# BALANCED AND MEASURED

FOAM CONFERENCE – THOUGHTS AND REACTION BY TOM CORTINA (2ND FROM THE LEFT) OF THE FIRE FIGHTING FOAM COALITION.

*Over the past 12 years, a debate about fluorinated fire fighting foams has taken place in a number of venues. Most notable are the five Reebok Stadium meetings held in Bolton, UK between 2002 and 2013. Those in attendance at the most recent meeting in March saw a more balanced program compared to past meetings, and noted a higher level of understanding of the issues among participants. Gone were many of the unsubstantiated claims about the environmental impacts of AFFF agents and the efficacy of alternative products that were prevalent at previous meetings. These were replaced by more measured presentations focusing on advancements in fire fighting techniques, foam equipment, and environmental science.*

*This change was signaled with the opening presentation by conference program chair Dr Roger Klein. Dr Klein confirmed the current understanding related to the environmental acceptability and regulatory approval of AFFF agents containing short-chain (C6) telomer-based fluorosurfactants. He also set the tone for the meeting by focusing on the importance of foam performance, by noting that all foams have environmental impact, and by asking participants to avoid overreaching when making their points. In addition he focused on the need for researchers to publish their data in peer-reviewed journals.*

*One of the more unique and enlightening presentations was by Manuel Acuna of VS Focum, who summarised his company's development of a fluorine-free foam agent [to be published in the next issue]. It was unique in that it was one of the few presentations that contained side-by-side test data done at the same facility under the same conditions comparing the fire performance of AFFF agents and fluorine-free foams. The data showed that AFFF agents performed significantly better than fluorine-free foams in spray extinction tests, on large-scale pan fires, and in lab tests for fuel contamination. It was enlightening because, despite the clear differences in performance compared to AFFF agents, the fluorine-free foam in question has obtained international certifications such as EN 1568-1, EN 1568-3, and ICAO Level B. The lesson that foam users can take from this presentation is that just because two foam agents meet the same specifications, it does not mean that they will perform the same under live fire conditions.*

*After over a decade of intense focus on the environmental impact and performance of fire fighting foams, it is not surprising that foam users, manufacturers and regulators have a much better understanding of the relevant issues, and this was reflected in the conference presentations and discussion. Highlights of some of the key messages from the conference that underline these basic understandings are summarised below.*

- *Foam manufacturers are transitioning from the use of predominantly short-chain (C6) telomer-based fluorosurfactants in AFFF agents to pure C6 telomer-based fluorosurfactants in response to the United States Environmental Protection Agency (EPA) PFOA Stewardship Program (and other global agencies such as in Canada and Germany).*
- *These short-chain fluorochemicals and their potential degradation products are persistent in the environment. However, based on current data they are considered to be low in toxicity and not bioaccumulative. They are approved for use as alternatives to longer-chain fluorochemicals by EPA and other national environmental authorities.*
- *Fluorine-free foams have been developed by most foam manufacturers as alternatives to AFFF and are being used for some applications in Europe and Australia, particularly in environmentally sensitive areas. They can meet international test specifications such as EN 1568, Lastfire, and ICAO Level B, but are not currently able to provide the same level of fire suppression capability, flexibility, applicability, and scope of usage as AFFF agents.*
- *Compressed air foam systems (CAFS), a 40-year old technology, is currently being reevaluated for use in municipal and ARFF applications. The use of CAFS can increase the effectiveness of foam, in particular fluorine-free foam, although there are still some questions about the practicality of its use for certain applications.*
- *All fire fighting foams impact the environment, and as a result the fire protection industry must be committed to minimising emissions whenever possible. The use of training foams and alternative fluids/methods for system and equipment testing has significantly reduced foam discharges as compared to legacy practices.*
- *Recent enhancements in foam equipment such as sophisticated fire trucks, long-range monitors, high-volume skid pumps and hoses, ultra hydrants, and more effective personal protective equipment have increased the efficacy of fire fighting techniques and provided improved safety for firefighters.*

*I wish to take this opportunity to congratulate the sponsors and organizers of the Reebok conferences and thank the speakers at the March 2013 conference for their contribution to a better understanding of the environmental and performance issues surrounding the use of fire fighting foams.*

# INTERNATIONAL FOAM CONFERENCE

THE FIFTH INTERNATIONAL FIRE FIGHTING FOAM CONFERENCE HELD IN MARCH AT THE REEBOK STADIUM IN BOLTON (UK) SAW THE WORLD'S FOREMOST EXPERTS GATHERED TOGETHER TO DISCUSS THE MANY ISSUES THAT REVOLVE AROUND THE EXTINGUISHING MEDIA OF CHOICE FOR LIFE/DEATH SITUATIONS IN HIGH-RISK ENVIRONMENTS – FOAM. IN THIS TWO-PART SERIES *INDUSTRIAL FIRE JOURNAL* BRINGS YOU SOME OF THE HIGHLIGHTS OF THE CONFERENCE.


Dr Roger Klein, Cambridge. Top: colourful snapshot of foam concentrate manufacturer Bio-Ex's exhibits at the conference.

## Foam – what issues? Dr Roger Klein, Cambridge, UK

Roger Klein started by outlining the position that industry had reached 13 years after the decision by 3M to pull out of the field PFOS containing products in May 2000. 'We have a heightened environmental sensitivity at all levels whether manufacturer, end user, regulator or fire and rescue service. We now have US EPA C6-complaint fluorotelomer AFFFs, which have substantially solved the problems of bioaccumulation and toxicity of PFOA and its longer homologues. And I think this has to be accepted. Environmental persistence is a problem, however, that still remains. We also have fluorine-free foams with relevant class B approvals including AR.'

The issues that still remain are independent protocol-compliant testing based on operation performance; how to define what is meant by 'green'; and the BOD and COD problem – biological oxygen debt/chemical oxygen demand. These problems still remain for all foams.

On BOD and COD Dr Klein pointed out that it is impossible to achieve a rapid degradation of foam in the environment (as required by regulators) and still retain a low BOD.

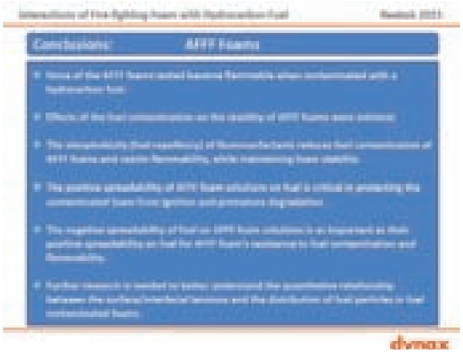
He then made the point that many people will say that the fluorochemical content in AFFF-type foam is extremely low – which it is, until it is translated into the percentage of total organic material present, giving typically 10%-30% of the total organic material as fluorochemical.

Another issue that Dr Klein outlined regarded the spreading coefficient, or the 'interplay' between the surface tensions of the fuel-air, foam/air and foam/fuel interfaces. In essence, certain fuels have such low surface tensions that they result in a negative spreading coefficient, meaning that AFFF is no longer able to film-form. This is the case with 'light tops', light naphtha, hexane fraction, and wet gas condensate containing isomeric pentanes. In addition, winter-grade gasoline contains butane, which lowers the tension below the 'magic level' resulting again in a negative spreading coefficient: 'And test fuel n-heptane is very close to zero spreading coefficient.'

Equally concerning is that by raising the temperature of even a heavy hydrocarbon results in a lowering of the surface tension, which is why emergency responders have to cool a fuel before achieving film formation.

Roger Klein finished his presentation with an appeal against excesses in sales and marketing which damages end-user credibility for the foam industry. 'Emotive hyperbole where you claim competitors' products endanger human life; overstating a case that would otherwise be reasonable by saying, for example, that a product has high toxicity when actually it doesn't – it may have slightly higher toxicity than other products but doesn't count as highly toxic. Arguing from material that is not available in the public domain or readily available is scientifically unacceptable.

'There is no foam with zero effect on the environment so you shouldn't claim there is. All fire fighting foams whether AFFF-type or fluorine-free have an undesirable effect in the environment to a greater or lesser extent. Please avoid these excesses, the overall credibility of your industry is at stake. End users are not stupid.'




## Interactions of fire fighting foam with hydrocarbon fuel; Dr Chang Jho, Dynax Corporation, New York, USA

Interactions between foam and hydrocarbon fuel are not well understood but it is important to understand the process – not only to understand how a foam performs but also to design a better foam for the future.

Fuel contamination is a serious issue particularly under direct or forceful applications, as specified on major international foam standards such as UL-162, US Mil-spec, ICAO A/B/C and EN 1568. Fuel contamination can cause premature breakdown of the foam blanket, flicker fires and flashovers that lead to poor extinguishment and burnback.

Dr Jho outlined two laboratory experiments carried out to simulate fuel contamination; one was a flammability test of fuel-contaminated foam, and the other, stability of fuel contaminated foam. Five fluorine-free foams (F3) and four AFFFs were tested with iso-octane, gasoline, n-heptane, cyclohexane, and Jet A1.

The results of the foam flammability test revealed that all the fluorine-free foams when contaminated with a fuel ignited and burned away, in contrast with the fluorine-containing AFFF foams, which did not. As for foam stability, none of the fluorine-containing foams broke down in the 30 minutes of the test, as opposed to the fluorine-free foams, which all degraded rapidly, especially with gasoline.

To investigate why this was the case Dr Jho looked at spreading and sealability of foam solution over fuel, as well as the spreadability of fuel over foam. All fluorine-containing foams spread and sealed over the fuel as expected, but none of the fluorine-free foams spread over the fuel. Reversing the experiment, none of the fuels could spread on the fluorine-containing foams but all fuels could – to different degrees – spread over the fluorine-free foams.

This dramatic difference was ascribed to the type of surfactant used in fire fighting foams. Hydrocarbon surfactants used as foaming agents have one thing in common – they have oleophilic properties and so attract oil and hydrocarbon fuel. However, the introduction of fluorine atoms into the hydrocarbon chain results in a dramatic change: the oleophilic hydrocarbon chain turns into an oleophobic chain – it no longer attracts but repels fuel. Fluorosurfactants used in AFFF agents are therefore fundamentally oleophobic and repel hydrocarbon fuel.

Looking at a representation of a foam bubble, the effect is that the surface of the fluorine-containing foam bubble becomes oleophobic toward hydrocarbon fuels like heptane, while a fluorine-free foam bubble containing only hydrocarbon surfactants attracts the fuel. 'So the message is that hydrocarbon surfactants attract hydrocarbon fuels, and fluorosurfactants repel them.'

The oil-loving properties of fluorine-free, hydrocarbon surfactant are the fundamental issue that limits the effectiveness of F3 foams and what can be achieved in terms of improving fluorine-free foams, highlighted Dr Jho. 'As long as you use hydrocarbon surfactants as the foaming agent you cannot avoid this fundamental issue.'

Dr Jho concluded by promising that further research would continue on this area, and played a video (http://www.youtube.com/watch?v=IuKRU-HudSU) showing the typical flammability difference between a fuel-contaminated fluorine-free foam and a fuel-contaminated AFFF foam. The fluorine-free foam retained the red colour of the fuel indicating even distribution of the fuel in the foam, in contrast with the AFFF foam which didn't because of the rapid separation of the coloured fuel out of the foam. A flammability test then reinforced the results already presented by Dr Jho.


## Commercialisation of AFFF containing C6 fluorosurfactant: Steve Hansen, Solberg Foams, USA

After a summary of the history behind C6 chemistry Mr Hansen started describing some of the issues Solberg had associated with this type of chemistry during recent tests.

Solberg adopted UL-162 test method to compare C8-containing chemistries (AFFF) with similar formulation where the C8 chemistry had been replaced with C6.

The test used a 5.6m$^2$ tray, 7.5 l/m for 3 minutes, 1 minute preburn, and 9-minute period after extinguishment before burnback resistance test.

'The C8 chemistry was very capable of achieving the desired results time and again. If you take the same base of formulation and use an equivalent loading of fluorine with C6 chemistry, the results became different.'

While control times were possible with C6, extinguishment at 3 minutes did not occur and the tests resulted in failure. 'In order to get to the point where we needed to be, we started looking at bumping up the fluorine level. That was the wild card in everything, and rather than introduce lots of variables into the product, this controlled fluorine addition was used to get us to where we wanted to be.'

The more fluorine that was added to the product the more the results changed. In all instances the control time or the initial spreading over the fuel surface was consistent, and extinguishing time began to improve. 'But the criteria of 9-minute waiting period after application of the foam became a concern, because that is when the foam would begin to break down, revealing openings at the fuel surface.'

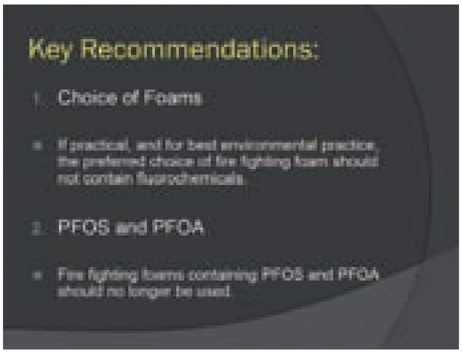
This led Solberg to carry on its research at the laboratory, looking at the surface tension and the fuel foam interface. This work revealed that surface tension phenomena between C6 and C8 chemistry are significantly different, and that there was a definite correlation between fluorine levels and


The Reebok Stadium in Bolton provided a dramatic backdrop for the Foam Conference.

performance. 'You can formulate a lesser performing product – which really isn't an option – or increase the volume of surfactant. But increasing the fluorosurfactant increases the amount of fluorine in the product.

'It is our estimation that regardless of what you do in reformulating C6 product it is a significant change to that product, and any agency that approves those products should look at that and determine whether there is a need to re-list or re-test those products.'

The alternative answer that is being promoted by Solberg is to move to the fluorine-free foam realm, where the same standards and listings are being achieved. 'There are alternatives to film-forming technologies that perform in topside applications on an equal basis. Drain times have been improved; they are free flowing over the fuel surface; heat absorption is terrific; they are organohalogen free, UL approved, with FM pending, and don't compromise on performance for firefighters.'




## Fire fighting foam – environmental impact and acceptance: Dr Jimmy Seow, Department of Environment and Conservation, Western Australia

Dr Seow introduced a paper he had put together for the Department of Environment and Conservation of Western Australia: 'Fire Fighting Foams with Perfluorochemicals – Environmental Review'.

This position paper (available for download on www.hemmingfire.com) discusses the current issues regarding the use of fire fighting foams containing perfluorochemicals and of fluorine-free foams now commercially available on the market.

The paper's aim is to highlight and discuss:

- Environmental and human health issues associated with the use of perfluorochemicals in fire fighting foams;
- Current legislation and policy in Australia and overseas (namely the US, UK, Norway, Germany and the EU) pertaining to the use of perfluorochemicals in fire fighting foams;
- Environmental acceptance criteria for the use of fire fighting foams;
- Recommendations for the use of fire fighting foams containing fluorochemicals and fluorine-free foams in Western Australia for the Department of Environment and Conservation to consider or adopt as its policy.

The comprehensive paper is the culmination of collaboration with regulators (eg EPA in the USA, ICAO), manufacturers, and related organisations (eg Fire Fighting Foam Coalition) throughout the world. 'This review was consolidated and the recommendations enclosed go beyond those of the Government of Western Australia. It was officially released to the Norwegian Department for the Environment, the equivalent in Germany and UK, all regulators in Australia, as well as major fire fighting agencies. So far there has been no adverse response from anybody, although I had to draw the line at December 1st 2012 for rewrites, as we were still getting new information in about the environment and foam.'

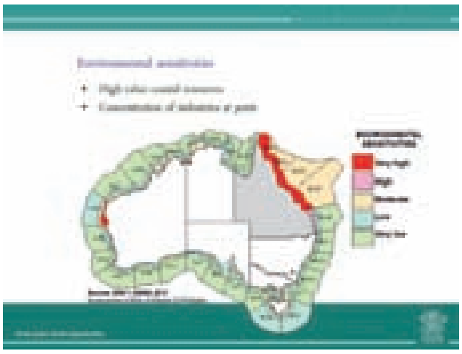
The paper's position does not give user guidance on the choice of fluorine or non-fluorine free foam nor the performance of foams: 'Rather it's a question of whether your foam is environmentally acceptable based on sound scientific principles. Which means if you come to my department and say, "can I use this foam?" I'm going to ask you what is the toxicity data, bioaccumulation, persistence and BOD. And I need data that is defensible and from independent research organisations.'

The Department of the Environment does not approve the use of foam, but it can provide information on how environmentally acceptable it is in terms of discharge, confinement and containment. 'So don't come to us and say can I have a piece of paper to say the foam is approved – we don't have the regulatory power to do that.'

However, a precautionary principle is at play and fluorochemical foams used in anger will have to be confined, contained and disposed of. A similar approach would be taken with fluorine-free foams with high BOD levels.

Concluding, Dr Seow said that his department would soon be adopting the nine key recommendations in his paper.

To download the paper visit: www.hemmingfire.com/news/fullstory.php/aid/1713/Fire_Fighting_Foams_with_Perfluorochemicals__96_Environmental_Review,_by_Dr_Jimmy_Seow,_Manager,_Pollution_Response_Unit,_Department_of_Environment_and_Conservation_Western_Australia.html.



## The future of foams in Queensland – moving towards the inevitable: Nigel Holmes, Queensland Department of Environment and Heritage Protection, Rockhampton, Australia

Queensland's environmentally sensitive areas are concentrated along its 7,000km of coastline, this includes high value wetlands, seagrass beds, mangrove forests, river estuaries, rocky reefs and coral reefs, all readily impacted by water pollution. Of particular ecological and economic importance along the northern coast is the Great Barrier Reef World Heritage Area, with its enormous diversity of habitats and species.

Sharing the coast with the range of environmentally sensitive areas are highly urbanised areas, major ports and industrial cities that have many AFFF and other foam users including airports, large tank fuel storage facilities, bulk stockpiles, port wharfs and tugs. These facilities are inevitably located on or adjacent to environmentally sensitive wetlands and waterways with the potential for discharge of contaminants directly to the aquatic environment.

Historically such swamp and port areas were not highly valued environmentally and industrial development has proceeded with little thought about containing discharges of pollutants. With growing recognition of the importance of environmental values, plus a new awareness of the impacts of some pollutants, we are now faced with the problem of needing to changing practices and put into place the necessary environmental protections to ensure long-term sustainability.

Of particular concern is the use of fire fighting foams that have the potential to cause acute, short-term harm as well as some that contain highly persistent chemicals responsible for chronic, long-term impacts. The risks of impacts by foam are not just from the infrequent large-scale incidents such as terminal fires but also the smaller ongoing releases from training activities, accidents, testing and equipment servicing.

A case in point are airports where there are rarely ever any significant fire incidents but where there have already been very significant contamination of soils, groundwater and waterways by foam training and testing releases to sensitive wetlands that were previously regarded as low value swamps.

Other chronic small-scale but regular discharges of fluorinated organic compounds have recently been identified through investigation of other release sources such as maintenance of hand-held fire extinguishers and mining vehicles. These releases are directly to ground or to sewer and end up in soils, sludge and waterways. In the case of the mining sector in Queensland it has come to light that large mine vehicles contain AFFF fixed systems that are annually tested, and 'their best practice is to dump the foam onto the ground wherever the vehicle is.'

Similarly, investigations into spills have revealed incidences of PFOS and PFOA in sewage treatment plant sludges and discharges. 'So the realisation has dawned that fire extinguisher recharge companies servicing small premises and warehouses are not taking extinguishers away for testing and refilling – otherwise companies would be unprotected – and normal procedure is to dump the foam solution to sewer, refill the extinguisher and hang it back on the wall.'

As for the problems faced by responders and regulators, a significant issue is the inadequacy of most safety data sheets and their variability in information quality about composition and environmental impacts. 'We need to know what is in the foam so we can work out the action plan for containment and treatment of the firewater. The most frustrating safety data sheets say in the ecological and waste disposal section, ''see the local EPA.'' Great, we are looking for guidance in the safety data sheet, and it is referring us back to ourselves.'

The primary environmental concerns for releases of fire fighting foams are the biochemical oxygen demand (BOD), acute toxicity of the detergents and components with long term persistence. 'In terms of BOD, there is a lack of appreciation by responders that BOD is one of the biggest problems because it can decimate a waterway by the simple depletion of oxygen from the water as the foam decays, especially in enclosed water bodies. A milk tanker rolling over would have the same effect as foam.'

Mr Holmes went into some detail about the effect on the naturally low oxygen concentrations in most waterways and how relatively small downward shifts from degrading foam can have serious impacts on aquatic life. 'BOD typically progresses over 28 days with 90% depletion occurring in the first 10 days, as aerobic bacteria degrade the organic components, in the process using up the dissolved oxygen in the water to the detriment of the other life present.'

Even once the BOD degradation process has concluded, re-oxygenation of water is another consideration and it will also take some time for normal populations to re-establish an area.

Dilution, he emphasised, was not a 'solution to pollution' as it is in some cases, as no matter how much water is thrown at a foam incident the BOD levels will still impact on the naturally low dissolved oxygen concentrations.

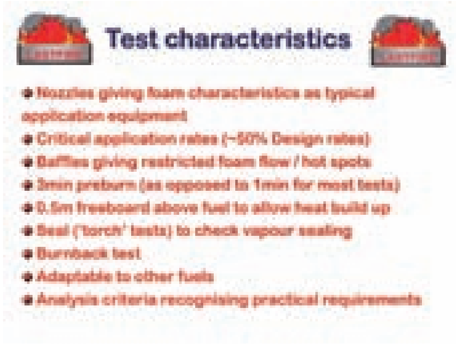
Moving onto regulatory issues dealing with risk management and the impacts of foams from persistence, bioaccumulation and toxicity, Mr Holmes said no further

specific legislation was needed to deal with foams. In Queensland anyone carrying out an activity that could have an impact on the environment is bound by the General Environmental Duty as explained under the Environmental Protection Act, in particular its duty to prevent foreseeable harm. 'At a recent incident someone suggested a release of foam was not foreseeable. You have to debate that because if it was not foreseeable, why did someone have the foresight to stockpile the foam in the first place?'

The EP Act also requires that all reasonable and practical measures to prevent environmental harm are in place. 'So it's not a question of having fluorinated or unfluorinated foams, but it's a question of being able to contain them and dispose of them appropriately. That is a matter for industry to consider carefully in their choices of foam, containment and contingency plans, particularly considering that the polluter is obliged to pay for the clean up'.

As for response expectations, biodegradable fluorine-free foams are clearly easier to deal with from an environmental perspective as remedial actions are relatively simple in terms of containment, managing the BOD, and then disposal by discharge or irrigation to land. 'Fluorinated foams are a different issue. You do need to fully contain firewater, it is very expensive to dispose of, and contaminated soil and groundwater remediation will be problematic as well.'

Looking at the broader environmental picture, Mr Holmes pointed out that if (when) there is a release, it is far better to have a large, but short-term fish-kill ('the fish will likely bounce back next year') than to have something, although of lower initial impact, that persists almost indefinitely with no chance of practical remediation and mounting evidence that the impacts will be very significant.




## Foam testing – getting it right: Dr Niall Ramsden, Resource Protection International, UK

Dr Ramsden focussed on batch testing of foam. Having worked with several foam manufacturers in previous job roles, Dr Ramsden said he knew 'all the tricks of the trade' and all the pressures that foam manufacturers were under to reduce costs of their formulations. 'We live in a world where price becomes very important, especially if the end user has not developed a performance-based specification, and manufacturers are also under increasing pressure to change the environmental aspects of foam – so formulations have changed. And that is where mistakes can happen or formulations change and are still marketed under the same trade name – and hence why it is important to batch test.'

Batch testing has to be part of a procurement process involving 'decent' quantities of foam: 'If you buy a 25-litre drum and batch test it test cost will be prohibitive

Batch testing is a quality process and retesting the actual foam every three years will tell you whether it would still actually extinguish a fire. 'If you've noticed the physical properties changing you may want to know if it will still actually do the job it is intended to do – put out a fire efficiently and effectively! We saved one of the offshore operators a lot of money by having this requirement to continually check, retain samples and site sample foam concentrate. It was found that site concentrate was degrading but without retained samples we wouldn't have been able to prove that it was something in the formulation that was wrong rather than the storage conditions.'

Thought has to go into the type of fire test to be used for batch acceptance, and it has to be relevant to the applications. 'Any fool can do a test applying foam at ten times the application rate – and strangely enough it works. You have to do it at a critical rate to prove there are appropriate safety factors to allow for real life issues. In an ideal world you should be applying foam with a big safety factor over the critical minimum application arte anyway.'

The application technique used in the fire test has to be relevant too (eg relatively gentle application in fixed systems, forceful application for monitors). 'There are other factors and the three important parameters – extinguishing time, vapour suppression and burnback – all vary according to the application.'

Fire tests have to be reproducible, and hence the right fuel has to be specified (gasoline formulation changes from place to place and season to season).

Dr Ramsden then provided a number of examples of different tests for different applications, including aviation fire fighting (where knock down is the vital parameter – not the absolute final extinguishment) and tank fires with fixed systems (where the important factor is putting out the fire completely and keeping it out).

The LASTFIRE programme was initiated a number of years ago in order to identify performance specifications for tank fires. 'We have tried to produce a critical relevant fire test with nozzles that give foam characteristics appropriate to the application techniques you are going to use. So we use a monitor nozzle and the application technique is the same – plunging straight into the fuel. It is critical that application rates are around half of what would normally be used at design stage so that there is a safety factor in real situations. And we have baffles to obstruct the foam and to ensure it will flow around distorted tank shells. And we give it a long preburn of three minutes as opposed to most fire tests which give it one minute.'

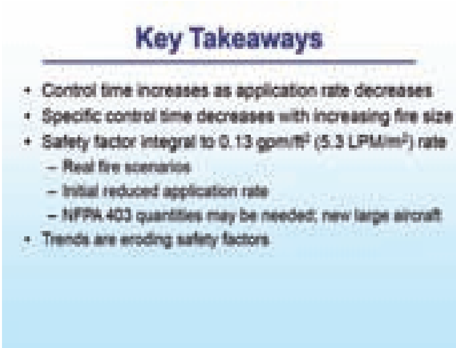
On acceptance criteria, Dr Ramsden emphasised that there is no overall standard pass or fail result under LASTFIRE: just a rating on how good the foam is under different categories. 'You might decide on environmental or cost reasons that you might choose slightly lower quality foam but apply a higher application rate – it's up to you.'

A number of caveats were then outlined in the context of carrying out these types of tests. Ambient conditions are always a bit of a problem, and using small nozzles can make massive differences to an end result if they are blocked by debris in the feed line. 'And then there is the interpretation of results. It is not always a straight pass or fail and you might need to interpret the result to make sure it is relevant to the real application. If the foam failed due to small flickers at the test pan edges – well, maybe that is something you can live with. Ultimately it's about performance that meets your needs.'

Mistakes do happen at formulation stage and therefore Dr Ramsden's message was that generic testing does not necessarily show the exact performance you will get with every batch. 'What you should be doing as part of your procurement management process is demanding the same test for each batch that you receive, and either witness it or have it witnessed it by somebody else.'

His last comment was a stark warning: 'Don't believe everything you hear from manufacturers. I know most manufacturers are reliable and reputable, but some aren't. Make sure you test your foam with a test that suits your applications.'

Warm welcome at reception: organisers Kevan Whitehead and daughter Rebecca Whitehead.




## Fire testing of fluorine-free foams using the Mil-spec: Joe Scheffey, Hughes Associates, USA

Due to the impossibility of getting small quantities of non-ethanol juiced gasoline on the east coast of the USA at this time of year, Mr Scheffey had to postpone his original plan of small scale testing and data collection for his presentation. 'So I thought it would be useful to go back and take a look at where all these requirements came from, and their basis, in relation to ARFF.'

Mr Scheffey's review of the performance requirements for ARFF began with historical data from ICAO rescue and fire fighting panels in the late 60s and early 70s, as can be seen in NFPA 403's Annex.

Many of those conclusions and data relied on large scale fire tests carried out by George B Geyer for the Federal Aviation Administration and US Air Force. 'This was during the evolution of AFFF as a fire fighting agent and the development of Mil-spec for AFFF.

In 1994 Hughes Associates were asked by the FAA to recommend criteria for foam performance and subsequently it was recommended that FAA adopt the Mil-spec for the lowest application rate.

The subject was revisited recently for the FAA in regard to composite aircraft (eg Boeing 787) and the implications of larger aircraft with greater fuel loads.

The basis for current performance criteria is a formula that says vehicle response time plus extinguishing time has to be less than burn-through time of the fuselage. 'We assume an intact fuselage and of course that doesn't always happen.'

Tom Lindemann, a past member of the NFPA 403 Technical Committee wrote in the 1980s that aluminium will melt in about a minute, and that thermal insulation (not necessarily fire insulation) will provide another minute or two, and then the windows will melt out – at which point almost instantaneously there will be untenable conditions in the aircraft. 'And that's where the three minutes come from. We generally accept that we want to control – if not totally extinguish – the fire in 60 seconds, so that gives us the response time of two minutes.'

In Mr Scheffey's 1994 report he went through all fire test data including Geyer's, which concluded that with 0.04 to 0.0.6 gallons per minute per square foot, a static pool fire could be put out. 'But the recommended rate for regulatory purposes was about three times that amount, recognising that a safety factor was necessary for situations on rough terrain away from the terminal.'

The safety factor is necessary for factors such as proportioning equipment problems, overuse of foam, three dimensional fires, wind effects, air aspirated patterns etc.

After presenting a summary of data of various application rates derived from a number of standardised tests, Mr Scheffey approached the question of how well small scale tests 'scaled' to large results. Using data from the FAA and a technique that looked at specific control time, he showed how specific control time increased as the test fire area decreased ie it's harder to put out the small scale fires than the large scale fires. 'Which is good – you want a small-scale fire that's easier to use and less expensive to be as challenging or more challenging than a large scale one. Again, factor of safety.'

Why such a margin of safety is necessary was then illustrated by two examples of tests carried out at with different substrates (water, gravel, sand, grass) at low application rates. 'And you can see they had at least 30% increase in required application rate for gravel and rock substrate, and sometimes much more.'

The NFPA specifies for a Cat 8 airport 7,780 gallons of agent. 'Assume that there are three vehicles – and NFPA 403 allows sequencing of arrival – the first vehicle has to arrive within two minutes. To get critical application rate the next one has to arrive 30 seconds later, so with NFPA requirements we have a delay in achieving the 0.13 desired application rate of at least 30 seconds. And it gets worse, because the FAA requires much less agent than NFPA 403 and it would take an extra minute to reach the desired rate of 0.13 gallons per minute application rate. That is why we need factors of safety.'

Mr Scheffey then presented modelling work carried out to find out how much agent would be needed to prevent ignition of the interior of an aircraft and allow people to escape, where fuel spill quantity as a result of a crash was unlimited. 'Using a Cat 9 example, it would be up to 9,000 gallons in a downwind situation – otherwise in the 7,000 gallons range.'

Turning to trends in the industry, the US Navy is looking to change its fuel to less expensive commercial heptane – but a more worrying trend is a proposed change to NFPA 403, the 'gold standard' of ARFF protection, which is moving from a two-minute response time to three minutes. 'This is unbelievable. I don't understand why the fire service hasn't picked up on this.

'I question that because there is no technical basis for it.

'We had a look at composites and luckily if the composites are intact, say in a 787, the surface flammability is not terrible so the agents that you have are probably OK. But as our Air Force friends have found out, a crash scenario with composites can be a challenge, so that is the next thing that the FAA needs to look at.

'If foam standards are revised to allow the small scale extinguishment densities to be directly applied to airport conditions, previously established safety factors will be diminished. My sense of the trends is that safety factors are being eroded, and the technical basis is unclear.'

*Part II of the conference review will be published in September.*


Exhibitors Caroline Blanchon and Olivier Houlbert of Leader-owned Bio-Ex.