) **Fixed Foam System**

Fixed foam conveying system comprises of fixed piping for water supply at adequate pressure, foam concentrate tank, eductor, suitable proportioning equipment for drawing foam concentrate and making foam solution, fixed piping system for onward conveying to foam makers for making foam, vapor seal box and foam pourer.

(ii) **Semi-Fixed Foam System**

Semi-fixed foam system gets supply of foam solution through the mobile foam tender. A fixed piping system connected to foam makers cum vapor seal box in case of cone roof tanks and foam maker and foam pourers in the case of floating roof tanks conveys foam to the surface of tank.

(iii) **Mobile System**

Mobile system includes foam producing unit mounted on wheels which should be self propelled or towed by a vehicle. These units supply foam through monitors/foam towers to the burning surface.

(iv) **Sub-surface foam injection**

This system is for protection of fixed roof storage tanks. It comprises of high back pressure foam generator connected through product lines or separate lines near the bottom of the tank.

(v) **Under the Seal  Foam application**

This is a system for floating roof tank where the foam travels through a flexible pipe inside the tank up to the center of the tank roof and exits at the seal rim of the floating roof precisely where the fire is located thus rapidly flooding the seal rim area and quickly extinguishing the fire.

4.4.4 FLOATING ROOF TANK PROTECTION

For floating roof tank, foam shall be poured at the foam dam to blanket the roof seal. Features of foam system for floating roof tank protection shall be as follows:

i) System shall be designed to create foam blanket on the burning surface in a reasonably short period.

ii) Foam shall be applied to the burning hazard continuously at a rate high enough to overcome the destructive effects of radiant heat.

iii) Foam makers/foam pourers shall be located not more than 24 M apart on the shell perimeter based on 600 mm foam dam height. The height of foam dam shall be at least 51 mm above the top of metallic secondary seal.

iv) A minimum of two foam pourers shall be provided.

**Automatic Actuated Rim seal Protection System for Floating Roof tanks:**
Automatic actuated rim seal fire detection and extinguishing system shall be provided on all existing as well as new external floating roof tanks storing Class A petroleum.

Only those Rim seal protection systems, which use the linear heat hollow metallic tube type detectors with foam based extinguishing media, either for existing/ new or for replacements of existing detection system when due, shall be used. These detection systems shall be certified by any of the international certifying agencies like UL, FM, VdS or LPC to ensure that those systems are used which meet with highest international standards of safety certification.

(Refer Explanatory Note for implementation vide Annexure VI)

The minimum requirement in design for the of automatic rim seal protection using foam system is given in Annexure V.

This is in addition to the fixed water spray system and fixed foam system or Semi-fixed foam system on all floating roof tanks storing Class A & B petroleum.

4.4.5 FIXED ROOF TANK PROTECTION

Foam conveying system shall have same features as of floating roof tank excepting that a vapor seal chamber is required before the foam discharge outlet.

Features of the foam system for fixed roof protection shall be as follows:

i) The vapor seal chamber shall be provided with an effective and durable seal, fragile under low pressure, to prevent entrance of vapor into the foam conveying piping system.

ii) Where two or more pourers are required these shall be equally spaced at the periphery of the tank and each discharge outlet shall be sized to deliver foam at approximately the same rate.

iii) Tanks should be provided with foam discharge outlets/pourers as indicated below :-

<table>
<thead>
<tr>
<th>Tank diameter (In M)</th>
<th>Foam Pourer (Min. Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 18 &amp; up to 20</td>
<td>2</td>
</tr>
<tr>
<td>Above 20 &amp; up to 25</td>
<td>3</td>
</tr>
<tr>
<td>Above 25 &amp; up to 30</td>
<td>4</td>
</tr>
<tr>
<td>Above 30 &amp; up to 35</td>
<td>5</td>
</tr>
<tr>
<td>Above 35 &amp; up to 40</td>
<td>6</td>
</tr>
<tr>
<td>Above 40 &amp; up to 45</td>
<td>8</td>
</tr>
<tr>
<td>Above 45 &amp; up to 50</td>
<td>10</td>
</tr>
</tbody>
</table>

In case foam pourers are provided on tanks having diameter up to 18 m, minimum 2 nos. foam pourers shall be provided.

The estimation of number of foam discharge outlet is based on pourer capacity of 1000 lpm at a pressure of 7 kg/cm$^2$ (g) upstream of eductor. This can be suitably adjusted for different pourer capacity in accordance with section 4.4.4 (iii).

4.4.6 FLOATING CUM FIXED ROOF TANK PROTECTION

Protection facilities shall be provided as required for fixed roof tank.

4.4.7 PROTECTION FOR DYKE AREA/SPILL FIRE

Portable monitors/foam hose streams shall be provided for fighting fires in dyked area and spills. Additionally, Medium expansion foam generators shall be provided to arrest vapor cloud formation from spilled volatile hydrocarbons.
Installation of medium expansion foam generator shall be as per following criteria:

Class A tanks:
2 nos. Fixed type foam generators for each tank dyke.

Class B tanks:
Two nos. portable foam generator for each location.

(Refer Explanatory Note for implementation vide Annexure VI)

4.4.8 FOAM APPLICATION RATE

The minimum delivery rate for primary protection based on the assumption that all the foam reaches the area being protected shall be as indicated below:

For cone roof tanks containing liquid hydrocarbons, the foam solution delivery rate shall be at least 5 lpm/\( m^2 \) of liquid surface area of the tank to be protected.

For floating roof tanks containing liquid hydrocarbons foam solution delivery rate shall be at least 12 lpm/\( m^2 \) of seal area with foam dam height of 600 mm of the tank to be protected. The height of foam dam shall be at least 51 mm above the top of metallic secondary seal.

In the case of Floating roof tank roof sinking, the application rate shall be considered as 8.1 lpm/\( m^2 \).

In determining total solution flow requirements, potential foam losses from wind and other factors shall be considered.

4.4.9 DURATION OF FOAM DISCHARGE

The equipment shall be capable of providing primary protection at the specified delivery rates for the following minimum duration:

i) Tanks containing Class 'A' & 'B' 65 minutes.

ii) Where the system's primary purpose is for spill fire protection 30 minutes.

4.4.10 WATER FOR FOAM MAKING

Water quantity required for making foam solution depends on the percent concentration of foam compound. Foams in normal use have a 3% to 6% proportioning ratio. However, foam supplier data shall be used for determining water requirement.

4.4.11 FOAM QUANTITY REQUIREMENT

The aggregate quantity of foam solution should be calculated as below:

i) Foam solution application at the rate of 5 lpm/\( m^2 \) for the liquid surface of the single largest cone roof tank or at the rate of 12 lpm/\( m^2 \) of seal area of the single largest floating roof tank whichever is higher. (Annexure-III).

ii) Based on the size of the terminal, quantity of foam solution required should be calculated as per the following guidelines:

<table>
<thead>
<tr>
<th>Size of Terminal (In KL)</th>
<th>Water/Foam Monitor (Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Installation having aggregate capacity of 1000 KL</td>
<td>Nil.</td>
</tr>
<tr>
<td>For Installation having aggregate capacity up to 10,000 KL</td>
<td>Minimum 2 No. up to 1000GPM</td>
</tr>
<tr>
<td>For Installation having aggregate capacity more than 10,000 KL</td>
<td>More than 2 No. no. of 1000 GPM (as per 4.3.7(vi)c)</td>
</tr>
</tbody>
</table>
iii) Two hose streams of foam each with a capacity of 1140 lpm of foam solution. The aggregate quantity of foam solutions should be largest of 4.4.11(i), 4.4.11(ii) and 4.4.11 (iii) as above for a minimum period of 65 minutes. From this the quantity of foam based on 3% or 6% proportion should be calculated. However, for installation having aggregate storage not more than 10,000 KL, the foam concentrate storage shall be based on 4.4.1(i) only. In case of Aviation Fuelling Stations where aggregate product storage capacity is less than 1000 KL, foam quantity for spill fire protection of 30 minutes shall be made. Additional Foam quantity requirement & foam monitor requirement shall be in line with 4.3.7(vi) d.

4.4.12 FOAM COMPOUND STORAGE

Foam compound should be stored as explained in IS-4989:2006/UL-162.

Type of foam compound to be used can be protein, fluro-protein or AFFF. Alcohol Resistant Foam shall be used for handling methanol/ ethanol or furfural fires. Minimum 1000 liter of Alcohol Resistant Foam compound shall be maintained at the installation to handle methanol/ethanol or furfural fire.

Shelf life of foam compound shall be taken from manufacturer’s data.

Foam compound shall be tested periodically as per OEM guidelines to ensure its quality and the deteriorated quantity replaced. The deteriorated foam compound can be used for fire training purposes. For details of type of tests & their periodicity, refer IS 4989: 2006/UL-162 or Equivalent Standard.

Quantity of foam compound equal to 100% of requirement as calculated in 4.4.11 should be stored in the Installation. This quantity can be suitably reduced, if mutual aid for foam supply is available. For sample calculation, refer (Annexure- III).

4.5 CONTROL ROOM AND COMPUTER ROOM PROTECTION

Control room and computer room should be protected by Clean Agent Fire Extinguishing System.

It is considered good practice to avoid unnecessary exposure to Clean Agent Fire Extinguishing System. In order to minimize the exposure, persons should be evacuated from the areas before the system comes into operation.

Clean agent fire extinguishing system as per NFPA-2001 (Latest edition) shall be provided for such protection system.

Each hazard area to be protected by the protection system shall have an independent system. The time needed to obtain the gas for replacement to restore the systems shall be considered as a governing factor in determining the reserve supply needed. 100% standby containers shall be considered for each protected hazard.

Storage containers shall be located as near as possible to hazard area but shall not be exposed to fire.

Storage containers shall be carefully located so that they are not subjected to mechanical, chemical or other damage. All the components of the system shall be capable of withstanding heat of fire and severe weather conditions.
4.6 FIRST AID FIRE FIGHTING EQUIPMENT

4.6.1 Portable Fire Extinguishers

i) All fire extinguishers shall conform to respective IS/UL or Equivalent codes, viz. 10 Kg DCP Type (IS: 15683 /UL 299), 4.5/6, 8 Kg CO2 Type (IS: 2878/UL 154) & 25/50/75 Kg DCP Type (IS: 10658/UL 299) and bear ISI/UL mark. BIS/UL or Equivalent certificates of all extinguishers shall be maintained at the location.

ii) While selecting the Extinguisher, due consideration should be given to the factors like flow rate, discharge time and throw in line with IS: 2190 / UL 711.

iii) The Dry Chemical Powder used in extinguisher and carbon dioxide gas used as expelling agent shall be as per relevant IS/UL or Equivalent code.

iv) While selecting the dry chemical powder, due consideration should be given to the typical properties viz. Apparent Density (0.65 +/- 0.05), Fire Rating (144B), Thermal Gravimetric Analysis (with decomposition at around 250°C) and foam compatibility.

v) Siliconised Potassium bicarbonate DCP powder (IS 4308:2003) / Mono-ammonium phosphate based DCP powder (IS: 14609) can also be used for recharging DCP fire extinguishers.

vi) Spare CO2 cartridges and DCP refills as required based on their shelf life should be maintained. However, minimum 10% of the total charge in the extinguishers should be maintained at the location.

vii) Portable fire extinguishers shall be located at convenient locations and are readily accessible and clearly visible at all times.

viii) The sand buckets shall have round bottom with bottom handle.

ix) having 9 liter water capacity conforming to IS: 2546. The sand stored in bucket shall be fine and free from oil, water or rubbish.

x) Rain protection of suitable design should be provided for all extinguishers & sand buckets.

xi) The maximum running distance to locate an extinguisher shall not exceed 15 m.

xii) The extinguisher shall be installed in such a way that its top surface is not more than 1.5m above the floor/ground level.

xiii) The no. of extinguishers at various locations shall be provided as under.
Petroleum Depots, Terminals & Lube Oil Installations

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of Area</th>
<th>Scale of Portable Fire Extinguishers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Lube Godown</td>
<td>1 No. 10 Kg DCP extinguisher for every 200 m² or min. 2 Nos. in each Godown whichever is higher.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Lube Filling Shed</td>
<td>1 No. 10 Kg DCP extinguisher for 200 m² or min. 2 Nos. in each Shed whichever is higher.</td>
</tr>
<tr>
<td>(iii)</td>
<td>Storage of (Class A/B)</td>
<td>1 No. 10 Kg DCP extinguisher for 100 m² or min. 2 Nos. in each Storage Area whichever is higher.</td>
</tr>
<tr>
<td>(iv)</td>
<td>Pump House (Class A/B)</td>
<td>1 No. 10 Kg DCP extinguisher for 2 pumps.</td>
</tr>
<tr>
<td></td>
<td>Up to 50 HP</td>
<td>1 No. 10 Kg DCP for each pump. 2 Nos. of 10 kg or 1 no. of 25 kg DCP for each pump.</td>
</tr>
<tr>
<td></td>
<td>Above 50-100 HP</td>
<td>1 No. 10 Kg DCP for each pump.</td>
</tr>
<tr>
<td></td>
<td>Beyond 100 HP</td>
<td>2 Nos. of 10 kg or 1 no. of 25 kg DCP for each pump.</td>
</tr>
<tr>
<td>(v)</td>
<td>Pump House (Class C)</td>
<td>1 no. 10Kg DCP for every 4 pumps up to 50 HP.</td>
</tr>
<tr>
<td></td>
<td>Up to 50 HP</td>
<td>2 nos. 10 Kg DCP or 1x25 kg DCP for 4 pumps.</td>
</tr>
<tr>
<td>(vi)</td>
<td>Tank Truck loading &amp; unloading gantry for POL/Special products</td>
<td>1 No. 10 Kg DCP extinguisher for each bay plus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 No. 75 Kg DCP extinguisher for each gantry.</td>
</tr>
<tr>
<td>(vii)</td>
<td>Tank Wagon loading and unloading gantry/siding</td>
<td>1 No. 10 Kg DCP extinguisher for every 30 m of gantry/siding plus 1 No. 75 Kg DCP extinguisher for each gantry/siding.</td>
</tr>
<tr>
<td>(viii)</td>
<td>A/G Tank Farm</td>
<td>2 Nos. 10 Kg DCP extinguishers for each tank plus 4 Nos. 25 Kg DCP extinguishers for each Tank Farm positioned at four corners. In case of adjoining tank farms, the no. of 25 Kg extinguishers can be reduced by 2 nos. per tank farm.</td>
</tr>
<tr>
<td>(ix)</td>
<td>U/G Tank Farm</td>
<td>2 Nos. 10 Kg DCP extinguisher for each Tank Farm</td>
</tr>
<tr>
<td>(x)</td>
<td>Other Pump Houses</td>
<td>1 No. 10 Kg DCP extinguisher for every two pumps or min 2 Nos. 10 Kg DCP extinguisher for each Pump House whichever is higher.</td>
</tr>
<tr>
<td>(xi)</td>
<td>Admin. Building/Store House</td>
<td>1 No. 10 Kg DCP extinguisher for every 200 m² or min. 2 Nos. 10 Kg DCP extinguishers for each floor of Building/Store whichever is higher.</td>
</tr>
<tr>
<td>(xii)</td>
<td>DG Room</td>
<td>2 Nos. each 10 Kg DCP &amp; 4.5 Kg CO2 extinguishers for each DG room.</td>
</tr>
<tr>
<td>(xiii)</td>
<td>Main switch Room/Sub-Station</td>
<td>1 No. 4.5 Kg CO2 extinguisher for every 25 m² plus 1 No. 9 Liter sand bucket.</td>
</tr>
<tr>
<td>(xiv)</td>
<td>Computer Room/ Cabin</td>
<td>2 Nos. of 2 Kg CO2 or 2 Nos. of 2.5 Kg Clean Agent extinguisher per Computer Room and 1 No. 2 Kg CO2 or 1 No. 1.0 Kg Clean Agent extinguisher per cabin.</td>
</tr>
<tr>
<td>(xv)</td>
<td>Security Cabin</td>
<td>1 No. 10 Kg DCP extinguisher per cabin.</td>
</tr>
<tr>
<td>(xvi)</td>
<td>Canteen</td>
<td>1 No. 10 Kg DCP extinguisher for 100 m².</td>
</tr>
<tr>
<td>(xvii)</td>
<td>Workshop</td>
<td>1 No. 10 Kg DCP extinguisher &amp; 1 No. 2 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(xviii)</td>
<td>Laboratory</td>
<td>1 No. 10 Kg DCP extinguisher &amp; 1 No. 4.5 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(xix)</td>
<td>Oil Sample Storage Room</td>
<td>1 No. 10 Kg DCP extinguisher per 100 m² or min. 1 no. 10 Kg extinguisher per room whichever is higher.</td>
</tr>
<tr>
<td>(xx)</td>
<td>Effluent Treatment Plant</td>
<td>1 No. 75 Kg. &amp; 2 nos. 10 Kg. DCP Extinguisher</td>
</tr>
<tr>
<td>(xxi)</td>
<td>Transformer</td>
<td>1 No. 10 Kg. DCP extinguisher per transformer.</td>
</tr>
<tr>
<td>(xxii)</td>
<td>UPS / Charger Room</td>
<td>1 No. 2 Kg. CO2 extinguisher.</td>
</tr>
</tbody>
</table>

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NOTE: - ALL FIRE EXTINGUISHERS SHALL BEAR ISI OR EQUIVALENT MARK

Pipeline Installations

For pipeline installations, the portable extinguisher shall be provided as per the above list (4.6.1) suitably amended along with following additions:-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of Area</th>
<th>Scale of Portable Fire Extinguishers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Main line pump shed (Engine/Motor Driven)</td>
<td>1 No. 75 Kg DCP, 10 Kg DCP &amp; 6.8 Kg CO2 extinguishers per two pumps up to a maximum of 4 nos.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Booster Pump</td>
<td>1 No. 10 Kg DCP per two pumps up to a maximum of 3 nos. and 1 No. 6.8 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(iii)</td>
<td>Sump Pump, Transmix Pump &amp; Oil Water Separator Pump</td>
<td>1 No. 10 Kg DCP extinguisher.</td>
</tr>
<tr>
<td>(iv)</td>
<td>Scraper Barrel</td>
<td>1 No. 10 Kg DCP extinguisher.</td>
</tr>
<tr>
<td>(v)</td>
<td>Control Room</td>
<td>2 Nos. 2.5 Kg Clean Agent and 1 No. 4.5 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(vi)</td>
<td>UHF / Radio Room</td>
<td>2 Nos. 2.5 Kg Clean Agent and 1 No. 4.5 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(vii)</td>
<td>Meter Prover/Separator Filter</td>
<td>1 No. 10 Kg DCP extinguisher.</td>
</tr>
<tr>
<td>(viii)</td>
<td>Repeater Station</td>
<td>1 No. 10 Kg DCP &amp; 1 No. 2 Kg CO2 extinguisher.</td>
</tr>
<tr>
<td>(ix)</td>
<td>Mainline Emergency Equipment Centre</td>
<td>4 Nos. 10 Kg DCP &amp; 2 Nos. 2 Kg CO2 extinguishers.</td>
</tr>
<tr>
<td>(x)</td>
<td>Air Compressor</td>
<td>1 No. 2 Kg CO2 &amp; 1 No. 5 Kg DCP extinguisher.</td>
</tr>
</tbody>
</table>

4.6.2 Wheeled Fire Fighting Equipment

For Installations having tanks of diameter larger than 9 m, following fire fighting equipment shall be provided:-

<table>
<thead>
<tr>
<th>Size of Terminal (In KL)</th>
<th>Water/Foam Monitor (Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For installation having aggregate capacity of 1000 KL</td>
<td>Nil.</td>
</tr>
<tr>
<td>For installation having aggregate capacity up to 10,000 KL</td>
<td>Minimum 2 nos. capacity up to 1000 GPM each</td>
</tr>
<tr>
<td>For installation having aggregate capacity more than 10,000 KL</td>
<td>More than 2 nos. of 1000 GPM each (as per clause 4.3.7 (vi)c</td>
</tr>
</tbody>
</table>

Foam compound trolley 200/210 liters shall be provided as under:-

<table>
<thead>
<tr>
<th>Tank diameter (In m)</th>
<th>Foam compound trolley (Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 24 m</td>
<td>1 No.</td>
</tr>
<tr>
<td>24 m - 30 m</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>Above 30 m</td>
<td>3 Nos.</td>
</tr>
</tbody>
</table>

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4.6.3 HOSES, NOZZLES & ACCESSORIES

(i) Hoses

i) Reinforced rubber lined canvas or Non-percolating synthetic fire hoses conforming to IS- 636/ UL 19 (Type A or B) shall be provided.

ii) The length and diameter of the hoses shall be 15 m and 63 mm respectively fitted with instantaneous type male & female couplings of material as specified in IS 636/UL 19.

iii) The number of hoses stored in an oil installation shall be 30% of the number of hydrant outlets. The minimum No. of hoses stored, however, shall not be less than 10.

iv) The hoses shall be stored at convenient and easily accessible location in the oil installation.

(ii) Nozzles

In addition to the jet nozzle provided in each hose box, there shall be at least two nozzles in each category viz. Jet nozzle with branch pipe, Fog nozzle, Universal nozzle, Foam branch pipe and Water curtain nozzle as per relevant IS/UL Codes maintained at the location.

(iii) Accessories

The following minimum no. of Personal Protective Equipment, First Aid Equipment & Safety Instrument shall be provided as indicated against each item.

- Sand drum with scoop: 4 Nos.
- Safety helmet: 1 No. per person.
- Stretcher with blanket: 2 Nos.
- First Aid box: 1 No.
- Rubber hand glove: 2 Pairs.
- Explosimeter: 1 No.
- Fire proximity glove: 1 Suit.
- Resuscitator: 1 No.
- Electrical siren (3 Km range): 1 No.

Hand operated siren: One each at strategic locations such as Admn Bldg, Laboratory, T/L Loading/Unloading Facility, T/W Loading/Unloading Facility, Tank Farm, FW Pump House & Product Pump House (s).

Water jel blanket: 1 No.

Red & Green flag for fire drill: 2 Nos. in each color.

SCBA Set (30 minute capacity): 1 set with spare cylinder.

PA system - 1 No.

Hose box: Between two hydrant points.

Fire hose: 2 Nos. per hose box.

Jet nozzle: 1 No. in each hose box.

The above guidelines are minimum requirement of each item and can be increased depending on the scale of operations/size of installation or requirement of Local Statutory Bodies/State Govt.

A trolley containing Fire Proximity Suit, B. A. Set, Water Jel Blanket, Resuscitator, First Aid Box, Stretcher with blanket, Spare fire hoses, Special purpose nozzles, Foam branch pipes, Explosive meter, P. A. System shall be readily available at the location and positioned to have easy access to it during emergency situation.

In addition, an emergency kit shall be provided consisting of safety items as per the attached list (Annexure VII) and shall be readily available at the terminals.

All the items of the kit shall be kept on a trolley specifically designed for the purpose. List of PPE’s as mentioned in other clauses should be merged with this list.

(Refer Explanatory Note for implementation vide Annexure VI)

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4.7 MOBILE FIRE FIGHTING EQUIPMENT

Mobile fire fighting equipments include Foam trolleys, Portable water-cum-foam monitors, etc. In view of comprehensive Fixed and First Aid Fire protection equipment recommended in the standard, provision of Mobile fire fighting equipments in the installation is not considered necessary. However, the requirement of such equipment should be reviewed keeping in mind the size, nature and location of the installation.

5.0 FIRE ALARM/COMMUNICATION SYSTEM

5.1 FIRE ALARM SYSTEM

i) Hand operated sirens shall be provided at strategic locations and clearly marked in the installation.

ii) Electric fire siren shall be installed at suitable location with operating switch located near the risk area at a safe, identifiable and easily accessible place.

iii) Electric fire siren shall be audible to the farthest distance in the installation and also in the surrounding area up to 1 km from the periphery of the installation.

iv) Electric fire sirens shall be connected to feeder to ensure continuous power supply during emergency shut down.

v) The tone of fire siren shall be different from shift siren.

vi) The following fire siren codes should be followed for different emergency situations.

- **FIRE**: For fire situation, the siren shall be wailing sound for 2 minutes.
- **DISASTER**: For disaster situation, the siren shall be wailing sound for 2 minutes repeated thrice with a gap of 10 seconds.
- **ALL CLEAR**: For all clear situation, the siren shall be straight run sound for 2 minutes.
- **TEST SIREN**: For testing, the siren shall be straight run sound for 2 minutes.

5.2 COMMUNICATION SYSTEM

i) Communication system like Telephone, Public Address System, etc. should be provided in non-hazardous areas of the installation.

ii) In hazardous areas, flame-proof/intrinsically safe Paging System, Walkie-talkie system or VHF Set shall be provided.

iii) Wherever possible hot line connection between City Fire Brigade & nearby industries shall be provided for major installation on need basis.

5.3 DETECTION AND ALARM SYSTEM

Hydrocarbon detectors shall be installed near all potential leak source of class-A e.g. tank dykes, tank manifolds, pump house manifold etc. (Refer Explanatory Note for implementation vide Annexure VI)

Hydrocarbon detector of proper type shall be selected and also shall be proof tested and shall be maintained in good condition.

6.0 FIRE SAFETY ORGANISATION/TRAINING

6.1 ORGANISATION

A well defined comprehensive On-site Emergency Plan as per OISD-GDN-168 shall be drawn.

6.2 TRAINING

i) The safety, rescue operation and fire fighting training shall be compulsory for all officers, operators, security, T/T drivers & contract workmen, clericals who are likely to be present in the installation& record maintained. The training shall be conducted through oil industry approved reputed institute (Refer Explanatory Note for implementation vide Annexure VI)
ii) Every employee or authorized person of contractor working in the installation shall be familiarized with fire siren codes and the location of fire siren operating switch nearest to his place of work.

iii) Instructions on the action to be taken in the event of fire should be pasted at each siren point and familiarity with these instructions ensured and recorded.

iv) Monthly fire drills considering various scenarios shall be conducted regularly with full involvement of all employees of the installation. The mock drill shall include the full shut down system activation once in six months. (Refer Explanatory Note for implementation vide Annexure VI)

v) The offsite disaster mock drills shall be conducted periodically as per local statutory requirements. The company should approach and coordinate with the district authority for conducting “Offsite Mock Drills”.

vi) The post drill analysis should be carried out & discussed emphasizing areas of improvements.

vii) The record of such drills should be maintained at the location.

viii) Security staff should be trained as first responders for fire fighting and rescue operation along with plant operating personnel through oil industry approved reputed institute.

6.3 Mutual Aid:

Installation shall have a ‘Mutual Aid’ arrangement with nearby industries to pool in their resources during emergency.

7.0 FIRE EMERGENCY MANUAL

i) Each installation shall prepare a Comprehensive fire emergency manual covering all emergency scenarios outlining the actions to be taken by each personnel in the event of fire emergency for effective handling and the same shall be available to all personnel in the installation.

ii) The key action points of this manual shall be displayed at strategic locations in the installation for ready reference.

8.0 FIRE PROTECTION SYSTEM, INSPECTION AND TESTING

i) The fire protection equipment shall be kept in good working condition all the time.

ii) The fire protection system shall be periodically tested for proper functioning and logged for record and corrective actions.

iii) One officer shall be designated and made responsible for inspection, maintenance & testing of fire protection system.

iv) The responsibilities of each officer shall be clearly defined, explained and communicated to all concerned in writing for role clarity.

v) In addition to the following routine checks/maintenance, the requirements of OISD-STD-142 in respect of periodic inspection, maintenance & testing of fire fighting equipment shall be complied with.

8.1 FIRE WATER PUMPS

i) Every pump shall be test run for at least half an hour or as per OEM guidelines, whichever is higher twice a week at the rated head & flow.

ii) Each pump shall be checked, tested and its shut-off pressure observed once in a month.

iii) Each pump shall be checked & tested for its performance once in six month by opening required nos. of hydrants/monitors depending on the capacity of the pump to verify that the discharge pressure, flow & motor load are in conformity with the design parameters.

iv) Each pump shall be test run continuously for 4 hours at its rated head & flow using circulation line of fire water storage tanks and observations logged once a year.

v) The testing of standby jockey pump, if provided shall be checked weekly.
Frequent starts & stops of the pump indicate that there are water leaks in the system which should be attended to promptly.

8.2 FIRE WATER RING MAINS

(i) The ring main shall be checked for leaks once in a year by operating one or more pumps & keeping the hydrant points closed to get the maximum pressure.
(ii) The ring mains, hydrant, monitor & water spray header valves shall be visually inspected for any missing accessories, defects, damage and corrosion every month and records maintained.
(iii) All valves on the ring mains, hydrants, monitors & water spray headers shall be checked for leaks, smooth operation and lubricated once in a month.

8.3 FIRE WATER SPRAY SYSTEM

i) Water spray system shall be tested for performance i.e. its effectiveness & coverage once in six months.
ii) Spray nozzles shall be inspected for proper orientation, corrosion and cleaned, if necessary at least once a year.
iii) The strainers provided in the water spray system shall be cleaned once in a quarter and records maintained.

8.4 FIXED/SEMI FIXED FOAM SYSTEM

Fixed/Semi fixed foam system on storage tanks should be tested once in six months. This shall include the testing of foam maker/chamber.

The foam maker/chamber should be designed suitably to facilitate discharge of foam outside the cone roof tank. After testing foam system, piping should be flushed with water.

8.5 CLEAN AGENT SYSTEM

Clean agent fire extinguishing system should be checked as under:

i) Agent quantity and pressure of refillable containers shall be checked once every six month.
ii) The complete system should be inspected for proper operation once every year (Refer latest NFPA 2001(2008 & latest edition) for details of inspection of various systems.

8.6 HOSES

Fire hoses shall be hydraulically tested once in six months to a water pressure as specified in relevant IS/UL/Equivalent codes.

8.7 COMMUNICATION SYSTEM

Electric and hand operated fire sirens should be tested for their maximum audible range once a week.

8.8 FIRE WATER TANK/RESERVOIR

i) Above ground fire water tanks should be inspected externally & internally as per OISD-STD-129.
ii) The water reservoir shall be emptied out & cleaned once in 3 years. However, floating leaves, material or algae, if any shall be removed once in 6 months or as & when required.

8.9 FIRE EXTINGUISHERS

Inspection, testing frequency and procedure should be in line with OISD-STD-142.
9.0 REFERENCES

1) NFPA 11 - Standard on Low, Medium and high Expansion Foam Systems

2) NFPA 13 - Standard on Installation of Sprinkler System.


6) No.72-289 - French Regulation for Hydrocarbon Depots.


16) IS-3844: Code of Practice on Installation of Internal Hydrants in Multistory Building.


ANNEXURE- I

SAMPLE CALCULATION OF FIRE WATER FLOW RATE
(Clause 4.3.2 to be applicable)

1. DESIGN BASIS

The fire water system in an installation shall be designed to meet:

i) The fire water flow requirement of fighting single largest fire contingencies for locations where total aggregated storage capacity in the location is less than 30,000KL

ii) The fire water flow requirement of fighting two largest fire contingencies simultaneously for all locations where total aggregated storage capacity in the terminal is more than 30,000 KL.

2. FIRE WATER DEMAND FOR SINGLE LARGEST FIRE
(For locations with aggregate storage capacity less than 30000KL)

Consider various areas under fire and calculate fire water demand for each area based on design basis as indicated below, however, actual tank dimensions available in the terminal shall be considered.

2.1 FIRE WATER FLOW RATE FOR FLOATING ROOF TANK PROTECTION

Data

Total storage capacity in one dyke area = 20,000 m³.
No. of tanks = 2.
Capacity of each tank = 10,000 m³.
Diameter of each tank = 30 m.
Height of each tank = 14.4 m.

a) Cooling water flow rate

(i) Cooling water required for tank on fire

Cooling water rate = 3 lpm/m² of tank area for tank on fire.

Cooling water required = 3.142 x 30 m x 14.4 m x 3 lpm/m².

= 4070 lpm.

= \frac{4070 \times 60}{1000} m³/hr = 244 m³/hr.

Assuming that second tank is also located within the same tank dyke at a distance more than 30 m from the tanks shell. Therefore, in such case cooling required is at the rate of 1 lpm/m² of tank shell area.

(ii) Cooling water required for tank falling beyond (R+30) from centre of tank on fire

Cooling water rate = 1 lpm/m² of tank area.

Cooling water required = 3.142 x 30 m x 14.4 m x 1 lpm/m².

= 1357 lpm.

= \frac{1357 \times 60}{1000} m³/hr = 81.33 m³/hr.
Total Water required for cooling of tanks (item i + ii) = 244 + 81 = 325 m³/hr

b) Foam water flow rate
Water flow required for applying foam on a largest tank burning surface area (rim seal area)
For floating roof tank of 30 M diameter,
Diameter of the tank (D1) = 30M
Distance of foam dam from shell = 0.8M
Diameter of roof up to foam dam (D2) = 30 - (2X0.8) = 28.4
Rim seal area = \( \frac{\pi}{4} \times (30^2 - 28.4^2) \)
= \( \frac{\pi}{4} \times 125.44 \)
= 93.4 m²
Foam solution rate @ 12 lpm/ m²
= 1120.8 lpm
= 1120 lpm.
Foam water required (For 3% foam concentrate)
= 0.97 x 1120 lpm
= 1086.4 lpm.
= 1086.4 x 60 m³/hr
= 65.2 m³/hr.
Say 65 m³/hr

c) Water Requirement for supplementary Hose:
Water for 4 single hydrant streams = 4 x 36 = 144 m³/hr.
Water for 2 monitor stream (HVLR) = 2 x 228 = 456 m³/hr.
Total water requirement = 600 m³/hr.

Total water flow rate (item a + item b) for floating roof tank protection:
(i) Tank cooling = 325 m³/hr.
(ii) Foam solution application = 69 m³/hr.
(iii) Supplementary hose requirement = 600 m³/hr

Total (item i + ii + iii) = 994 m³/hr.

2.2 FIRE WATER FLOW RATE FOR CONE ROOF TANK PROTECTION

Data
Total storage capacity in one dyke area = 30,000 m³.
No. of tanks = 4
Capacity of each tank = 7,500 m³.
Diameter of each tank = 28.5 m.
Height of each tank = 12 m.

a) Cooling water flow rate
(i) **Cooling water required for tank on fire**

Cooling water rate = 3 lpm/m² of tank area for tank on fire.

Cooling water required = \( 3.142 \times 28.5 \times 12 \times 3 \) lpm.

\[ = 3222 \text{ lpm.} \]

\[ = \frac{3222 \times 60}{1000} \text{ m}^3/\text{hr} = 193.32 \text{ m}^3/\text{hr}. \]

\[ = 193 \text{ m}^3/\text{hr}. \]

Assuming that other three tanks are also located within the same tank dyke at a distance less than 30 m from the tanks shell. Therefore, in such case cooling required is at the rate of 3 lpm/m² of tank shell area.

(ii) **Cooling water required for tanks falling within (R+30) from centre of tank on fire**

Cooling water rate = 3 lpm/m² of tank area.

Cooling water required = \( 3 \times 3.142 \times 28.5 \times 12 \times 3 \) lpm/m².

\[ = 9465 \text{ lpm.} \]

\[ = \frac{9465 \times 60}{1000} \text{ m}^3/\text{hr} = 568 \text{ m}^3/\text{hr}. \]

**Total cooling water required (item i+ ii) = 193+568 = 761 m³/hr.**

b) **Foam water flow rate**

Foam solution application rate = 5 lpm/m² of liquid surface area.

Foam solution required = \( 3.142 \times (28.5)^2 \times 5 \) lpm/m².

\[ = 3188 \text{ lpm.} \]

\[ = \frac{0.97 \times 3188}{1000} \text{ lpm} = 3092 \text{ lpm.} \]

(For 3% foam concentrate)

\[ = \frac{3092 \times 60}{1000} \text{ m}^3/\text{hr} = 185 \text{ m}^3/\text{hr}. \]

**c) Water Requirement for supplementary Hose:**

Water for 4 single hydrant streams = 4 x 36 = 144 m³/hr.

Water for 2 monitor stream(HVLR) = 2 x 228 = 456 m³/hr.

**Total water requirement = 600 m³/hr.**

**Total water flow rate (item a + b + c) for cone roof tank protection:**

(a)Tank cooling = 761 m³/hr.

(b)Foam solution application = 185 m³/hr.

(c)Supplementary hose requirement = 600 m³/hr.

**Total = 1546 m³/hr.**
2.3 FIRE WATER FLOW RATE FOR COOLING POL TANK WAGON LOADING GANTRY

Data

Total No. of loading points = 72 Conventional or 48 BTPN.
No. of loading points on each side = 24 Nos.
Width of tank wagon gantry = 12 m.
(Cooling two spur)

a) Cooling water flow rate

Divide total area of gantry into 24 segments, each segment measuring 15 m X 12 m and consider 3 segments operating at a time.

Water rate required = 3 x 15 m x 12 m x 10.2 lpm/m^2.
= 6426 m^3/hr
= 385 m^3/hr

b) Water Requirement for supplementary Hose:

Water for 4 single hydrant streams = 4 x 36 = 144 m^3/hr.
Water for 1 monitor stream (HVLR) = 1 x 228 = 228 m^3/hr.
Total water requirement = 372 m^3/hr.

Total water flow rate (item a + b) for gantry protection:

(a) Gantry cooling = 385 m^3/hr.
(b) Supplementary hose requirement = 372 m^3/hr

Total = 757 m^3/hr.

2.3 TOTAL DESIGN FIRE WATER FLOW RATE FOR SINGLE FIRE CONTEGENCY

The total fire water flow requirement will be highest of one of the fire water requirement calculated in 2.1 (994 m^3/hr) & 2.2 (1546 m^3/hr) & 2.3 (757 m^3/hr) above i.e. 1546 m^3/hr.

WATER STORAGE REQUIREMENT

1546 m^3/hr X 4 hrs. storage = 6184 m^3
3.0 FIRE WATER DEMAND FOR TWO MAJOR FIRES SIMULTANEOUSLY
(For locations with aggregate storage capacity more than 30000KL)

Consider various areas under fire and calculate fire water demand for each area based
on design basis as indicated below, however, actual tank dimensions available in the
terminal shall be considered.

3.1 FIRE WATER FLOW RATE FOR FLOATING ROOF TANK PROTECTION

Data

Total storage capacity in one dyke area = 32,000 m³.
No. of tanks = 2.
Capacity of each tank = 16,000 m³.
Diameter of each tank = 40 m.
Height of each tank = 14.4 m.

a) Cooling water flow rate

(i) Cooling water required for tank on fire

Cooling water rate = 3 lpm/m² of tank area for tank on fire.
Cooling water required = 3.142 x 40 m x 14.4 m x 3 lpm/m².
= 5426 lpm.
= \frac{5426 \times 60}{1000} \ m³/\text{hr}.
= 326 \ m³/\text{hr}.

Assuming that second tank is also located within the same tank dyke at a distance
more than 30 m from the tanks shell. Therefore, in such case cooling required is at
the rate of 1 lpm/m² of tank shell area.

(ii) Cooling water required for tank falling beyond (R+30) from centre of tank on fire

Cooling water rate = 1 lpm/m² of tank area.
Cooling water required = 3.142 x 40 m x 14.4 m x 1lpm/m².
= 1809 lpm.
= \frac{1809 \times 60}{1000} \ m³/\text{hr}.
= 109 \ m³/\text{hr}.

Total fire water requirement for cooling of tanks (item i + ii)= 326+109
= 435 \ m³/\text{hr}.

b) Foam water flow rate

Water flow required for applying foam on a largest tank burning surface area (rim seal area)

For floating roof tank of 40 M diameter,
Diameter of the tank (D1) = 40M
Distance of foam dam from shell = 0.8M
Diameter of roof up to foam dam (D2) = 40 - (2X0.8) = 38.4
Rim seal area = (\pi / 4) x (40²-38.4²)
= (\pi / 4) x 125.44
= 98.5 \ m².

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Foam solution rate @ 12 lpm/ m² = 1182 lpm
Foam water required = 1182 lpm.
(For 3% foam concentrate) = 0.97 x 1182 lpm = 1147 lpm.

= 1147 x 60 m³/hr
1000
= 68.8 m³/hr.

Say 69 m³/hr

c) Water Requirement for supplementary Hose:
Water for 4 single hydrant streams = 4 x 36 = 144 m³/hr.
Water for 2 monitor stream (HVLR) = 2 x 228 = 456 m³/hr.
Total water requirement = 600 m³/hr.

Total water flow rate (item a + b + c) for floating roof tank protection
Tank cooling = 435 m³/hr.
Foam solution application = 69 m³/hr.
Fire water requirement for supplementary hoses Total = 600 m³/hr

Total water requirement = 1104 m³/hr.

3.2 FIRE WATER FLOW RATE FOR CONE ROOF TANK PROTECTION

Data
Total storage capacity in one dyke area = 50,000 m³.
No. of tanks = 4.
Capacity of each tank = 12,500 m³.
Diameter of each tank = 37.5 m.
Height of each tank = 12 m.

a) Cooling water flow rate

(i) Cooling water required for tank on fire
Cooling water rate = 3 lpm/m² of tank area for tank on fire.
Cooling water required = 3.142 x 37.5 m x 12 m x 3 lpm/m².
= 4242 lpm.
= 4242 x 60 m³/hr = 255 m³/hr.
1000
Assuming that other three tanks are also located within the same tank dyke at a distance less than 30 m from the tanks shell. Therefore, in such case cooling required is at the rate of 3 lpm/m² of tank shell area.

(ii) Cooling water required for tanks falling within (R+30) from centre of tank on fire
Cooling water rate = 3 lpm/m² of tank area.
Cooling water required = 3.142 x 37.5 m x 12 m x 3 lpm/m² x 3 m.
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\[
= 12726 \text{ lpm.} \\
= \frac{12726 \times 60}{1000} \text{ m}^3/\text{hr} = 764 \text{ m}^3/\text{hr.}
\]

Total cooling water required (item i + ii) for cone roof tank protection = 1019 m\(^3/\)hr.

b) Foam water flow rate

Foam solution application rate = 5 lpm/m\(^2\) of liquid surface area.
Foam solution required = \(3.142 \times (18.75 \text{ m})^2 \times 5 \text{ lpm/m}^2\).
= 5523 lpm.
Foam water required = \(0.97 \times 5523 \text{ lpm} = 5357 \text{ lpm.}\)
(For 3% foam concentrate) = \(\frac{5357 \times 60}{1000} \text{ m}^3/\text{hr}\)

Total Foam water required = 321 m\(^3/\)hr.

c) Water Requirement for supplementary Hose:

Water for 4 single hydrant streams = \(4 \times 36 = 144 \text{ m}^3/\text{hr.}\)
Water for 2 monitor stream (HVLR) = \(2 \times 228 = 456 \text{ m}^3/\text{hr.}\)
Total water requirement = \(600 \text{ m}^3/\text{hr.}\)

Total water flow rate (item a + b + c) for cone roof tank protection

Tank cooling = 1019 m\(^3/\)hr.
Foam solution application = 321 m\(^3/\)hr.
Total Water requirement for Supplementary hose

Total = 1940 m\(^3/\)hr.

3.3 FIRE WATER FLOW RATE FOR COOLING POL TANK WAGON LOADING GANTRY

a) Data

Total No. of loading points = 72 Conventional or 48 BTPN.
No. of loading points on each side = 24 Nos.
Width of tank wagon gantry = 12 m.
(Cooling two spur)

b) Cooling water flow rate

Divide total area of gantry into 24 segments, each segment measuring 15 m X 12 m and consider 3 segments operating at a time.

Water rate required = \(3 \times 15 \text{ m} \times 12 \text{ m} \times 10.2 \text{ lpm/m}^2\).
= 6426
= \(385 \text{ m}^3/\text{hr}\)

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c) **Water Requirement for supplementary Hose:**

Water for 4 single hydrant streams = 4 x 36 = 144 m³/hr.
Water for 1 monitor stream (HVLR) = 1 x 228 = 228 m³/hr.
**Total water requirement** = 372 m³/hr.

**Total water flow rate for gantry protection**

(a) Gantry cooling = 385 m³/hr.
(b) Supplementary hose requirement = 372 m³/hr

**Total** = 757 m³/hr.

### 3.4 TOTAL DESIGN FIRE WATER FLOW RATE

Fire water rates for above 3 cases are given below:

i) Floating roof tank protection = 1104 m³/hr
ii) Cone roof tank protection = 1940 m³/hr
iii) Tank wagon Loading Gantry = 757 m³/hr

For fighting the two major fires simultaneously, the design firewater rate is the sum of the two highest water rates i.e.

Design fire water rate = (1940+1104) m³/hr
= 3044 m³/hr

**Design fire water rate** = 3044 m³/hr

### 3.5 FIRE WATER STORAGE REQUIREMENT:

**Case 1: When make water is not available:**

Fire water storage required (4 hrs) = 4X3044
= 12176 m³

**Case-2: When 50% make up is available (consider single largest fire)**

Fire water storage requirement =1940 X 4
= 7760 m³

---

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Fire water calculation for full surface fire on largest floating roof tank (roof sinking case)

Data:

- Total storage capacity in one dyke area = 32000 m$^3$
- No. of tanks = 2
- Capacity of each tank = 16,000 m$^3$
- Diameter of each tank = 40 M
- Height of each tank = 14.4 M

b) Cooling water requirement:

Cooling water rate @ 3 lpm/ m$^2$ of tank shell area for tank-on-fire

\[
\text{Cooling water required} = \pi \times 40 \times 14.4 \times 3
\]

\[
= 5426 \text{ lpm}
\]

\[
= 326 \text{ m}^3/\text{hr}
\]

Assuming that second tank is located within the tank dyke at a distance more than 30M from the tank shell.

Then, cooling water requirement @ 1 lpm/ m$^2$ of tank shell area = \(\pi \times 40 \times 14.4 \times 1\)

\[
= 1808 \text{ lpm}
\]

\[
= 109 \text{ m}^3/\text{hr}
\]

Total cooling water = 326 + 109

\[
= 435 \text{ m}^3/\text{hr}
\]

c) Water requirement in foam application

Foam Application Rate : 8.1 lpm (as per NFPA-11)

\[
\text{Foam Solution Requirement} = (\pi \times 40 \times 40)/4 \times 8.1
\]

\[
= 10174 \text{ lpm}
\]

\[
= 610 \text{ m}^3/\text{hr}
\]

Water required for the foam solution = 97% x 610 m$^3$/hr

\[
= 592 \text{ m}^3/\text{hr}
\]

d) Fire water for supplementary hose stream based on 4 hydrant streams + 2 High Volume Long Range water monitor.

4x36 m$^3$/hr + 2x228 m$^3$/hr = 600 m$^3$/hr

Total water required for roof sink case:

- Tank cooling = 435 m$^3$/hr
- Foam application = 592 m$^3$/hr
- Supplementary stream = 600 m$^3$/hr

Total = 1627 m$^3$/hr

Say Total water requirement = 1630 m$^3$/hr

Note:

Full surface fire of floating roof tank roof sinking case being a remote possibility, it is considered as a single largest contingency for the purpose of arriving at design fire water requirement.
ANNEXURE - II

FIRE WATER FLOW RATE FOR COOLING POL TANK WAGON LOADING GANTRY

a) Data

Total No. of loading points = 72 Conventional or 48 BTPN.
No. of loading points on each side = 24 Nos.
Width of tank wagon gantry = 12 m.
(Cooling two spur)

b) Cooling water flow rate

Divide total area of gantry into 24 segments, each segment measuring 15 m X 12 m and consider 3 segments operating at a time.

Water rate required = 3 x 15 m x 12 m x 10.2 lpm/m².
= 6426
= 385 m³/hr

Water Requirement for supplementary Hose:

Water for 4 single hydrant streams = 4 x 36 = 144 m³/hr.
Water for 1 monitor stream (HVLR) = 1 x 228 = 228 m³/hr.
Total water requirement = 372 m³/hr.

Total water flow rate for gantry protection

(a) Gantry cooling = 385 m³/hr.
(b) Supplementary hose requirement = 372 m³/hr.

Total = 757 m³/hr.

----- ) 0 x 0 ( -----
ANNEXURE - III

SAMPLE CALCULATION OF FOAM COMPOUND REQUIREMENT FOR A DEPOT/Terminal

1.0 FOAM COMPOUND CALCULATION FOR SINGLE LARGEST FLOATING ROOF OR CONED ROOF TANK IN A DYKE, WHICHEVER IS HIGHER.

1.1 Foam compound calculation for single largest floating roof tank in a dyke.

Tank Data
Total storage capacity in one dyke area = 1,20,000 m$^3$.
No. of tanks = 2.
Capacity of each tank = 60,000 m$^3$.
Diameter of each tank = 79 m.
Height of each tank = 14.4 m.

Foam compound requirement for tank
Foam solution application rate = 12 lpm/m$^2$ of rim seal area of tank.
Foam dam height = 800 mm.
Diameter of the tank (D1) = 79 M
Distance of foam dam from shell = 0.8 M
Diameter of roof up to foam dam (D2) = 79 - (2X0.8) = 77.4
Rim seal area = ($\pi /4$) x (79$^2$ - 77.4$^2$)
Foam solution rate @ 12 lpm/m$^2$ = 2356.8 lpm
3% Foam Compound required = 0.03 x 5523 lpm = 165.69 lpm.
Foam compound required for 65 minutes = 65 minutes x 165.69 lpm = 10770 litres.

For Floating roof tank sinking case, the Foam compound application rate shall be considered as 8.1 lpm/m$^2$.

1.2 Foam compound calculation for single largest coned roof tank in a dyke.

Tank Data
Total storage capacity in one dyke area = 50,000 m$^3$.
No. of tanks = 4.
Capacity of each tank = 12,500 m$^3$.
Diameter of each tank = 37.5 m.
Height of each tank = 12 m.

Foam compound requirement for tank
Foam solution application rate = 5 lpm/m$^2$ of liquid surface area of tank.
Foam solution required = 3.142 x (18.75)$^2$ m$^2$ x 5 lpm/m$^2$.
Foam compound required (3%) = 0.03 x 5523 lpm = 165.69 lpm.
Foam compound required for 65 minutes = 65 minutes x 165.69 lpm = 10770 litres.
2.0 FOAM COMPOUND CALCULATION FOR INSTALLATION HAVING AGGREGATE PRODUCT STORAGE CAPACITY MORE THAN 25,000 KL

Foam compound requirement for two portable foam monitors of 2400 lpm capacity
Foam solution required = 2 x 2400 lpm.
Foam compound required (3%) = 0.03 x 4800 lpm = 144 lpm.
Foam compound required for 65 minutes = 65 minutes x 144 lpm = 9360 litres.

3.0 FOAM COMPOUND CALCULATION FOR TWO HOSE STREAMS OF FOAM EACH WITH A CAPACITY OF 1140 LPM.

Foam compound requirement for two foam hose streams of 1140 lpm capacity
Foam solution required = 2 x 1140 lpm.
Foam compound required (3%) = 0.03 x 2280 lpm = 68.4 lpm.
Foam compound required for 65 minutes = 65 minutes x 68.4 lpm = 4446 litres.

The aggregate quantity of foam concentrate shall be largest of the 1, 2, or 3 as above.

----- ) 0 x 0 ( -----
ANNEXURE-IV

BRIEF DESCRIPTION OF FIRE FIGHTING FOAM

1.0 FIRE FIGHTING FOAM

Fire fighting foam is a homogeneous mass of tiny air or gas filled bubble of low specific gravity, which when applied in correct manner and in sufficient quantity, forms a compact fluid and stable blanket which is capable of floating on the surface of flammable liquids and preventing atmospheric air from reaching the liquid.

2.0 TYPES OF FOAM COMPOUND

Two Types of foams are used for fighting liquid fires:

2.1 CHEMICAL FOAM

When two or more chemicals are added the foam generates due to chemical reaction. The most common ingredients used for chemical foam are sodium bicarbonate and aluminum sulphate with stabilizer. The chemical foam is generally used in fire extinguishers.

2.2 MECHANICAL FOAM

It is produced by mechanically mixing a gas or air to a solution of foam compound (concentrate) in water. Various types of foam concentrates are used for generating foam, depending on the requirement and suitability. Each concentrate has its own advantage and limitations. The brief description of foam concentrates is given below.

3.0 TYPES OF MECHANICAL FOAM

Mechanical foam compound is classified into 3 categories based on its expansion ratio.

3.1 LOW EXPANSION FOAM

Foam expansion ratio can be up to 50 to 1, but usually between 5:1 to 15:1 as typically produced by self aspirating foam branch pipes.

The low expansion foam contains more water and has better resistant to fire. It is suitable for hydrocarbon liquid fires and is widely used in oil refinery, oil platforms, petrochemical and other chemical industries.

3.2 MEDIUM EXPANSION FOAM

Foam expansion ratio vary from 51:1 to 500:1 as typically produced by self aspirating foam branch pipes with nets. This foam has limited use in controlling hydrocarbon liquid fire because of it's limitations w. r. t. poor cooling, poor resistant to hot surface/radiant heat, etc.

3.4 HIGH EXPANSION FOAM

Foam expansion ratio vary from 501:1 to 1500:1, usually between 750:1 to 1000:1 as typically produced by foam generators with air fans. This foam also has very limited use in controlling hydrocarbon liquid fire because of its limitations w. r. t. poor cooling, poor
resistant to hot surface/radiant heat, etc. It is used for protection of hydrocarbon gases stored under cryogenic conditions and for warehouse protection.

4.0 TYPES OF LOW EXPANSION FOAM

4.1 PROTEIN FOAM

The foam concentrate is prepared from hydrolyzed protein either from animal or vegetable source. The suitable stabilizer and preservatives are also added.

The concentrate forms a thick foam blanket and is suitable for hydrocarbon liquid fires, but not on water miscible liquids. The effectiveness of foam is not very good on deep pools or low flash point fuels which have had lengthy preburn time unless applied very gently to the surface.

The concentrate is available for induction rate of 3 to 6%. The shelf life of concentrate is 2 years.

4.2 FLUORO PROTEIN FOAM

This is similar to protein base foam with fluro-chemical which makes it more effective than protein base foam.

The concentrate forms a thick foam blanket and is suitable for hydrocarbon liquid fires, but not on water miscible liquids. The foam is very effective on deep pools of low flash point fuels which have had lengthy preburn time.

The concentrate is available for induction rate of 3 to 6% and the shelf life is similar to that of protein base foam.

4.3 AQUEOUS FILM FORMING FOAM (AFFF)

The foam concentrate mainly consists of fluoro carbon surfactants, foaming agent and stabilizer. This can be used with fresh water as well as with sea water.

It produces very fluid foam, which flows freely on liquid surface. The aqueous film produced suppresses the liquid vapor quickly. The foam has quick fire knock down property and is suitable for liquid hydrocarbon fires. As the foam has poor drainage rate, the effectiveness is limited on deep pool fires of low flash point fuels which have lengthy pre burn time.

The concentrate is available for induction rate of 3 to 6% and the shelf life is more than 10 years. This can also be used with non aspirating type nozzles.

4.4 MULTIPURPOSE AFFF

Multipurpose AFFF concentrate is synthetic, foaming liquid designed specially for fire protection of water soluble solvents and water insoluble hydrocarbon liquids. This can be used either with fresh water or sea water.

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When applied it forms foam with a cohesive polymeric layer on liquid surface, which suppresses the vapor and extinguishes the fire. The foam is also suitable for deep pool fires because of superior drainage rate and more resistive to hot fuels/radiant heat.

The 3% induction rate is suitable for liquid hydrocarbon fires and 5% for water miscible solvents. The shelf life of concentrate is not less than 10 years. This can also be used with non aspirating type nozzles.

4.5 FILM FORMING FLOURO PROTEIN FOAM (FFFPF)

FFFPF combines the rapid fire knock down quality of conventional film forming AFFF with the high level of post fire security and burn back resistance of flouro-protein foam. The concentrate can either be used with fresh water or sea water.

The foam is suitable for hydrocarbon liquid fires including deep pool fires of low flash point fuels which have had lengthy pre burn time.

The concentrate is available for induction rate of 3 to 6% and the shelf life is 5 years. This can also be used with non aspirating type nozzles.

5.0 TYPES OF MEDIUM AND HIGH EXPANSION FOAM

Synthetic foam concentrate is used with suitable devices to produce medium and high expansion foams. This can be used on hydrocarbon fuels with low boiling point. The foam is very light in weight and gives poor cooling effect in comparison to low expansion foams. The foam is susceptible to easy break down by hot fuel layers and radiant heat.

The induction rate in water should vary from 1.5 to 3%. Many of the low expansion foam concentrate can also be used with suitable devices to produce medium / high expansion foam.
ANNEXURE- V

SYSTEM OF AUTOMATIC ACTUATED RIM SEAL FIRE DETECTION AND EXTINGUISHING SYSTEM FOR EXTERNAL FLOATING ROOF TANKS STORING CLASS- A PETROLEUM

The automatic actuated foam flooding system is a system designed to automatically detect and extinguish the floating roof tank rim seal fire at its incipient stage. The system is mounted on the roof of the tank. The minimum requirement for the design of the system is given below:

1.0 Foam Flooding System

Selection and design of foam based rim seal fire protection system shall be as defined in the latest NFPA – 11 & 11A Standard for Low and Medium Expansion Foam. Film Forming Fluro Protein Foam (FFF) / Aqueous Film Forming Foam (AFFF) type concentrate is used in the system.

1.1 Foam Application System

A large storage tank require one or more than one modular units for foam application in the entire rim seal. Each such unit consists of a foam distribution pipe, laid along the tank perimeter over the rim seal area. The spray nozzles for foam application are mounted on the distribution pipe at suitable intervals. Distribution pipe is permanently connected to a storage vessel containing pre-mix foam and both are placed on the roof. The foam is kept pressurized with nitrogen the premix foam solution is contained in a vessel which is kept charged with nitrogen. The system is designed for minimum foam application rate of @ 18 lpm/ m² of rim seal area. For effective control, foam is discharged in approximately 40 seconds.

1.2 Alarm & Auto Actuation System

In case of fire on the rim seal, it is automatically detected by a device capable to sense the same. The device then actuates the spray system for application of foam in the complete area of rim seal to quickly extinguish the fire in its incipient stage. An audio-visual alarm is also coupled with the detection & extinguishing system for necessary fire alert.

The system includes a fire detector network which senses fire and actuates the automatic release of the extinguishing medium on the rim seal area. Each tank shall have independent detection & extinguishing system.

The validity of the approach must be demonstrated by the designer for an effective total flooding extinguishing system which quickly detects and extinguishes fire in its incipient stage without re-flash. Also, the design considerations should include the impact of the weight of the modules placed on the floating roof.

The detection system needs to be highly reliable and shall work at varied site ambient temperatures for protection of rim seal fire.

Only those Rim seal protection systems, which use the linear heat hollow metallic tube type detectors with foam based extinguishing media, either for existing/ new or for replacements of existing detection system when due, shall be used. These detection systems shall be certified by any of the international certifying agencies like UL, FM, VdS or LPC to ensure
that those systems are used which meet with highest international standards of safety certification.

1.3 Calculations for Modular Foam Application System

\[ \text{Rim seal area of tank} = \pi \times 79 \text{ m} \times 0.3 \text{ m} = 74.5 \text{ m}^2 \]
(Considering a flexible seal width of typically 300 mm)

\[ \text{Foam solution application rate} = 18 \text{ lpm/m}^2 = 1341 \text{ Liters.} \]

\[ \text{Total foam solution required in 40 seconds} = 894 \text{ Liters.} \]

\[ \text{Total nos. of modular unit required} = 7 \text{ Nos.} \]
(Considering a vessel of 150 Liters capacity containing 135 Liters of foam)
Annexure-VI

Explanatory Note for Implementation

Clause 4.2. Design Criteria for fire protection system &
Clause 4.3.2: Basis: Fire water system

i. For exiting terminals this shall be provided progressively within a period of 4 years from the issuance of the standard.
ii. For new/upcoming locations it shall be implemented with immediate effect.

Clause 4.2.12, 4.4.4

Automatic actuated rim seal fire detection and extinguishing system shall be provided on all external floating roof tanks storing Class A petroleum.

i. The rim seal protection system shall be implemented in all existing installations progressively within 24 months for class A floating roof tanks above 5000 KL capacity & balance class A floating roof tanks progressively in 36 months from the date of issuance of the standard.
ii. Installation of rim seal system shall be done for all new/upcoming external floating roof tanks storing Class A petroleum storage tanks with immediate effect.
iii. The automatic actuated rim seal fire detection & extinguishing system already provided in existing tanks shall be replaced with linear heat hollow metallic tube type detectors with foam based extinguishing media whenever the existing system is due for replacement or shall be replaced within a period of 4 years from the day of installation whichever is earlier.

Clause: 4.2.13 Sprinkler system for Lube oil drums:

i. Shall be provided within 12 months from the issuance of the amended standard for existing locations.
ii. For new/upcoming location this shall be implemented with immediate effect.

Clause: 4.3.5 (x) Fire Water Pumps

i. Shall be progressively implemented within 24 months from the issuance of the Standard for existing locations.
ii. For new/upcoming locations it shall be implemented with immediate effect.

Clause 4.3.7 (vi) Hydrants & Monitors:

i. Shall be provided progressively within 24 months from the issuance of the Standard for existing tank farms.
ii. Installation of monitors for all new/upcoming tanks shall be done along-with commissioning of the tanks.
Clause 4.4.7: PROTECTION FOR DYKE AREA/SPILL FIRE

i. Medium expansion foam generators shall be provided progressively within 18 months from the issuance of the standard for existing locations.
ii. For new/upcoming location it shall be implemented with immediate effect.

Clause 4.6.3 (iii) Accessories:

i. Emergency Kit with the items mentioned in Annexure-VII shall be provided progressively within 24 months from the issuance of the amended standard for existing locations.
ii. For new/upcoming locations it shall be implemented with immediate effect.

Clause: 5.3 DETECTION AND ALARM SYSTEM

i. Hydrocarbon Detectors shall be provided progressively within 24 months from the issuance of the Standard for existing locations.
ii. For new/upcoming locations it shall be implemented with immediate effect.

Clause 6.2 (i) Training:

Training by oil Industry approved reputed institute shall start within next 6 months.

Clause 6.2 (iv) Full activation of shut down system during mock drill:

Shall be implemented with immediate effect.
EMERGENCY KIT

Emergency Kit consists of listed emergency equipments required for rescue and control/arresting leakage in case of emergency in oil terminals & depots. The equipments shall be mounted on a compact light weight trolley. Emergency Kit shall be consisting of the following emergency equipments:

<table>
<thead>
<tr>
<th>S.N.o.</th>
<th>Item</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>COLD/LOW TEMPERATURE PROTECTIVE SUIT.</td>
<td>2 sets.</td>
<td>For LPG locations</td>
</tr>
<tr>
<td>2</td>
<td>FIRE PROXIMITY SUIT</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PVC SUIT</td>
<td>2 sets</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>LEAK CONTROL KIT</td>
<td></td>
<td>Consisting of 1 no each of leak arresting pad, leakage control of external pipes, internal pipes, large external pipes up to 8 inch, drums / containers leakages, general purpose leakages, large hole leakages in storage tanks.</td>
</tr>
<tr>
<td>5</td>
<td>PETROLEUM PRODUCT CLEANUP CHEMICAL</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>OIL SPILL DISPERSANT (WATER BASED)</td>
<td></td>
<td>Dispersant : 40 litre Spray Gun with back pack : 1 set.</td>
</tr>
<tr>
<td>7</td>
<td>NON SPARKING TOOLS</td>
<td>One Set.</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Breathing Apparatus Set (40-minute duration)</td>
<td>2 sets</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Emergency Escape Sets (15 minutes duration)</td>
<td>2 Sets</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Flame Proof Search Light</td>
<td>2 nos</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rechargeable type suitable for Explosive Environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>MEGA PHONE Ex-Proof</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Portable battery operated PA System with 1 loud speaker with a range of 1 KM in still air and 500 M in noisy areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Hand Siren with Stand</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Approx. range of 1.6 KMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Fireman Axe</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>First Aid Box</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Manual Rescuer</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manually operated for artificial respirators consisting of adult size nose, mouth, face plate, air bulb with oxygen inlet connection, non-return, non-breathing human valves and first aid charge packed in a plastic bag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Folding Stretcher</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Size 6 feet X 3 feet with tying belts &amp; blanket.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Mechanical Tool Kit</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Cold / Low Temperature Hand Gloves</td>
<td>4 Pairs</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Electrical Rubber Hand Gloves</td>
<td>2 pair</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitable for Electrical jobs up to 33000 Volts</td>
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<td></td>
</tr>
<tr>
<td>20</td>
<td>Electrical Tester</td>
<td>1 no</td>
<td></td>
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<tr>
<td>21</td>
<td>Chemical/Oil Splash Proof Goggles</td>
<td>4 nos.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANSI/CE marked</td>
<td></td>
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</tr>
</tbody>
</table>

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