Chapter 30

FIRE-FIGHTING

This Chapter discusses events which may follow cargo spillage and the procedures which can be adopted to protect life and property in such circumstances.

It also describes the types of fire that may be encountered on a gas tanker.

30.1 The Principal Hazards

The gases with which this Guide is concerned are either flammable or toxic or both.

Most are stored and handled at sub-zero temperatures, or under pressure or by means of a combination of the two. The main hazards are, therefore, vapour release, flammability, toxicity and the effects of sub-zero temperatures on personnel and structures.

30.1.1 Flammability

As already described in Section 27.22, when a gas is released to atmosphere, if within its flammable range and if exposed to a source of ignition, it will burn. Depending upon the conditions under which combustion takes place, some degree of over-pressure will occur due to the rapid expansion of the heated gas.

A liquid spill or vapour cloud burning over open water will develop little over-pressure due to the unconfined nature of the surroundings. At the other extreme, the ignition of vapour within an enclosed space will rapidly create an over-pressure sufficient to burst the boundaries. Between these two extremes, that is in cases of partial confinement such as might occur among shore plant and equipment, ignition may produce over-pressures sufficient to cause substantial damage, so escalating the hazard and its consequences.

A leakage of liquid or vapour from a pipeline under pressure will burn, if ignited, as a jet which will continue as long as fuel is supplied.

A particularly destructive form of vapour burn, associated with the storage of liquefied gas in pressurised containers, is the BLEVE (Boiling Liquid Expanding Vapour Explosion). This is described in 27.22.

30.2 Liquefied Gas Fires

30.2.1 General

It is not proposed in this Guide to deal with fires that can occur in terminal buildings, store rooms, the tanker's accommodation or machinery spaces. The characteristics and methods of fighting such fires are covered elsewhere. Provided cargo containment is not ruptured, it is rare for such fires to spread to the cargo. Accordingly, this section deals only with cargo liquid or vapour fires.

Cargo-related fires may be broadly categorised as follows:

- Jet fires from leaks at pumps or pipelines,
- Fires from confined liquid pools,
- Fire, from unconfined spillages,
- Fires in enclosed spaces, such as compressor rooms and
- Manifold fires.

30.2.2 Jet Fires

Small leaks from pump glands, pipe flanges or from vent risers will initially produce vapour. This vapour will not ignite spontaneously but, if the escape is large, there may be a risk of the vapour cloud spreading to a source of ignition. Should a gas cloud occur, ignition should be prevented by closing all openings to hazardous areas. Furthermore, the vapour cloud should be directed or dispersed away from ignition sources by means of fixed or mobile water sprays (see 30.3.1). If ignition does occur, it will almost certainly flash back to the leak. Leaks from pipelines are likely to be under pressure and, if ignited, will give rise to a jet flame. Emergency shut-down of pumping systems and closure of ESD valves should have already occurred but, even so, pressure may persist in a closed pipeline until the liquid trapped within has been expelled through the leak. In such a case, the best course of action is often to allow the fire to burn out. The alternative of extinguishing the fire has a high risk of further vapour cloud production and flash-back causing re-ignition. While the fire is being allowed to burn itself out, the surroundings should be protected with cooling water.

30.2.3 Liquid (pool) Fires

Significant pool fires are not likely on tankers' decks because the amount of liquid which can be spilled in such a location is limited. The arrangement of the tanker's deck, with its camber and open scuppers, will allow liquid spillage to flow quickly and freely away over the tanker's side. In case of cargo leakage, open scuppers on gas carriers are an important feature to allow cold liquids to escape quickly so reducing the risk of metal embrittlement and the possibility of small pool fires on a tanker’s deck.

Prompt initiation of ESD procedures further limits the availability of liquid cargo.

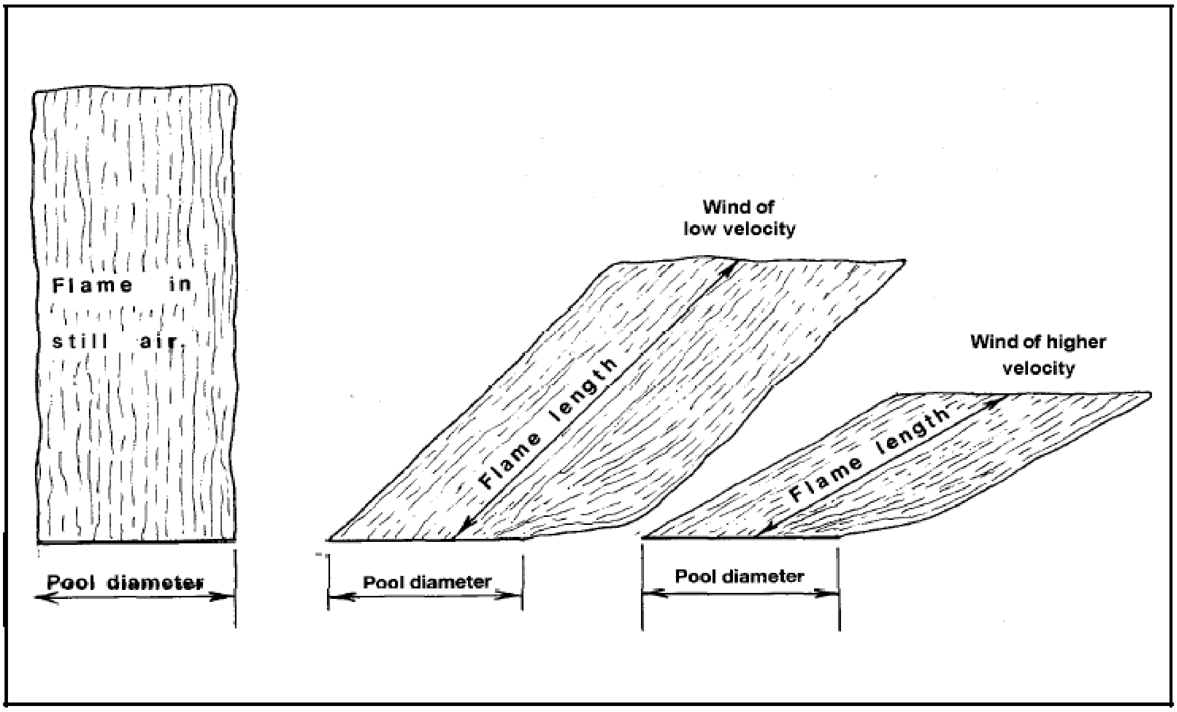

Figure 30.1 - Pool fire configurations

A liquid spillage on shore, from tank or pipeline ruptures, may involve large quantities but should be contained in bunded areas or culverts. Any ignition of the ensuing vapour cloud would then result in a pool fire. The flame height from such a fire, in the absence of wind, is as illustrated in Figure 30.1. Figure 30.1 also illustrates the effect of wind in deflecting the axis of the flame and in shortening flame-length. The emissive power of a flame surface increases with pool diameter. Heat radiation levels of LPG pool fires dictate that unprotected personnel must escape from the immediate vicinity as quickly as possible.

Heat radiation from a fire falls away approximately as the inverse square of the distance between the object and the flame. The human body will feel extreme pain on bare skin after only 10 seconds of incident radiation of 6 kW/m^2 and will suffer severe blistering after 10 seconds exposure to 10 kW/m^2. Incident radiation greater than 10 kW/m^2 will quickly vaporise PVC cables and will seriously affect fibreglass lifeboats. The estimation of safe distances from a pool fire involves complex factors but, for a large pool fire, such safe distances are likely to be some tens of metres.

Because of the damage which radiation can inflict on surrounding tanks and plant, such equipment is always protected (often by insulation or by remotely operated water deluge systems). Also, the bunds and culverts where pool fires may occur are often provided with remotely operated dry powder installations. Alternatively, they may be fitted with a high expansion foam system for rapidly building up and maintaining a depth of foam to control the rate of burning.

30.2.4 Fires in Compressor Rooms

Enclosed spaces containing cargo plant such as compressors, heat exchangers or pumps will normally be provided with a fixed and remotely activated fire extinguishing system such as carbon dioxide. Provided no major disruption to the enclosure has occurred, these systems should be immediately effective.

30.2.5 Manifold Fires

Manifold fires may consist of a jet fire (see 30.2.2) as a result of leakage from the manifold flanges, or of a pool fire from a drip tray (see 30.2.3), although the amount of liquid in a drip tray is comparably small. Prompt initiation of ESD procedures further limits the availability of liquid cargo.

30.3 Liquefied Gas Fire-Fighting

30.3.1 Extinguishing Mediums

There are a number of established and proven methods for dealing with gas fires but, to be effective, the appropriate extinguishing medium must be used.

Water

Water should never be applied to a burning liquefied gas pool. This would provide a heat source for more rapid vaporisation of the liquid and increase the rate of burning. Nevertheless, water remains a prime fire extinguishing medium for liquefied gas fire-fighting. Being abundantly available, water is an excellent cooling agent for surfaces exposed to radiation or direct fire impingement. Also, it may be used in spray form as a radiation screen to protect fire-fighters. In some circumstances, water can be used to extinguish a jet of burning gas but this is not always desirable.

Fixed water deluge systems are customary for surfaces such as tankers' structures, deck tanks and piping, shore storage tanks, plant and jetties, all of which can be exposed to liquefied gas fires. Such systems are designed to supply a layer of water over the exposed surfaces and thus to provide a useful cooling effect. Provided a water layer of some thickness can be maintained, the surface temperature cannot exceed 100°C. Application rates vary with the distance of the structure to be protected from the envisaged fire source and range from two to ten or more litres of water per square metre of protected surface.

Water spray from fixed monitors or from hand-held hose nozzles can provide radiation protection for personnel in their approach to shut-off valves. Additionally, they can provide protection when approaching jet fires in order to deliver more effectively an attack by dry chemicals to extinguish the flame.

A special application of water sprayed from hoses is to deflect an unignited vapour cloud away from ignition sources.

Dry chemical powders

Dry chemical powders such as sodium bicarbonate, potassium bicarbonate and urea potassium bicarbonate can be very effective in extinguishing small LPG fires.

It is also usual for jetty manifold areas to be protected by substantial portable or fixed dry powder systems. Dry chemical powders are effective in dealing with gas fires on deck or in extinguishing jet fires from a holed pipeline and have been used successfully in extinguishing fires at vent risers.

Dry chemicals attack the flame by the absorption of free radicals in the combustion process but have a negligible cooling effect. Re-ignition from adjacent hot surfaces, therefore, should be guarded against by cooling any hot areas with water before extinguishing the flame with dry powder.

Foam

High expansion foam, adequately applied to the surface of a burning liquid pool (when confined within a bunded area), suppresses the radiation from the flame into the liquid beneath and reduces the vaporisation rate. Consequently, the intensity of the pool fire is limited. Continuous application is required in order to maintain a foam depth of at least one to two metres. High expansion foam of about five-hundred to one expansion ratio has been found to be the most effective for this purpose.

Foam, however, will not extinguish a liquefied gas fire and, while effective for the above purposes, requires to be applied to a substantial depth. For liquefied gases, therefore, foam is only appropriate for use in bunded areas and for this reason is only found at terminals and is not provided on gas carriers.

Inert gas and carbon dioxide

Inert gas or nitrogen is commonly used on gas carriers and in terminals for the permanent inerting of interbarrier spaces or for protective inerting of cargo-related spaces. These spaces can include tankers' hold spaces or enclosed plant spaces on shore which are normally air-filled but in which flammable gas may be detected.

Because of the comparatively low rate at which such gas can be delivered, it is not normally used for the rapid inerting of an enclosed space in which a fire has already begun. For this, high-pressure bottled carbon dioxide gas or halon replacements is injected through multiple nozzles, the mechanical ventilation system to the space having been first shut off. While carbon dioxide injection systems are effective in enclosed spaces, they have two disadvantages. Their fire extinguishing action is achieved by displacing oxygen in the space to a level which will not support combustion and it is, therefore, essential that all personnel evacuate the space before injection begins. Secondly, the injection of CO_2 produces electrostatic charging which can be an ignition hazard if CO_2, is injected inadvertently or as a precautionary measure into a flammable atmosphere.

CO_2 or nitrogen injected into safety relief valve outlets may be used as an effective means of extinguishing vapour fires at the vent risers. This is particularly valuable once the initial pressure flow has subsided.

After CO_2 has been injected into an enclosed space, the boundaries of the space should be kept cool - usually with water sprayed from a hose. The space should remain sealed until it is established that the fire is extinguished and has sufficiently cooled so that it will not re-ignite with the introduction of oxygen.

Halon replacements

Halon can now no longer be used, as there is a total ban on this CFC under the provisions of an international treaty. This is because it has a high Ozone Depletion Potential and is, thus, a danger to the environment. There has been considerable research into halon substitutes and replacement agents are now commercially available.

For information on Halon replacements, reference should be made to Section 5.3.3.

30.3.2 Training

For effective use of any of these systems, a thorough knowledge of the capabilities of each is essential. Speed in correctly tackling a fire is vital if escalation is to be minimised and life and property safeguarded. This knowledge can only be achieved by a serious approach to training by management and operating personnel alike. Training of ship and shore personnel who may have to lead a fire party should be given in shore-based fire schools where fire-extinguishing techniques can be demonstrated and practiced. The training should be consolidated by frequent exercises on board tanker and in terminals and these should be realistically staged.

Proper maintenance of fire-fighting equipment is also of importance. Inspection and maintenance should be incorporated into on board and on-site training programmes and these aspects should help to familiarise personnel with the equipment and to provide them with a fuller understanding of its operation.