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RISING TO THE CHALLENGE: A MAJOR FOAM ATTACK

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Introduction

In his foreword to Hertfordshire Fire & Rescue Service's review of the fire response to the Buncefield oil depot incident, CFO Roy Wilsher noted that:

"... it presented a significant challenge for everyone involved, not only on a personal level but as a national logistical challenge never before faced by the UK fire and rescue service."

As the sometimes lengthy single and multi-agency debriefs and regulatory reports have been compiled and published, a series of recommendations have been made in an attempt to ensure that a similar incident can never happen again. However, some of those recommendations for improving the fire and rescue service's preparedness for incidents requiring a bulk foam attack involve significant capital budget allocations based on a clear and robust understanding of local risk and now, approaching five years since Buncefield, some of these improvements are still being implemented.

Worst case credible scenarios'

The final report of the Buncefield Standards Task Group (BSTG) – Safety and environmental standards for fuel storage sites – was published in 2007 and has since been superseded by the final report of the Process Safety Leadership Group (PSLG) published in December 2009. While there was a general assumption that before 2005 planning scenarios generally consisted of an incident involving the largest single tank in a given fire and rescue service's operational area, the experience of Buncefield clearly demonstrated that this is no longer a valid scenario on which to plan. Therefore, the PSLG final report makes reference to new and vastly increased 'worst case planning scenarios' in the following terms:

"... it presented a significant challenge for everyone involved, not only on a personal level but as a national logistical challenge never before faced by the UK fire and rescue service."

"Planning should consider the scenario of a multiple tank fire following an explosion." (PSLG Final Report, pp 216, para. 13)

This recommendation provides us with an interesting issue. While it can certainly be accepted that (depending on the local risk profile) planning for an individual tank fire is no longer a valid planning assumption, the new recommendation of 'multiple tank fires' provides a huge range of scale between 'more than one' and 'lots'. So where does that sliding scale come to rest? The ten-step process (see Annex 1) recommended in the Energy Institute's Model Code of Safe Practice Part 19: Fire precautions at petroleum refineries and bulk storage installation – and itself recommended as 'relevant good practice' in the PSLG's final report with which operators "... should comply fully" (PSLG, pp 217, para. 22) – takes the 'worst case credible scenario' one stage further by using the 'worst case scenario for the fire event' as the basis for contingency planning. This is a subtle but important difference as the impact it has on both local fires and rescue services and operators in terms of degrees of preparedness could be huge. In fact, the IP-19 report goes on to define the 'worst case scenario' for fuel depots as:

"... either the largest tank in a single bund, or the largest group of tanks in a single bund."

About the author

Pete Davis is Head of Risk Planning for Avon Fire & Rescue Service and has previously worked within local authorities, the NHS and ambulance service. He joined the fire and rescue service in 2004 to head up the implementation of the Civil Contingencies Act 2004 and has since developed and co-ordinated Avon's introduction of the Inter-Agency Liaison Officer (ILO) role. He is a Founding Fellow of the Institute of Civil Protection and Emergency Management.

For further details on Avon Fire & Rescue Service's use of the IP-19 ten-step process, Pete Davis may be contacted at peter.davis@avonfire.gov.uk or on 0117 926 2061.

The IP-19 'ten-step process'

The recommendations and actions in the PSLG final report (including the 'ten-step' process to determine the worst case scenarios for fire events) are aimed at the operators of sites subject to the Control of Major Accident Hazards (COMAH) Regulations 1999 (as amended) and, in particular, at all establishments storing large volumes of gasoline and other substances capable of giving rise to a large flammable gas cloud in the event of a loss of primary containment. However, it also provides an effective model against which local authority fire and rescue services (FRSs) may assess their own preparedness to address their local risk profile established through their integrated risk management planning process.

In balancing the preparedness of both operators and local authority FRSs, it is interesting to compare the different sections of relevant legislation (see Box 1). While operators have duties under the COMAH Regulations , which are effectively supplemented by the recommendations of the PSLG final report, the local fire and rescue authority has statutory duties under Section 7 of the Fire and Rescue Services Act 2004 in respect of making provision for the extinction of fire within its area. Nowhere in that Act does it exclude fires at sites falling within the remit of the COMAH Regulations (unless these are taken to fall outside the definition of 'normal circumstances'), and yet the regulations clearly place a requirement on operators to maintain safety equipment and resources – including firefighting equipment – to deal with the 'worst case credible scenario'. Indeed, step 5 of the ten-step process recommends that:

EXTRACTS FROM RELEVANT LEGISLATION

Fire and Rescue Services Act 2004 (Ch. 21)

Part 2 - Function of fire and rescue authorities - Core functions

7. Firefighting

(1) A fire and rescue authority must make provision for the purpose of:

(a) extinguishing fires in its area, and

(b) protecting life and property in the event of fires in its area ...

[Explanatory note: Section 7 re-enacts (from the Fire Services Act 1947) the existing statutory duty for a fire and rescue authority to plan and provide arrangements for fighting fires and protecting life and property from fires within its areas. A fire and rescue authority is required to secure the provision of sufficient personnel, services and equipment to deal with all normal circumstances as well as adequate training.]

Control of Major Accident Hazards Regulations 1999 (as amended)

Reg. 9(1) - On-site emergency plan

"Every operator of an establishment shall prepare an emergency plan (in these regulations referred to as an 'on-site emergency plan') which shall be adequate for securing the objectives in Part 1 of Schedule 5 and shall contain the information specified in part 2 of that schedule."

Schedule 5, part 2 - Information to be included in on-site emergency plan.

The information referred to in regulation 9(1) is as follows:

3. For foreseeable conditions or events which could be significant in bringing about a major accident, a description of the action which should be taken to control the conditions or events and to limit their consequences, including a description of the safety equipment and the resources available ...

Explanatory note: This is the principal component of the on-site emergency plan and should include:

(a) the types of foreseeable accidents to people or the environment;

(b) the intended strategy for dealing with these accidents;

(c) details of the personnel who have roles to play in the emergency response, and their responsibilities;

(d) details of the availability of function of special emergency equipment including firefighting materials, and damage control and repair teams; and

(e) details of the availability and function of other resources.

Foam attack

"Ideally operators should have the means and quantity of foam on site to cope with a fire in the largest bund immediately." (PSLG Final Report, pp 218, para. 28)

Further, Annex D of IP-19 recognises that local authority FRSs are not generally equipped to deal with fires in large fuel storage tanks and that the operators have a clear role in the provision of suitably trained and equipped industrial response teams experienced in the complexities of such incidents (see Box 2), just as they did at Buncefield.

What is clear is that the best state of preparedness comes from the pro-active partnership approach between local authority FRSs and the operators themselves when planning for potential fire scenarios. But if the recommendations of the PSLG final report are to be implemented completely this will, inevitably, cost significant amounts of money in terms of additional foam stocks, equipment and training once the increased worst case credible scenarios are realistically analysed.

EXTRACTS FROM MODEL CODE OF SAFE PRACTICE PART 19: *FIRE PRECAUTIONS AT PETROLEUM REFINERIES AND BULK STORAGE INSTALLATIONS*

Annex D: Typical application rates

(vi) Fire and rescue services response issues
Taking these factors into account, it is considered that the unofficial role of FRSs during major fire incidents is to respond and provided trained and disciplined personnel for hose deployment, water and foam monitor deployment and foam supply.

There is therefore a clear need to ensure that a competent industry response team will mobilise the major resources required and provide the guidance and expertise to FRSs to deal with the incident, if necessary.

So, for stocks of foam at industrial sites, the big question will naturally be – "How much is enough?".

In the case of Avon Fire & Rescue Service, the ten-step process has been effectively used to develop a comprehensive understanding of worst case credible scenarios in the industrial port of Avonmouth. Taking the recommendations of the PSLG report, the logistical requirements for a major foam attack on the single largest fuel storage tank in the Avonmouth area, the group of tanks in the largest single bund and a full surface fire in the largest bund have all been calculated and represent significant increases over and above the foam stocks currently maintained by both the local authority FRS and the operators themselves (see Table 1). The work has also involved detailed calculations of water flow rates and pressures to be pumped from the nearest inexhaustible supply at the Eastern Arm of Avonmouth Docks (Fig. 3). Again, this took into account the learning from the Buncefield incident and assumed that any on-site emergency water supplies may not be available following the initiating event.

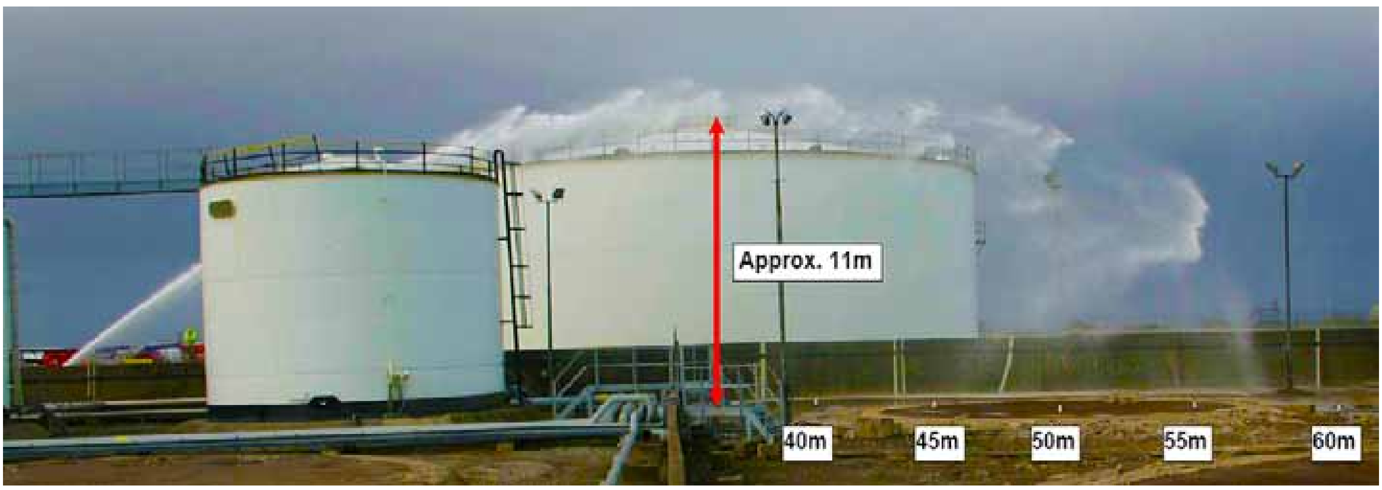
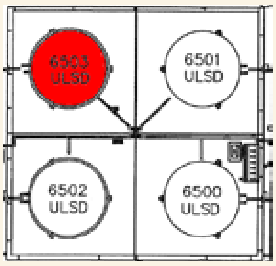
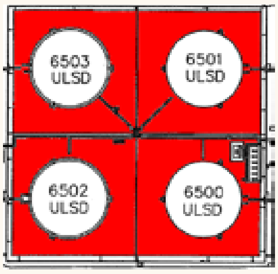


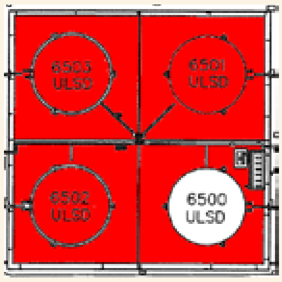
Fig. 1 - Exercise Gillette, Avonmouth Docks (14 September 2009)

Fig. 2 - Foam monitor trials during Exercise Gillette Fusion, Avonmouth Docks (15 November 2009)

> What is clear is that the best state of preparedness comes from the pro-active partnership approach







	Scenario A: Largest full-surface tank fire	Scenario B: Largest full-surface bund fire	Scenario C: Simultaneous full-surface tank fires within the largest bund
Total surface area (full-surface tank fire / bund) (m2)	855.5 / 0	0 / 6 498	2 567 / 6 498
Total quantity of foam solution required (litres)	533 832	1 559 520	3 161 016
Total amount of foam concentrate required (3% induction, litres)	19 218	56 143	113 796
Total amount of water required for foam production (litres)	514 614	1 503 377	3 047 219
Total cooling water required (litres)	3 056 573	13 754 578	13 754 578
Total water requirement (litres)	3.571 million	15.3 million	16.8 million
Water flow rate for foam attack (l/min)	8 577	25 056	50 787
Water flow rate for cooling (l/min)	12 736	57 311	57 310
Total water flow rate (l/min)	21 313	82 367	108 097
Total liquid (water + foam concentrate) required (l/min)	21 633	83 303	109 993
Angus bipod foam monitors (FC27B) @ 7 bar.g required	4	10	19

Table 1: Summary of water and foam requirements for the IP-19 'worst case scenarios for fire events' in the Avonmouth area

Foam attack

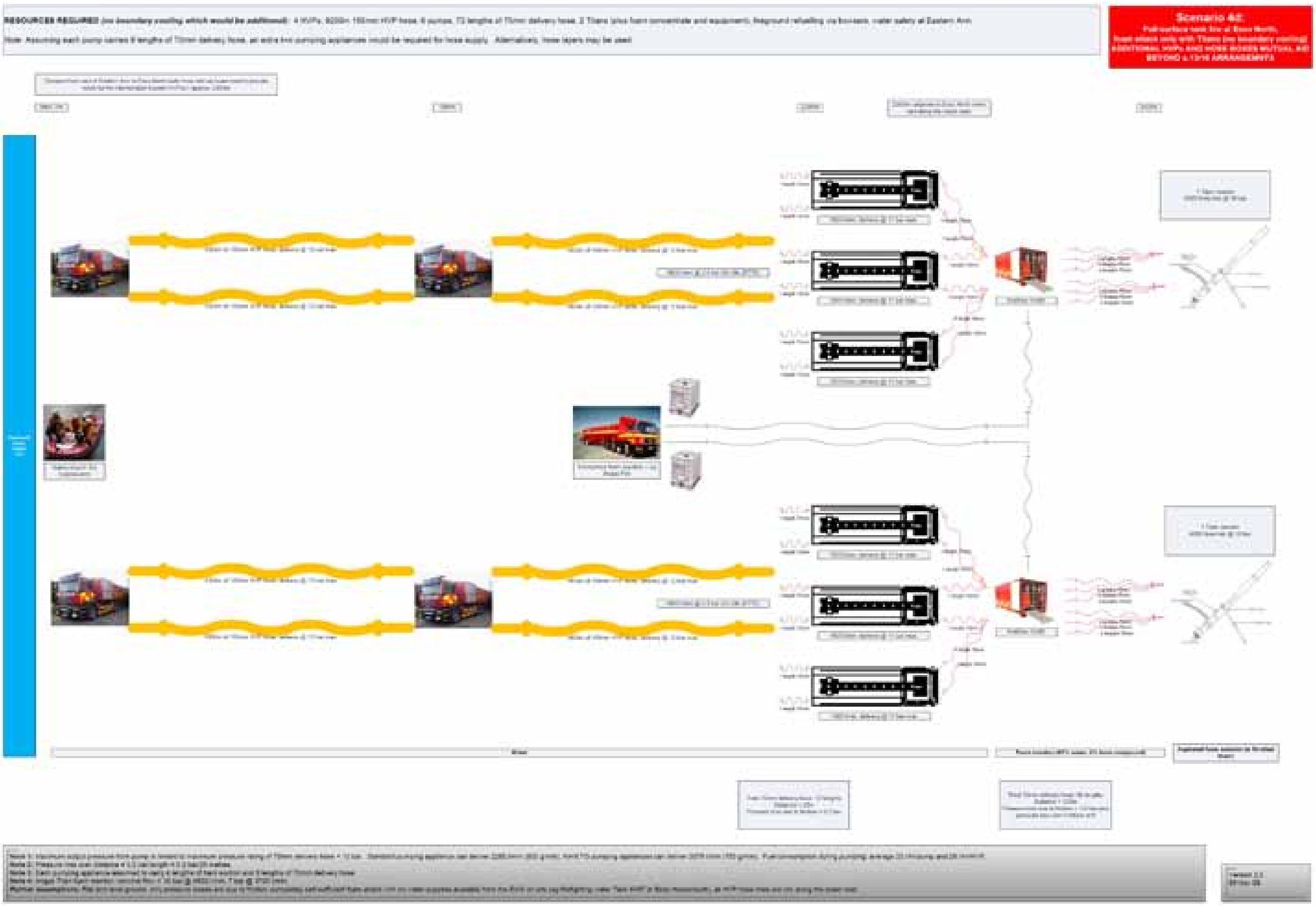


Fig. 3: Detailed planning and practical exercising has resulted in several water supply plans for 'worst case credible scenarios' in the Avonmouth area.

The work undertaken to analyse the realistic requirements for mounting a major foam attack in Avonmouth also addressed a series of practical issues including:

- assessment of fire appliance pump performance to confirm that they are capable of pumping at pressures in the region of 10 bar over at least a 65 minute fire attack time without any adverse mechanical effects (for example, overheating);
- the supply of water required to undertake the foam attack, with options developed using both National Resilience High Volume Pumps (HVPs) and standard fire service appliances (see Figs. 2 and 3);
- the effect of the use of salt water on foam production and quality ;
- the foam compound stocks required and methods for transportation and induction;
- the monitors and pressures required to achieve the necessary throw in order to project the finished foam onto the ignited surface of a fuel tank fire while ensuring that all operations are conducted at a suitable distance outside the bund wall in order to maintain firefighter safety;
- an analysis of the prevailing meteorological conditions in Avonmouth, including wind directions and strength; and
- detailed analysis of friction losses over extended HVP and conventional hose line runs to ensure that adequate pressures are provided at the monitors themselves to achieve the throws required.

During the autumn of 2009, these theoretical considerations were tested in a series of modular exercises to be able to offer corporate assurance that the plan would actually work in practice (Figs. 1 and 2).

Annex 1: 'Ten-step process' drawn from Model Code of Safe Practice Part 19: Fire precautions at petroleum refineries and bulk storage installations and recommended in safety and environmental standards for fuel storage sites - Process Safety Leadership Group final report

Step 1: Determine the worst-case scenario for the fire event. For fuel depots this is considered to be either the largest tank in a single bund, or the largest group of tanks in a single bund. If the plan adequately covers the resources for the worst-case scenario, it can be considered capable of dealing with lesser similar events, eg fires in smaller tanks etc. (EI 19 sections 2.5–2.7, section 3.2.)

Step 2: Assume a full surface tank fire and bund fire.

Step 3: Determine the radiant heat hazard ranges using appropriate consequence modelling (and including weather factors) to determine safe locations for the firefighting resources deployme nt. (EI 19 section 2.6.) This also determines the size of monitor necessary to achieve the required throw to reach the tank roof. The actual distance from the monitor to the involved tank only depends on the effective reach of the monitor used. It is important to determine the wind direction because the monitor should be placed to allow the wind to carry the foam to the fire. Changes in wind direction will have to be accommodated in the plan. Fire monitor performance is available from the manufacturer, but be aware the figures quoted will relate to best performance. Operators should base their plan on perhaps 20% reduction in performance to counter this, and then test it appropriately to prove the effectiveness.

Step 4: Determine the amount of foam concentrate and water necessary to firefight the worst case scenario. (EI 19 Annex D.)

Step 5: Assess whether the necessary foam stocks are available on site. If not, consider how quickly these stocks can be brought to the site and by whom – what arrangements have been made with the fire and rescue service, foam manufacturers and/or neighbouring sites. Ideally operators should have the means and quantity of foam on site to cope with a fire in the largest bund immediately. Operators will also need to consider how foam stocks can be transported around the site.

Step 6: Is the water supply sufficient in terms of quantity, pressure and flow rate? (EI 19 Annex D6.) The pressure required is back-calculated starting at the monitor. Most monitors require 7 to 9 bar, then add in the frictional losses from the monitor to the pumps. Operators need to remember that the system demands will not just be at the monitors; water drawn from any fixed system applications and cooling streams will also need to be considered. It is important to determine the required volumes and pressures used. Dynamic system demand testing will provide the evidence

that the system can deliver the required resources.

Step 7: If High Volume Pumps or High Pressure Pumps are necessary to achieve the required water capacities, where will these be provided from and how long will they take to arrive and be set up? The possibilities include fixed firewater pumps at the site, mobile firewater pumps purchased by the site, pre-arranged mutual aid from other nearby facilities or the fire and rescue service. All resources will need to be considered in the plan so they can be logistically arranged for relay pumping purposes. Remember to build in redundancy to cover for the nearest resources being already in use or in repair, for example.

Step 8: What means are there for delivering the required foam/water to the fire? How many and what size monitors are necessary? This is determined by the area at risk and the application rates required to secure and extinguish this risk. Remember the need for compatibility where hardware is brought from a variety of sources.

Step 9: How much and what size and pressure rating of hose is required? Where will this quantity of hose be obtained from? The size and quantity of hose required on the flow rate, pressure and distance from the water supply. The greater the flow rate, pressure or distance from the water supply, the larger the diameter and pressure rating of the hose needed.

Step 10: How will any firewater run-off be dealt with? Hose and pumps will be necessary to transfer firewater run-off from the bund to another bund or catchment area. Alternatives include purpose-built bund overflows to a remote tertiary containment system, or increasing the capacity of an existing bund. Transfer could be by pumps or via gravity flow.

Foam attack

Next steps

With the completion of the calculations which now form the basis of our contingency planning and having tested the practicalities in a series of exercises, Avon Fire & Rescue Service is now moving to the procurement stage which will see a significant uplift in the foam stocks held within the service as well as the replacement of the appliances and equipment needed to implement the revised bulk foam plan. This has involved significant market research including various foam concentrates and foam induction options and, due to the value of the contracts involved, is expected to involve a full European tendering process.

We have also liaised closely with the Health and Safety Executive (as a competent authority under the COMAH Regulations) to understand how the PSLG recommendations will translate into enforcement policy in terms of foam stocks provided and maintained by the operators themselves. This is clearly of significant interest to local authority FRSs as it may well affect how much they themselves hold. However, it would appear that the bulk of the work in response to the BSTG and PSLG recommendations has, quite rightly, so far focused on the implementation of the preventative measures and the spotlight has not yet fallen on the recommended improvements relating to incident management. That said, once a bulk foam attack is required the theoretical calculated risk of an event happening is of little consequence – as, by definition, an incident has already occurred and an effective emergency response needs to be implemented. Therefore, the foam stocks and associated foam generation equipment which the competent authorities (CAs) require operators to hold – and against which the adequacy of their on-site emergency plans will partly be assessed – will be of significant interest. For example:

- Will the CAs really insist upon individual operators having the "... quantity of foam on site to cope with a fire in the largest bund immediately" as recommended by the PSLG report?
- If not, how much will they be required to hold?
- What will acceptable mutual aid look like, in terms of both quantities and timescales? and
- How will the words "... ideally" and "... as far as is reasonably practicable" – both included in the PSLG and IP-19 reports – really affect the quantities of foam held by fuel storage sites and hence the joint ability of local authority FRSs and the operators to tackle large scale fuel storage fires in the future?

Time will tell, but given the experience of Buncefield it is certain that the UK as a whole can rightly expect an effective and efficient response to any future incidents requiring a bulk foam capability and there will be little sympathy if our planning and preparedness is found to be inadequate.

Conclusions

- Prevention is clearly better than cure – but the 'cure' has to be ready if and when it is required.
- Major foam attack plans must be based on realistic scenarios which have been thoroughly tested to ensure that they really do work in practice.
- Effective partnerships and mutual aid schemes between industry and local authority FRSs will undoubtedly continue to form a vital element of successful response capabilities.
- The CAs will need to be very clear about how the PSLG recommendations will translate into COMAH enforcement policy to ensure that both operators and FRSs understand what may be expected from onsite firefighting resources and capabilities.

Further reading

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