More than half a million litres of foam concentrate was provided by the Angus Fire Emergency Service. So what has been learned about refinery & storage tank fires from Buncefield? Mike Willson investigates.

Foam concentrates the mind –Buncefield revisited

Perhaps the most crucial lesson to be learned from Buncefield is the importance of planning in advance and, in particular, planning for the unexpected, writes Mike Willson.

While the worst case scenario at fuel storage depots has traditionally been regarded as the largest storage tank catching fire, Buncefield taught us that it is, in fact, a much larger fire caused by several tanks burning simultaneously.

Buncefield is by no means unique. The Buncefield Investigation reports published by the UK's Health & Safety Executive state that there have been six similar overfill incidents in recent years, two in Europe and three in the USA.

Where there are products with a wide range of boiling points are involved, such as crude oil, there is the added risk of a boilover in which burning product can be projected over distances up to ten times the tank height and several times the tank diameter. This risk exists even if the fuel has been burning for just one hour.

Planning to extinguish a much larger fire inevitably means using much larger quantities of foam. Existing international standards like NFPA 11 assume a single tank is on fire and only take into account the extinguishing phase.

But remember, foam usage does not stop when the fire is out. At Buncefield only one-third of the foam supplied was used to put the fire out. The remaining two-thirds was used to provide a secure foam blanket for preventing the fire from re-igniting and burning back, and for pumping out the product that was saved.

[Above] At Buncefield, large capacity foam monitors proved ideal for projecting high quality aspirated foam over long distances onto storage tanks. [Below] Angus foam makers at work in the Buncefield depot.

Water supply issues

At incidents like Buncefield, large-capacity foam monitors are ideal for projecting high quality aspirated foam over long distances up on to storage tanks. But can the site fire water main be relied on to deliver sufficient water volume and pressure to operate them?

Two similar explosion incidents in the USA rendered the fire main ineffective. And what if the fire main is damaged by an explosion? Where is the nearest alternative water supply and how could water be transferred to the scene of the incident?

A well-engineered packaged solution incorporating large-capacity foam monitors and Large Diameter Hose (6 to 12 inch diameter) automatic deployment and retrieval systems need to be included in a foam emergency plan.

Angus foam pourers establish a foam blanket within the bund.

Fire hoses also play a key role at such incidents. 5 km of regular 65 to 70 mm (21/2 to 23/4 inch) and 45 mm (13/4 inch) Angus Duraline covered fire hose was also used at Buncefield. At another major tank fire in Turkey a few years ago, all the covered fire hose that was used gave problems of leakage, bursting or couplings blowing off except Angus Duraline. The plant restocked with nothing but Duraline after the fire based on its exceptionally good performance.

The right choice of foam

It is not just the quantity of foam that needs to be considered, it is the type of foam too. Growing numbers of fire & rescue services are turning to Angus Niagara to meet their fire fighting foam needs. This is because it is extremely versatile in use and therefore ideal for situations where the risk is not clearly defined.

However, the risk at fuel storage depots like Buncefield is predominantly hydrocarbon flammable liquids. In these situations it is more cost-effective to use fluoroprotein foams like Angus Tankmaster or FP70 that have been specially developed to extinguish large hydrocarbon storage tank fires.

FP70 performed extremely well at Buncefield. Suitable for use through large-capacity foam monitors, its fluoroprotein bubble structure provides exceptional resistance to heat, enabling it to pass through flames, impact on hot fuel and move over burning liquid surfaces.

Its bubble walls are also tough enough to seal tightly against the hottest tank shells, and even under a torrent of cooling water its stable foam blanket remains intact.

FP70 enabled the first 10 burning tanks to be extinguished in four hours once the foam attack had started. Detergent-based AFFF foams reportedly demonstrated poor resistance to reignition and burnback, and so on occasions firefighters had to return to fight the same fires again.

This problem did not occur with fluoroprotein foams or the small amounts of Alcohol Resistant foams that were used.

Much comment has been made of the small amount of PFOS-based foam used at Buncefield. However, this gives a distorted picture. At least 91% of the foam used at Buncefield is known to have been telomer-based, with an estimated 7% being PFOS-based.

Most of the runoff water was retained onsite and the UK Environment Agency inspectors only found trace quantities of PFOS material in rivers and groundwater adjacent to the site in the month following the fire, and two months later it was undetectable.

At no time did it exceed the water quality threshold specified by the Drinking Water Inspectorate of three micrograms per litre (three parts per billion). No identifiable environmental consequences were observed and levels were below those that would cause the Environment Agency concern about the health of humans or wildlife.

Foam logistics

Mutual aid schemes with local authority, industrial and airport fire services played a major role in supplying foam stocks to fire crews at Buncefield.

However, the incident also highlighted the importance of fire & rescue services working in partnership with a company that not only manufactures foam, but which is also capable of delivering that foam in the right quantities at the right time and place. In the light of the increased risk of terrorist attacks it is also wise for site managers to review their foam stockholding as they too could take some responsibility for having adequate stocks available in case of sudden emergencies.

Angus Fire, which today is part of UTC Fire & Security, has been doing just that for over twenty years. It has a proven track-record of delivering urgently needed supplies of foam to major incident sites worldwide. A dedicated emergency hotline (+44 (0) 15242 61166) provides a simple means of communication 24-7.

Bulk foam stocks are held in constant readiness at the company's foam production facility at Bentham in North Yorkshire. When a call for help is received an emergency plan springs into action. Depending on the scale and location of the incident, the company's logistics team can often co-ordinate delivery by road within one hour and by air freight within a few hours.

Foam production staff are also on constant standby to produce additional supplies of foam if required. The company works closely with the nearby specialist logistics firm DCL Transport Services, which has a team of drivers who are highly experienced in transporting foam under police escort in emergencies.

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Foam co-ordination officer

Co-ordinating the delivery of foam supplies to the fire ground is another important factor that needs to be borne in mind at the planning stage.

At Buncefield, Angus Fire's Martin Hough, who was on site, and Gary Godfrey, co-ordinated foam supplies and provided technical assistance to the fire crews. The company's foam scientist Maurice Birkill was also on hand to help with environmental and disposal issues.

Angus Fire believes there is a strong case for fire & rescue services to appoint a Foam Co-ordination Officer as part of their plans for handling major emergencies involving the use of large quantities of foam.

A key role for such an officer might be to decide how the foam should be delivered at different stages of the incident. Buncefield showed that road tankers were ideal for delivering foam during the firefighting operation to feed foam-hungry large-capacity monitors.

In contrast, 1,000-litre intermediate bulk containers proved more effective during the post-extinguishment phase since they could be carried on forklift trucks to specific locations where the foam blanket needed to be replenished.

Some conclusions

Buncefield has to be seen as a major success. The HSE Buncefield Investigation report confirms that over 37 million litres of fuel were salvaged despite the fire burning for over 60 hours. This is almost 40% of the product that was stored on-site.

Who would have thought that in such a large explosion and fire that nobody would be killed or seriously injured? This is a real credit to the Hertfordshire Fire & Rescue Service who led the response and the other regional and industrial responders who gave their invaluable support.

[Left] Extinguish a larger fire inevitably means using much larger quantities of foam. Existing international standards assume a single tank is on fire and only take into account the extinguishing phase. [Below] Angus Fire won a major contract to supply SembCorp Utilities UK with Tridol ATF 1x3 fire fighting foam. Based on Teesside in the North of England, SembCorp provides emergency response services to one of the highest concentrations of refineries in Europe.