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SAFETY IN PETROLEUM INDUSTRY

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Abstract: Hazard Identification is a proactive process to identify hazards and eliminate or minimize/reduce the risk of injury/illness to workers and damage to property, equipment and the environment. It also allows us to show our commitment and due diligence to a healthy and safe workplace. We must identify hazards and potential hazards in the workplace in order to be able to take action to eliminate or control them. This is a step by step process to guide responsible persons to an effective hazard identification, assessment and controls system. The steps include:

Hazard Assessment: identifying the hazards and potential hazards, determining the risks and the risk designation (rating) associated to the hazard based on:

- Probability,
- Severity and
- Frequency.

Hazard control - controlling the hazards and the risks associated with the hazard. Providing information, education, training and supervision on the hazards, risks and controls for employees affected by the hazards.

Introduction

General Classification of Petroleum Products

Petroleum products are classified according to their closed cup FLASH POINTS as given below: Class-A Petroleum: Liquids which have flash point below 23oC.

Class-B Petroleum: Liquids which have flash point of 23 oC and above but below 65 oC. Class-C Petroleum: Liquids which have flash point of 65 oC and above but below 93 oC. Excluded Petroleum: Liquids which have flash point of 93 oC and above. Liquefied gases including LPG do not fall under this classification but form separate category.

Hazardous Area An area in which an explosive gas atmosphere is present, or likely to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

Non- Hazardous area An area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

HAZOP A Hazard and Operability (HAZOP) study is structured and systematic examination of process and operability problem that may pose risk to personnel or equipment, or prevent efficient operation.

HAZAN Hazard Analysis (HAZAN) is simply the application of numerical methods to obtain an understanding of hazards in terms of: How often a hazard will manifest itself With what consequences for people, process and plant..

1 FIRE PROTECTION FACILITIES

1.1. GENERAL CONSIDERATIONS

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

1.2. FIRE PROTECTION PHILOSOPHY

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.

9.2.1 **Fire protection** Depending on the nature of risk, following fire protection facilities shall be provided in the installation. Fire Water System -(storage / pumps / distribution piping network with hydrant / monitors)

- Fixed Spray System
- Foam System.
- First Aid Fire Fighting Equipment.
- Trolley mounted/Mobile Fire Fighting Equipment.
- Carbon Dioxide System
- Dry Chemical Extinguishing System
- Clean Agent Protection System.
- Detection and alarm systems
- Communication System

1.2.2 Design criteria for fire protection system

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

b) The fire water pumps shall be provided with auto start facility with pressure drop in fire water network.

c) The fire water system shall be based on single contingency for all locations where total storage capacity in the location is up to 30,000 KL (Including storage of Class C products if stored with Class A and / or Class B). Wherever water replenishment @ 50% or more is available, the storage capacity can be reduced to 3 hours aggregate rated capacity of main pumps.

d) The fire water system shall be provided based on two largest fire contingencies simultaneously for all locations where total storage capacity in the location is above 30,000 KL (Excluding Class-C products stored in a separate dyke conforming to prescribed separation distances). Wherever water replenishment @ 50% or more is available, single fire contingency shall be considered for Fire water storage.

Fire water system design Water is used for fire extinguishments, fire control, and exposure protection of equipment, foam application and personnel from heat radiation. Header Pressure: Fire water system shall be designed for a minimum residual pressure of 7 kg/cm2 at hydraulically remotest point in the installation considering the design flow rate.

a) A fire water ring main shall be provided all around perimeter of the location facilities with hydrants monitors spaced at intervals not exceeding 30 M when measured aerially. Fire hydrants and monitors shall not be installed within 15 Meters from the facilities/ equipment to be protected.

b) 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.

1.2.5 Fire water design flow rate

a) Fire water flow rate for a tank farm shall be aggregate of the following :- or 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 calculated for cooling a tank on fire at a rate of 3 lpm / sqm 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 / sq.m 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. 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 whichever is higher.(Foam solution applicable rate for cone roof tanks shall be taken as 5 lpm/sqm and for floating roof rim seal protection it shall be 12 lpm / sqm)

9.2.6 Fire water storage

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

b) The effective capacity of the reservoir/tank above the level of suction point shall be minimum 4 hours aggregate rated capacity of pumps. This clause shall be read with clause c &d of 9.2.2 (design criteria)

c) 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.

d) Storage reservoir (RCC) shall be in two equal interconnected compartments to facilitate cleaning and repairs. In case of steel tanks there shall be minimum two tanks and all the tanks shall be of equal height/depth to prevent any migration/overflow due to difference in height/depth. During maintenance of water tanks, availability of at least 50% of the water capacity shall be ensured.

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

9.2.7 Fire water pumps

a) 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. Pumps shall be provided with suitable sized strainers on suction and NRVs on discharge lines.

b) 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. Fire water pumps shall be of equal capacity and head.

d) 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. Fuel tank should be installed outside of fire pump house and shall have provision for venting. If tanks are located inside the pump house, the vent shall have provision for venting outside the pump house. e) 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.

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

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

h)Jockey pump shall be provided for keeping the hydrant system /line pressurized at all times. The capacity of the pump shall be sufficient to maintain system pressure in the event of leakages from valves etc. Capacity of the jockey pump shall be 3% minimum and 5 % max of the designed firewater rate. Besides the main jockey pump the stand by pump of same capacity and type shall be provided.

i) Auto cut-in / cut-off facility should be provided for jockey pumps to maintain the line pressure.

j) The fire water pumps shall be provided with auto start facility which shall function with pressure drop in hydrant line and specified logic even if initial pump does not start or having started, fails to build up the required pressure in the fire water ring main system the next pump shall start and so on.

Fire hydrant network

a) Looping: The fire water network shall be laid in closed loops as far as possible to ensure multidirectional

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.

Hydrant / monitors

a) Hydrants/ monitors shall be located considering various fire scenario at different sections of the premises to be protected and to give most effective service.

b) At least one hydrant post shall be provided at every 30 mtrs 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 mtrs intervals. The horizontal range & coverage of hydrants with hose connections shall not be considered beyond 45 mtrs.

c) Hydrants shall be located at a minimum distance of 15 mtrs. From the periphery of storage tank or equipment under protection. In case of buildings this distance shall not be less than 2 mtrs. and not more than 15 mtrs. from the face of building.

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9.2.12 Foam systems

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.

Types of foam compound

Two Types of foams are used for fighting liquid fires:

A. 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 aluminium sulphate with stabilizer. The chemical foam is generally used in fire extinguishers.

B. 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

Types of mechanical foam

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

a) 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.

b) 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 its limitations w. r. t. poor cooling, poor resistant to hot surface/radiant heat, etc.

Types of low expansion foam

i) 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 pre-burn 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.

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

iii) 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 vapour 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 1 to 6% and the shelf life is more than 10 years. This can also be used with non aspirating type nozzles.

i) Fixed Foam System

Fixed foam conveying system comprises of fixed piping for water supply at adequate pressure, foam concentrate tank, eductor, suitable proportioningequipment for drawing foam concentrate and making foam solution, fixed piping system for onward conveying to foam makers for making foam, vapour 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 vapour 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.1.2.14 Foam protection

A. Floating roof tank protection

B. Fixed roof tank protection

C. Floating cum fixed roof tank protection

D. Protection for dyke area / spill fire

Conclusion: Hazards identification and risk assesement(HIRA)study is a widely used tool to account for all of foreseeable hazards whether they are accidental events or worst case scenarios. Not only does it provide an elaborate outlook on the hazards that occur in the industry, but it also accounts for the control and recovery measures in order to mitigate the hazards so caused, which will help the organization in following ways:

- A record of the HIRA procedures and results can be kept for future reference and updating purposes.
- Helps to identify the occupational health and safety (OHS) hazard and the associated risk of activities & sub activities in the plant on the account of the Routine & Non Routine task
- Helps in setting of OHS objectives and target and also operational control based on risk assessment as above including training, measurement, monitoring and other requirement.
- Helps inprioritizing the hazard & risk for all Routine & Non Routine activities on an account of time bounded objectives/target & management program for risk elimination/substitution/reduction.

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