Different perspectives: foam usage

The impact of the use of AFFF and AR-AFFF foam as an extinguishing agent worldwide cannot be underemphasised – but how do different countries approach its usage, and do viewpoints vary from country to country? Is the global community of firefighters singing from the same hymn sheet?

F&R contacted experts from four countries: Australia, Belgium, Sweden and the US, and asked them to write about the type of foam predominantly used to combat class B fires – e.g. AFFFs, "eco-friendly" foams etc. We asked them whether there was legislation in place on the use of PFC foams; whether firefighters had easily available resources to make informed decisions on aspects such as environmental impact and performance; and if more could be done to educate the firefighting community. Here are the results.

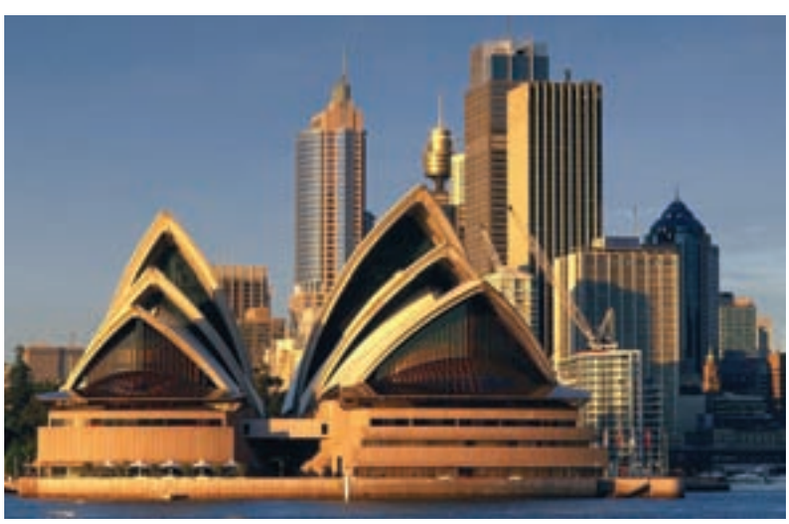
TED SCHAEFER, SOLBERG ASIA PACIFIC P/L, AUSTRALIA

Historically Australia's vast majority of industry, fire brigades and airports have been using AFFF for nearly 30 years, while the refineries have been using fluoroprotein foam.

Since 2000 however things have changed due to a heightened awareness of the implications associated with all fluorinated foams. The Australian Government, through the NICNAS department (New Industrial Chemical Notification Assessment Scheme) has been monitoring global and local situations, observing the activities of relevant Environmental Protection Authorities through regular meetings. (More information on the recommendations of NICNAS are found on the web site www.nicnas.gov.au/publications/NICNAS_Alerts. Australian Environmental Policy on organofluorides will eventuate from NICNAS recommendations.)

Australia's fire brigades have been using AFFF for nearly 30 years.

Currently PFOS, PFAS, PFOA PFCA, telomer and fluorinated materials usage is being surveyed and monitored by NICNAS. All these are recognised as being environmentally persistent, with some having a predicted chemical half-life of in excess of 10,000 years.



In the application of firefighting nevertheless, all of the above are allowed for use in fire emergencies.

NICNAS however recommends finding alternatives that do not degrade to PFOS, PFOA, PFAS or PFCA – which means a PFC of any chain length. Unfortunately over the past seven years the majority of fire authorities have been in a state of confusion as a result of the relevant chemistry, chemical terms, and the contradictory statements being made. Now fire brigade scientific officers have a good grasp on the issues and this has influenced the direction of some brigades. It should be noted that Australian fire brigades are well organised and thoroughly networked through AFAC (Australasia Fire Authorities Council) for the sharing of information – and they also enjoy NICNAS's support and advice.

Today, the majority of State and Federal fire brigades are still using AFFF, AFFF/AR or FFFP/AR fluorochemical-based firefighting foam concentrates. But there is now a significant and growing group of State and Federal fire brigades that are moving to high performance synthetic foam concentrates that contain no fluorochemicals, therefore avoiding the issue of environmental persistence.

It is the issue of persistence that most worries firefighting organisations, because there is the potential to leave a permanent chemical footprint which could have future implications on site remediation and post incident clean up.

A discussion point concerns the knowledge base on perfluorocarbon materials other than PFOS and PFOA, as the relevant materials are either incomplete or not in the public domain. At times it is as if Australia has been left out of the debate due to distance, and as a result have had to rely on publications from fire industry journals.

Australia has been forced to observe the debates from North America and Europe to gain meaningful insight on the situation. In the last two years certain key individuals have come to seminars and conferences in Australia, and now Australian fire brigade management has started to actually grasp the implications and issues surrounding perfluorinated chemicals.

The "stand out" is persistence and stability. Fire training grounds are regularly used to keep firefighters at their peak performance in some organizations, but how should they treat the effluent? Australia lacks the equipment to destroy any PFC in a cost-effective way, and exporting waste for destruction is not an option under Australian law.

What is important is for participation in the continuing forums on firefighting foam chemistry, while sharing peer reviewed scientific papers that assist in filling information gaps on environmental studies and impact. The scientific community needs to assist in the interpretation of the results and what it means to the public. Ultimately, I believe that Australia will follow UK/European-style legislation in that Organohalides will come under great pressure, with fluorochemicals eventually being eliminated from use.

LUC JACOBS, SOLBERG SCANDINAVIA, BELGIUM

Belgium is a typical AFFF (Aqueous Film Forming Foams) market in a similar way to Netherlands and Germany. As a country, it quickly understood the wide range of benefits of AFFF (and later AFFF/AR – alcohol resistant) and thus started to move away from protein foams.

Even when protein manufacturers introduced the famous (today infamous) fluorosurfactants to improve the proteins to FP (fluoroprotein) and FFFP (film forming fluoroprotein) types, the Belgium market seemed to be sold on AFFFs. This was possibly helped by 3M, which had a manufacturing side in Antwerp that was producing "Light Water" foams. Even today, many firefighters still believe that Light Water AFFF is the best in the world.

The PFOS (perfluorooctane sulfonate) molecule that 3M announced it would be phasing out of the foam business (16 May 2000) due to environmental reasons, had vastly enhanced the super performing qualities of AFFF.

PFOS-containing foam concentrates can't be used in Belgium after June 2011 (as per EU Directive 2006/122/ECOF). Currently there are no intentions to restrict foams containing PFCs (except PFOS).

AFFFs developed further to 3X6 ATC (alcohol-type content), and from there to what I consider the best foam in the world, 3X3 AFFF-ATC.

When 3M left the market, the cost price of fluorochemicals increased and foam concentrate quality arguably went down to "just meeting the EN standard". In the meantime PFC-free (Perfluorinated compounds) foams made an appearance in the market.

At first, some people claimed (those who didn't have them) that PFC-free foams were of lesser quality. Today, these PFC-free product have improved and pass the EN 1568 requirements – some of them even pass the LASTFIRE test. It is worth pointing

Q&A...

Should municipal fire brigades use class A foam for urban operations?

Thierry Bluteau, MD of foam innovating company BIO EX and Doctor in Organic Chemistry, addresses the question in the context of BIO FOR foam.

The major percentage of working alarms that fire brigades respond to are class A fueled fires, and from that standpoint, methodologies that increase fire suppression capabilities on them should be closely investigated. Brushfires and forest fires account for only a small percentage of the total Class A fires fire brigades encounter.

Our top quality foam BIO FOR meets and even exceeds the technical requirement for class A foams, as a multi-expansion foam and a class-B approved foam concentrate.

Although BIO FOR was originally developed for forestry firefighting in the 1990s, practical experience and testing has shown that it can be a valuable tool to combat other class A type fuels. Foam application equipment development has reduced the logistical requirements burdened on the pump operator to efficiently supply class A additive on the fire ground. This has made the technology feasible for urban fire operations.

Using BIO FOR correctly can provide a tool to increase the effectiveness of the application of water on these hazards. The benefits of adopting BIO FOR may include increased firefighter safety, increased fire operation efficiency, and reduced properly damage.

In most scenarios, using water more efficiently will mean reduced flame knockdown and total extinguishment times, and as a prime effect, firefighter stress from exposure to heat and toxic products of combustion will be lessened. Rural departments that rely on intensive water supplies, high labour and equipment could extend the capability of their water shuttle operations. Because of faster fire control, less total water may be needed for extinguishment when using BIO FOR. This can help reduce total fire and water damage, and thus the environmental and financial impact of fire on the community.

BIO FOR solution can be aspirated by application through a fog or air aspirating nozzle, or a Compressed Air Foam System (CAFS).

From a cost standpoint, BIO FOR additive is generally proportioned at 0.1% to 0.5% when used for direct attack. This is only a fraction of the proportioning ratio typically used with class-B flammable liquid foams (usually 3% and 6%). This low proportioning ratio and its ability to make water a more effective firefighting agent makes usage cost effective.

Many brigades have already made a cost benefit analysis on class A additive technology as regards implementation and operation. For them, the answer is loud and clear when it comes to daily firefighting.

out that a lot of lower quality AFFF-AR and Fluoroprotein-based products are not able to pass the LASTFIRE test.

This confusing situation is probably the reason why a lot of brigades in Belgium have large quantities of Light Water in stock. Are they waiting for the 3X3 to be PFC-free? Or are they not satisfied with today's poorer performance of "Light Water", AFFF alternatives? Officially, in Belgium, PFOS-containing foam concentrates can't be used after June 2011 (as per EU Directive 2006/122/ECOF).

Currently in Belgium, there are no intentions to restrict foams containing PFCs – except the PFOS type.

The question to be asked regarding PFOS, is it that much worse than other PFC-based surfactants? New developments have confused the issue.

One of them is the voluntary PFOA phase-out program* (precipitated by the US Environmental Protection Agency) being undertaken by most of the telomer fluorosurfactant producers. It aims to reduce PFOA by-product presence and/or potential degradation of products into PFOA. The newer type of telomer-based (PFC) surfactants should consequently have much lower PFOA by-product and no potential to biodegrade towards PFOA.

However, current testing of the new telomer-based, PFOA-free surfactants by different foam producers show some loss in performance. This is resulting in having to use higher quantities of newer PFC-surfactants to get the same performance. Yes these new PFC molecules (just like PFOA and PFOS) still have expected lifetimes of thousands of years.

Recommendations by Fluorosurfactant manufacturers "to collect and burn foams which are based on, or using, PFCs" (including the newer types of PFOA-free foams), do not help the end-user to make a decision.

As mentioned, Belgian firefighters prefer a 3X3 and possibly would be prepared to switch to a PFC-foam if it met the same performance as current AFFF-AR 3X3.

The main supplies of foam are to the Antwerp Fire Brigade and the Belgium Civil Defence. These are as mentioned 3X3 AFFF-AR foams. Other brigades have, mostly, 3X3 in smaller quantities.

The other big user of foam is OCI Chemical, mostly using 3X3 or 3X6 AFFF-AR. However we see some tendencies towards PFC-free foams in e.g. open applications where collection (for later destruction) is more difficult.

In Belgium, any firefighting foam with a PFOS level below 0,005% is acceptable (of course standard Safety Data Sheets use restrictions would apply).

Traditionally the Belgians have to be pushed by regulation to move to environmentally friendlier foam. Of course there are always people going for the best environmental approach and move to PFC-free foams right away. There are some workgroups in place that could study the issue and provide guidelines or more use restrictions towards the future.

However, opinions are divided. Lack of information, conflicting information from different sides etc makes discussion like this complex. There is performance versus environmental impact, there are defenders of the outstanding performance of AFFF-AR products, and others are scared of the long-term effects.

These long term effects are not fully known today, although one thing is for sure, PFCs have "inhumanely" long lifetimes. Once in the environment they will stick around for ever (half-life > 10,000 years), so when using them, better get them destroyed before they enter the environment (as recommended by manufacturers).

Today and tomorrow and for many more centuries to come, PFCs are and will be of concern. Trends show that they will disappear from firefighting foams sometime in the future. So better consider your options today.

In January 2006, a letter by former EPA Administrator Stephen Johnson initiated the 2010/15 PFOA Stewardship Program, in which the eight major companies in the industry committed voluntarily to reduce facility emissions and product content of PFOA and related chemicals on a global basis by 95 percent no later than 2010, and to work toward eliminating emissions and product content of these chemicals by 2015.

HENRY PERSSON, SP TECHNICAL RESEARCH INSTITUTE OF SWEDEN

Most municipal fire brigades in Sweden use alcohol resistant foam concentrates (AFFF-AR or FFFP-AR) for firefighting of class B-fires. This is based on recommendations from Swedish Civil Contingencies Agency (MSB).

The insight in the need of alcohol resistant foams was starting already in the beginning of the 1980s when there were plans to introduce methanol (M15 and M85) as an alternative to gasoline as fuel in cars. At that time, these plans were trigged by the energy crisis in the middle of 1970s.

SP Technical Research Institute of Sweden (SP) then conducted a series of fire tests which clearly showed the need for alcohol resistant foam instead of the detergent foam concentrates that was commonly used by the Swedish fire brigades at that time. The tests were made in a scale from 50 m^2 down to 0.25 m^2 with the aim to also develop a test method for alcohol resistant foams which was not available at that time.

In 1990, further full scale tests were made to provide a basis for the recommendation from MSB on a "base equipment for foam firefighting".

The background to these recommendations was the general tendency for increased transport of various chemicals, many of them being water miscible. Four tests were performed on a 200 m2 pool fire simulating a scenario with a burning tanker truck, two test with gasoline and two tests with a mixture of aceton/ethanol (70/30%, 30 m^3 of fuel in each test).

Based on these tests, recommendations were established which propose that most fire brigades (except very small ones) should have the necessary resources to tackle such a fire, eg by having a special designed foam fire fighting appliance. The recommendations specify a foam flow rate of minimum 2000-2500 l/min, minimum 1000 l of high quality alcohol resistant foam concentrate (AFFF-AR or FFFP-AR) and suitable equipment (foam injection system, foam monitors and foam hand lines). The total need of water was estimated to about 15 m^3.

Using this equipment, it is estimated that it is possible to fight a spill fire up to 300 m^2 in water miscible fuels (using gentle application) and 500 m^2 in water immiscible fuels.

In recent years, the need for using alcohol resistant foams has become even more obvious, as the use of ethanol has increased significantly due to the interest in replacing fossils fuels to fulfil the climate goals. One issue that is presently under discussion is the possibility to extinguish large storage tank fires with ethanol. This will not only require AR-foams but also an application technique to achieve a gentle application and the need for large scale verification tests are discussed.

Sweden is following the EC directive REACH which according to Annex XVII (item 53) bans the use of PFOS. Swedish authorities are not planning any restrictions on other fluoro chemicals (FCs) but strongly support the statement that there is a need for an ongoing review and risk assessment on the availability of safer alternatives or technologies related to the use of PFOA and related substances.

The discussion about the FCs in the AR-foams has also influenced the Swedish fire brigades. Most fire brigades are not allowed to use these foams for training purposes. Instead, special training foams or diluted detergent foam concentrates are used, but also here there might be restrictions in use resulting in reduced training activities using foam equipment. A problem is of course that the opportunities to test the foam equipment (foam proportioning systems, foam

monitors, etc) is thereby very restricted creating an uncertainty and a larger risk that the equipment is not working properly in case of a real fire incident. Some fire brigades are also using detergent foams for smaller fires, eg for extinguishment of car fires, small spill fires, etc. in order to reduce the use of foams containing FCs.

A very rough estimation shows that the annual use of foams concentrates in Sweden is about 380,000 litres. Most of these are AR-foams but as mentioned some part is also detergent and special training foams. The use of "eco-foams" is probably very limited. Except for class B-fires, there is also a growing interest for class A-foams and the use of CAFS. However, so far only a few fire brigades have started to use CAFS.

I think in general that the main problem is the lack of qualified training due to the restrictions in using foam. In a longer perspective, this might result in less successful extinguishing operations.

In order to develop a new generation of foam concentrates with less, new or no FCs, it is also necessary to really understand the extinguishing process of firefighting foams in order to optimise the important characteristics. Standard tests do not provide such information, and methods providing more quantitative information need to be developed. One such attempt was made during the EC-project FOAMSPEX completed in 2001, but further work is needed.

JOHN-OLAV OTTESEN, DAFO FOMTEC AB, SWEDEN

Swedish fire brigades have over the past two decades been very well educated and equipped in the use of firefighting foam. The majority have access to modern equipment and sufficient quantities of Class B foam.

Since the mid-1990s alcohol resistant AFFF has been the preferred product for use as universal foam for both water miscible and water immiscible fuels. The need for alcohol resistant foam is increasing as the use of Ethanol-based fuels like E85 is growing, and Swedish brigades are well prepared for this.

The call for so-called eco-friendly foams has not been very strong in Sweden. In recent years there has been a proliferation of tabloid-style doomsday prophecies in the trade press, conferences and even from some environmental agencies, often misleading and not backed up with scientific facts. Sweden has historically been a highly environmentally aware country and its response to all this misinformation has been more realistic and more demanding of fact-based judgements on the impact of foam-use.

In Sweden there hasn't been a call for a general restriction on fluorine-based foams, says John-Olav Ottesen.

A major debate in this arena concerns the use of fluorosurfactants in foam. Sweden and other EU countries have phased out PFOS foam, but there is no call for a general restriction of fluorine-based foams.

The fire brigades are aware that any chemical spill into the environment is of concern, but that actions should be based on fact and not speculation – fire is also an environmental hazard! The use of less potent foams will also result in larger quantities of polluted wastewater with an immediate risk to, land, rivers and lakes. The reasons for this balanced approach are many, but most of all that Swedes are not receptive to sales pitch type statements without facts. Information on the use of foam and its consequences' can be provided by the Swedish Civil Contingencies Agency and SP Technical Research Institute located in Borås. Both of these are good sources of information.

Constant focus on correct selection of and use of firefighting foams as the best extinguishing agent for hydrocarbon and polar solvent fires is important. New generations of firefighters need education and this should be provided by the brigades and supported by the industry.

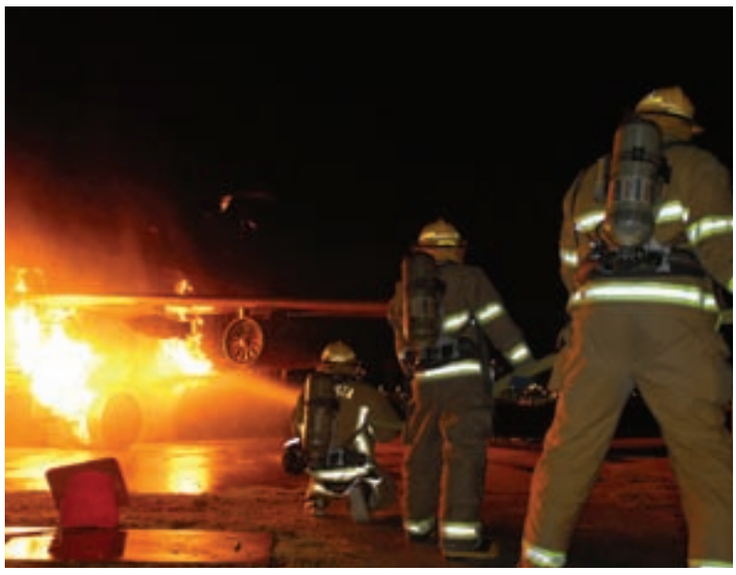
The emphasis of the education should be better understanding of foam selection and use, as well as equipment related to it. And also better training practices and awareness of how to avoid unnecessary spill of firewater into the environment.

TOM CORTINA, FIRE FIGHTING FOAM COALITION, UNITED STATES

Most municipal fire departments throughout the United States carry small quantities of AFFF for situations where they encounter flammable liquids, such as an overturned tanker truck or an automobile accident with ruptured fuel tanks.

Pumper trucks generally carry at least two 5-gallon containers of AFFF with portable foam eductors, and some pumpers have built-in foam concentrate tanks. Some departments also deploy foam tenders, which can bring large quantities of AFFF to the scene of major incidents involving flammable liquids.

A 2004 study by Hughes Associates of AFFF inventories determined that there are approximately 32,000 fire departments in the US that deploy a total of about 68,000 pumper trucks.



Firefighters from US Naval Station Guantanamo Bay's fire department put out an aircraft fire during a training exercise on the base in Cuba Oct. 5, 2009, prior to the beginning of Fire Prevention Week. Photo credit: DoD photo by Staff Sgt. Emily Russell, US Army.

Every fire department contacted for the study confirmed that they carry some AFFF. In recent years, in response to the increased use of alternative fuels, there has been a shift by municipal fire departments to the use of alcohol resistant AFFF agents (AR-AFFF). Gasohol, a mixture of 10% alcohol and 90% gasoline, is now the predominant fuel for passenger cars in the US.

In a 2007 study of foam effectiveness against alternative fuels by the Ethanol Emergency Response Coalition (EERC), AR-AFFF was found to be the most effective agent against gasohol fires and the only agent that was successful in all fire test scenarios. EERC and the International Association of Fire Chiefs have produced a training module entitled "Fire Fighting Foam Principles and Ethanol-Blended Fuel" to provide guidance to firefighters on dealing with gasohol fires.

It must be remembered that the US Environmental Protection Agency (EPA) has led the world in evaluating and controlling emissions of long-chain perfluorinated chemicals (PFCs) such as PFOS (perfluorooctane sulfonate) and PFOA (perfluorooctanoic acid). EPA's significant new use rules for PFOS chemicals preceded similar regulations in the European Union and Canada by five to seven years, and the EPA PFOA Global Stewardship Program is the worldwide model for controlling emissions of PFOA and related higher homologue chemicals.

In December EPA released an action plan that envisions the Agency taking additional steps to control emissions of PFCs after 2012. EPA is especially concerned about the continued production of PFOS-containing products in China (including PFOS-based AFFF), and wants to make sure the same thing doesn't happen with PFOA.

AFFF and fluorochemical manufacturers have worked closely with EPA over the past decade, and are currently doing the research and testing necessary to incorporate into their AFFF formulations the new fluorochemicals that are being developed to comply with the EPA stewardship program.

This work will ensure that safe and effective telomer-based AFFF agents that meet all environmental requirements will continue to be available to municipal firefighters to protect against flammable liquid fires. Because of the publicity surrounding the end of production by 3M of PFOS-based foams in 2002 and because this issue also affected popular consumer products such as Scotchgard, there is a high level of awareness in the fire protection industry regarding the environmental impact of firefighting foam.

But in reality there has always been a high level of awareness among firefighters about the environmental impacts of foam because there have always been environmental impacts related to the use of foam.

For municipal fire departments, local environmental issues such as foaming and fish kills are usually of more immediate concern than any long-term impact from very small concentrations of persistent chemicals.

The non-profit Fire Fighting Foam Coalition (FFFC) has published a fact-sheet, eight newsletters and numerous journal articles over the past eight years in order to educate the firefighting community about foam environmental issues. There have also been five education sessions in the last eight years at the NFPA World Safety Conference dedicated to foam environmental issues.

The 2010 edition of the NFPA 11 standard for low, medium, and high-expansion foam includes a revised appendix that reviews the recent fluorosurfactant developments and the more traditional environmental issues associated with the use of foam. It contains recommendations for minimising discharges of foam to the environment.