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Loss prevention in hydrocarbon facilities

Nirmal Surendran Menon

Associate Member, Institution of Mechanical Engineers (IMechE), Graduate Member, Engineering New Zealand

Correspondence: Nirmal Surendran Menon, Associate Member, Institution of Mechanical Engineers (IMechE), Graduate Member, Engineering New Zealand, Email nirmalsurendranmenon@gmail.com

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Abstract

Loss Prevention techniques in hydrocarbon facilities are to prevent personal injury or loss of life, to protect the installation from fire, explosion, and operational safety hazards inherent to the facilities and Protection of the environment by early detection of hazardous conditions and the subsequent shutdown, vapor depressurizing, and ventilation of hydrocarbons. The loss prevention philosophy is normally formulated based on a maximum of one major incident occurring at any one time, and the premise that hazards can arise in any section of the facility, in varying degrees of magnitude, and from a variety of sources. On normally-manned[1] facilities, personnel are trained to manage operational activities with the highest regard for safe procedures and to react appropriately in the event of emergencies. The safety of the facility requires that the plant is inspected and maintained, safe procedures are used and improved based on experience, to minimize the probability of occurrence of hazardous conditions. On un-manned facilities[2], fire protection systems are provided based on a formal risk assessment which shows them to be necessary. This article focuses on the loss prevention philosophy implemented in a hydro carbon facility for safe operation of the facility either during manned operations or unmanned operations by focusing on parameters such as the design strategy adopted while designing the facility (such as facility layout, fire protection, flaring design, drains design), areas classifications inside the facility that is designed, escape and evacuation route, climate control etc.

Keywords: loss prevention, operational safety, hazardous condition, normally manned and un-manned facilities, fire protection, risk assessment, Safety Instrumented System (SIS), Vapor Cloud Explosions (VCE)

Introduction

Hazard Assessments are carried out progressively during the execution of any hydrocarbon project. The establishment of the nature and realistic size of the possible hazardous events to which the facilities could be exposed is fundamental to the Hazard Assessments. These are established by carry out of studies of abnormal loads that could be placed on the facilities by the occurrence of hazardous event and are referred to Design Accidental Loads (DAL's).The DAL is established, based on assessment of fire and explosion loads to which critical equipment and structures had been designed. Typically design accidental loads include the following - Fire Loads, Extreme Low Temperature Loads, Explosion Loads, and Dropped Object Loads. Risk reduction is achieved by identifying hazards, risks and Development of design changes on material substitutions to eliminate, control or minimizing and, making the design changes required, evaluating the effects of the design changes, making further revisions is necessary to achieve the required risk reduction. Many design features can provide risk reduction to life, assets and environment, by reducing the risk of escalation of hazardous events. Typical of these are cooling water sprays on equipment, passive fire protection on critical structure layout and relative spacing of buildings and production facilities. The primary means for controlling fire on upstream facilities will be by automatic detection of fire, process isolation, safety shutdown (with depressurizing facilities available), together with passive or active fire protection. Active protection systems are autonomous after manual initiation. The primary action of personnel in case of a fire emergency is to move to an area of safety and/or escape. Manual intervention, such as application of firewater from monitors may be used as supplementary protection. However, design of systems and equipment for fire protection is based on the premise that there will be no trained fire brigade in any of the upstream facilities, and operators will attempt to extinguish fires only at the incipient stage. For this purpose, hand-held fire extinguishers are made available. In some locations, with the agreement of operations personnel, live hose reels are provided for early fire protection. Others, such as temporary refuges, and personal protective equipment, are directed solely towards life safety *(while preference is given to design features that can provide broad protection, their cost of implementation will be evaluated to ensure that they are reasonably practicable over the facility's lifecycle)*.

Strategy to Design

Hazardous events usually occur either as the result of a combination of unusual circumstances, occurring simultaneously, or by allowing the escalation of a series of minor events, none of which is, by itself, a major hazard. Therefore, the installation are designed robust to detect conditions which could lead to hazardous situations, and to rapidly, automatically apply, or allow the application of, corrective measures. Similarly, consideration is given to the design of escape facilities to prevent their obstruction or impairment by hazardous events.

[1]Buildings which are seldom occupied, this includes but not limited to: electrical substations, remote instrument buildings or modules analyzer houses, smoking pens, unmanned storerooms, rest rooms, etc., are not usually classified as Normally Occupied Buildings

[2]Buildings only occupied for part of the working day, include local operator shelters, change houses, locker rooms, mess rooms, dining rooms, meeting rooms, rooms used for issuing work permits, rooms for conducting training sessions, etc., are classified as Normally Occupied Buildings

Facility Layout

The design of the layout of the facilities is carried out to comply with Recommended Spacing within Operating Facilities as per the prevailing industry standards. Spacing may be modified to accommodate the results of the Gas Dispersion, Fire Radiation and Blast Overpressure studies, as necessary to achieve the required risk reduction. Normally manned areas, such as Control Centers, are not located where they can become engulfed in flammable vapors or liquids, exposed to either excessive thermal radiation, or where they could be exposed to blast overpressures in excess of their design loads.

Minimization of Accidental Release and Ignition

The process design for the minimization of accidental release and ignition is carried out such that releases are minimized, using the smallest vessel and tank sizes consistent with separation and stabilization requirements, and ensuring that the design of plant, structures and piping that complies with recognized applicable Codes and Standards. The probability of the ignition of accidental releases of flammable and combustible materials are minimized by plant layout, separating areas of potential release from potential ignition sources, and by the application of Hazardous Area Classification rules. Local Equipment Rooms/E-House/MCC and Control Rooms should not be in, nor share a boundary with, any Hazardous Area.

Fire Protection

The design of the comprehensive fire and gas detection system is carried out in compliance with international codes and standards as well as local regulation of the project jurisdiction. The selection of the type of fire and gas detection system to be used is based on an assessment of the nature of the mitigated risk. Detection of an accidental release of process fluids, or fire initiates a dedicated alarm, and automatically place active fire protection systems on standby, or automatically activates them. Both passive and active fire protection techniques will be used, as appropriate for the specific hazards. Passive protection may be achieved by providing "Fireproofing" for the facilities or active fire protection is achieved by providing "Firewater Systems and Devices" for the facilities. Provision should be made for first line firefighting by the supply of hand-held fire-fighting equipment. e.g., portable fire extinguishers and fire blankets, as appropriate for the local hazards.

Fire Water Pump and Distribution

Firewater pumps are designed in compliance with NFPA 20. The main fire water duty pump starts automatically upon low ring main pressure and by signal (manual Switch) from the control system. A jockey pump maintains the required ring main pressure in normal operation. The other pumps start automatically or manually whereas firewater is supplied by two separate water pumps 100% systems, each comprising an arrangement such as 1 x 100%, or 2 x 50% diesel driven firewater pumps. The firewater pumps for the two separate systems are separated for major maintenance work to be carried out on either pump without impeding operation of the other. Alternate arrangements, such as 3 x 33% diesel driven pumps, provide two separate 100% capacity systems, are also considered. The use of an electrically driven pump to supply 50% of the total capacity may be allowed, subject to consideration of the integrity of the electrical supply to the pumps under fire conditions, and to approval by the Owner's Engineer. The fire water ring main is designed to distribute fire water for fire-fighting from the fire water supply system(s) to the fire water application system(s) and device(s) at the facility. The firewater ring main is designed par NFPA 24.

Pressure Relief (Flare and Vapor Disposal)

An independent layer of over-pressure protection is provided, in the form of pressure relief valves, discharging either to the flare, or to a local vent to a safe disposal area. API RP 520 PT I, API RP 520 PT II, API RP 521, API STD 2000, as applicable, is allowed in the design of pressure-relieving, depressurizing, and flaring and venting devices and systems. It operates entirely independently of the Safety Instrumented System (SIS), and any other facility protection system. Its purpose is to limit the maximum pressure to which any part of the facility can be exposed, under the worst perceived operational conditions. Vents are located such that harmful levels of vent gases are not experienced in manned locations, and such that gas detectors are not initiated in low wind conditions such that the concentration of vapors from a vent not reach 25% of Lower Flammable Limit (LFL) at any part of the facility under the worst condition of flow and weather.

Open and Closed Drains

A system of open and closed drains, connecting to appropriate containment or disposal facilities, minimizes and controls the spread of process leakage and spills, and for the disposal of both clean and contaminated surface water. Liquid losses from the storage tanks such as diesel storage tank are contained in impervious bunds, used for containment of 110% of the largest tank volume that could be released into the bund. Provisions are normally made for drainage of water collected in these areas. The primary consideration of bund drainage is that there will be no overflow of collected liquids from the bunds under the design worst-case storm inundation conditions. In the case of oily or other water immiscible liquids, water must be drained into the non-hazardous open drain system from the bottom of the bunds during storm inundation, to prevent overflow.

Area classification

The purpose of area classification is to ensure that appropriate equipment is designed/selected for the various areas; ignition areas are identified and segregated from leakage sources; air inlets and air/exhaust outlets are properly arranged; the extent of flammable gas envelopes from vents are properly identified; lifesaving appliances, emergency control points, etc. are located in safe areas. Administrative and support buildings, such as warehouses, offices, maintenance, control, instrument and electrical buildings, are located sufficiently remote from the hazardous areas.

Blast protection of buildings

Impact from vapor cloud explosions (VCE) is considered in the design of Normally Occupied Buildings and Critical Operations Buildings; plant equipment is not typically designed to withstand VCE effects. Buildings which are only occupied for part of the working day, such as local operator shelters, change houses, locker rooms, mess rooms, dining rooms, meeting rooms, rooms used for issuing work permits, rooms for conducting training sessions, etc., are classified as Normally Occupied Buildings when one or more of the following criteria are met. API RP 752 provides examples of occupancy criteria that involve

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one or more of the range of values in Table 1.

Table 1 Criteria for Normally Occupied Buildings

Criteria	API 752
Occupancy load, personnel hours/week	200-400
Peak occupancy, maximum number of people for a given period (example: one hour)	5-40
Individual occupancy, maximum percent of total time in building	25-75

Climate

Heating, Ventilation, Air Conditioning (HVAC) systems are installed for Buildings and the building ventilation and air intakes are located well away from any source of flammable, toxic or exhaust gases.

Hot and cold surfaces

Temperature on surfaces that can be reached from work areas, walkways, ladders stairs or other passageways are not to exceed 158°F or be below 14°F. Where necessary, insulation or shielding for personnel protection is provided by way of Thermal Insulation.

Escape route

Requirement for number and location of escape routes on the facilities are determined by project-specific analysis. Areas in which escape could be impeded by factors as heat or smoke from a fire are identified and documented. Documentation includes description of the specific measures to be taken. The facilities normally maintains two independent means of egress from all operating areas where personnel may be present for routine operations and maintenance.

Evacuation route

Escape/Evacuation routes are as direct as possible, avoiding frequent changes of direction. Where changes in deck level are required, stairs or ramps are to be used rather than ladders. Dead leg areas over 16 ft long are provided with at least two exits leading to evacuation routes. Primary evacuation route clear passage width is required to be at least 5 ft. This dimension is maintained for any stairways in the evacuation route. The height will be at least 8 ft. The facilities normally maintains two independent means of egress from all operating areas where personnel may be present for routine operations and maintenance typically do not require protected escape routes.

Manual alarm call points

Manual alarm call (MAC) points are located throughout the facility within 200 ft of any point within a process unit or module. This distance may need to be reduced if equipment congestion in the module increases travel times, at exit routes, especially on the floor landings of staircases and at exits to open air. Manual alarm call points initiate audible and visual signals in a permanently manned location. Alarms indicate the area where the manual alarm call was initiated. MAC points are protected from inadvertent operation and are located in areas to be easily operable from the level of the exit route on which they are situated. MAC points are selected to be easily operable by personnel wearing Personal Protective Equipment (PPE - gloves, etc.) and are clearly visible and labeled.

Conclusion

Methods used to achieve the Loss Prevention objectives are chosen to avoid complex procedures that could lead to needless exposure of personnel to hazardous events. The safety of the facility requires that the facility is inspected and maintained, safe procedures are used and improved based on experience, to minimize the probability of occurrence of hazardous conditions. Formal Hazard Assessment is carried out progressively during the execution of the project. The circumstances of the design and construction activity may necessitate more specific, formal loss prevention studies to be performed and the findings of such studies are included in the final design.

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