# FIXED FIRE FIGHTING FOAMS – ASKING THE RIGHT QUESTIONS, MAKING THE RIGHT CHOICES

**While the petrochemical industry is undeniably one of the major users of fixed foam fire protection systems, it is essential to have a detailed understanding of the particular installation, the risks and processes before deciding on the most appropriate solution. Here, Andrew Shiner, Director, Marketing Europe, Middle East & Africa for Tyco Fire & Security's Fire Suppression Group explores some of the issues affecting system design and overviews the merits of different fire protection strategies and the foam agents currently available.**

No one would dispute that the petrochemical industry constantly faces an unrivalled fire safety challenge; the processing, storage and transportation of large quantities of highly flammable and combustible liquids. While they are infrequent, large storage tank fires are headline news and challenge all but the most professional and experienced fire fighting specialists. The cost of lost production has the potential to run into billions of dollars, and the life-threatening consequences are very real. However, risks can be minimised through the careful design of the fire protection systems, provided that this is based on a detailed and current risk assessment.

Indeed, it is an industry where the need for professionally undertaken and constantly updated risk assessment is of paramount importance. It has to address some tough questions. What is the worst possible fire scenario; what resources would be needed to fight such a blaze; what if the fixed installations are destroyed by explosion; what sort of response would the local municipal fire service provide, and how long would it take to be in place?

Certainly, the fire risk assessment should never be downgraded to the status of an occasional paperwork exercise. Risk assessment in this sector in particular must be a dynamic process and be top of the agenda, particularly when considering changes to the facilities or processes. These changes will often alter the facility's risk profiles, and this might well jeopardise the effectiveness of existing fire protection systems that, by their very nature, must be risk specific.

And it must be remembered that, in the UK for example, the Regulatory Reform (Fire Safety) Order of the Fire Services Act, which is planned to come into effect this year, places a whole new area of fire safety responsibility directly on the facility manager's shoulders. Under the Order, the onus for carrying out fire safety assessments passes from the local municipal fire brigade to the premises manager, who will have the legal obligation to ensure that competent people – either employees or sub-contract specialists - undertake fire risk assessments of their facilities.

**TAKING THE HOLISTIC APPROACH TO PETROCHEMICAL FIRE SAFETY.**

While outside the scope of this article, it is important to recognise that, in addition to commissioning a well-conceived fire fighting system, risks can be minimised by adhering to appropriate design guidelines at the facility's construction stage. For example, well designed and built storage tanks that are correctly installed and well maintained are essential; so too is the proper use of containment techniques and the adoption of passive fire protection measures.

This care and attention to fire safety detail applies to refineries and processing areas; flammable and combustible liquid storage areas, including tanks and warehousing; bund and dike areas; vehicle loading facilities and jetties. Inevitably, such a diverse collection of fire risks calls for a comprehensive toolbox of products; foam agents and design expertise to create an optimum fire protection solution for the entire facility.

The design of fire protection systems requires specific expertise and experience in identifying the risks associated with hazardous materials and processes. Each application may well warrant a different fire protection solution, depending on the type of liquid stored or processed. So, the system's designer must consider the liquid's flash point, its boiling point, and determine if it is a hydrocarbon or a water-soluble, polar solvent fuel. This information enables the designer to complete the first part of the design process, classify the liquid, and establishes the most appropriate type of foam concentrate, its application rate and the discharge time.

To assist the designer, the NFPA [National Fire Protection Association] has developed a taxonomy for flammable and combustible liquids, which assists in developing appropriate fire protection tactics. For example, volatile liquids have a high vapour pressure and are easy to ignite, while products with a high vapour pressure and low flash point are more difficult to extinguish than products with a low vapour pressure and high flash point.

**FIRE FIGHTING FOAM OPTIONS.**

There have, in recent years, been many advances in the field of foam concentrates, and some suppliers have been somewhat over enthusiastic when promoting their own type of generic product, the formulation of which has been dependent upon the company's manufacturing capability. However, it is important to be aware of the wide range of foams that are available today, from low cost but highly stable protein foams through to the latest leading-edge synthetic products, such as the Tyco Fire and Suppression's Thunderstorm 1 x 3, which was developed in consultation with Williams Fire and Hazard Control Inc, probably the world's most highly respected specialist in the fire protection of flammable liquids.

Basically, foam is a stable mass of small, air-filled bubbles that have a lower density than oil, petrol, or water. When it is discharged, it comprises three elements; the foam concentrate, water and air. Because of the product's low density, it readily floats on a fuel's surface to extinguish a flammable liquid fire by separating the fuel from oxygen. Effectively, it smothers the fire, while its high water content provides effective cooling. Well-formulated foam, correctly applied, will exhibit a number of characteristics. These include stability, cohesion, rapid fire-knockdown, heat resistance and vapour suppression; all of which will ensure that a fire is extinguished efficiently and securely to prevent reignition.

Briefly, the types of foam currently on the market can be summarised as follows:

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| Protein Foams: | Stable mechanical foam. |
| | Good expansion properties. |
| | Excellent heat and burn-back resistance. |
| | High fluidity. |
| | Low fuel tolerance. |
| Fluoroprotein Foams: | Inherent stability of protein base. |
| | Faster flame knock-down. |
| | Fuel tolerance. |
| | Greater fluidity. |
| | Hydrocarbon vapour suppression. |

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| Aqueous Film Forming Foams (AFFF): | High quality foam. |
| | Low or medium expansion. |
| | Compatible with wide range of equipment. |
| | Good shelf life. |
| | Concentrated agents available for 1% induction. |
| Film Forming Fluoroprotein Foams: | High stability foam. |
| | Rapid knock-down. |
| Alcohol Resistant Concentrates: | Synthetic or fluoroprotein. |
| | Highly versatile. |
| | Fast knock-down. |
| | Good burn-back resistance. |
| | Fuel tolerant (used on hydrocarbon and polar solvents). |
| | Excellent prolonged vapour-mitigating properties. |

Of course, it is not merely a matter of selecting the foam, critically important though that is; it is equally essential to decide on a supplier of foam concentrate and provider of delivery systems. And this must be a decision that is not based on cost alone! Continuity of supply, technical support, engineering know-how, manufacturing resources and industry expertise all have to be assessed.

**PETROCHEMICAL INDUSTRY APPLICATIONS.**

The petrochemical industry uses a variety of storage tanks for its products, each with a slightly different risk profile:

- Cone roof tanks (fixed roof tanks).
- Open-top floating roof tanks.
- Covered floating roof tanks.
- Horizontal tanks.

Usually, the primary protection of tanks is by means of fixed fire protection systems, with secondary protection being achieved through the use of foam monitors. Foam generators used in fixed systems have proved very successful in many installations and can provide a cost effective and reliable solution. However, any damage to the tank structure may well limit the foam generator's efficiency. This, together with maintenance issues, has lead to the widespread use of sub-surface injection systems, where sufficient water pressure is available for their use.

Sub-surface injection of foam into a storage tank is, as the name implies, where the foam is injected into the bottom of a tank, and then floats to the surface to spread and extinguish a fire. However, this method is unsuitable for use with polar solvents, even where alcohol-resistant concentrates are used, because the fuel destroys the foam. So extreme care must be taken to ensure that the sub-surface injection technique is not used on potential gasoline blends that contain alcohol or other polar solvent additives as oxygenates.

Sub-surface injection also cannot be used on cone roof tanks with internal floaters, in accordance with NFPA 11 - standard for low, medium and high-expansion foams. To overcome this problem, the so-called semi-subsurface injection technique has all of the benefits of sub-surface injection, and can be used for all types of fuel. The semi-subsurface technique uses a flexible hose, which floats to the surface when the system is activated, to deliver the foam.

Fixed monitors are a cost effective method of protecting relatively small storage tanks and associated spill or ground fires. Remote operation, which ensures that fire fighters are kept at a safe distance from the incident, can be achieved by using electrical or hydraulic control systems. Although monitor's streams have successfully been used for extinguishing fires in larger diameter tanks, using high-flow devices and large diameter fire hoses, monitors should not - in accordance with NFPA 11 - be considered as primary protection for larger cone roof tanks with diameters in excess 18 metres.

Fixed systems can also be used for floating roof tanks; foam pourers are used to protect the rim seal area, with the foam being contained by a dam. However, good foam fluidity is essential to ensure that rapid coverage is achieved, and some oil companies have adopted a belt-and-braces approach and installed both foam pourers and sub-surface systems on covered floating roof tanks.

Horizontal tanks have been known to rupture following an explosion, so it is necessary to ensure that the bund area is adequately protected. Fixed low or medium expansion generators can be used to create an effective foam blanket, even on larger bund areas in major tank farms, and any residual fuel in the tank can be protected using a monitor. In reality, monitors can be used to protect the bund area, but this results in much higher foam consumption. At least two monitors are recommended to protect larger bunds to ensure full coverage and access to devices under all wind conditions.

Truck loading racks require special attention as a fire in this situation can escalate and threaten lives. Foam can provide a quick knock-down with the added advantage of vapour suppression and containment to prevent reignition prior to the cleaning-up process. Foam is delivered through a combination of an overhead foam/water deluge sprinklers supplemented by low-level ground sweep nozzles. Additional protection is provided against radiant heat, and structural cooling is beneficial to prevent further damage. Monitors can provide cost effective protection, but coverage remains an issue and the designer must be certain that this strategy will deliver the site's fire protection objectives.