The Old Rectory
Mill Lane
Monks Risborough
Bucks HP27 9LG
info@lastfire.org

LARGE SCALE TEST PROGRAMME FOR STORAGE TANK FIRES

PRESS RELEASE

Introduction

As part of their ongoing determination to develop future policies for firefighting foam selection and application taking into account environmental issues as well as fire performance, the LASTFIRE Group has carried out the most extensive series of independent end-user managed large scale tank fire foam performance testing for more than 35 years.

The results have undoubtedly provided a major step forwards to this goal and identified where future work should be focussed to answer any remaining issues.

Background

The LASTFIRE Group, the international forum of oil companies developing best practices in storage tank Fire Hazard Management, is working with their members to provide a strong foundation of

knowledge and test data from which they can develop long term sustainable policies for firefighting foam selection and application.

It is very well known and accepted that the international pressure to minimise the environmental effects of firefighting foam has been increasing over a period of years. A recent example of this is the new legislation in South Australia that will prohibit the use of fluorosurfactant containing foams, although there is a possibility for a transition time provided it is shown that genuine efforts are being made to assess and prove alternatives. LASTFIRE is going through this process using an extensive research programme including testing and development of best practice guidance in foam management.

Manufacturers have developed "new generation" foams, some with "high purity C6" fluorosurfactant base and some with Fluorine Free formulations. Although C6 fluorosurfactants have been used for many years by some manufacturers in their formulations it must be accepted that all formulations on the market today are new to some extent and therefore unproven. With large scale testing being extremely expensive, and the industry generally being very good at preventing tank fires, it will be many years before extensive experience is gained from large diameter tank fires.

With this background, LASTFIRE embarked on a programme incorporating both small scale and "real life" situations testing using both Fluorine Free and high purity C6 formulations of new generation foams with different application techniques.

Test Objectives

The following critical objectives were established for the work, recognising the need to maximise returns on the investment being made. (It is considered that the total real cost of this test series was, conservatively, in the order of 800,000 Euros when taking into account the time of all the parties involved and the real equipment/foam costs, most of which was provided free of charge.):

- Developing a snapshot of current capability of a representative selection of the new generation foams, particularly to assess if they can be considered absolute "drop in" replacements with equivalent performance capability and without the need for system or application equipment modifications.
- Forming an overall view on whether or not modifications to current practices of foam application are required with new foam formulations to achieve acceptable performance, or if more efficient usage of resources can be gained with different application techniques.
- Revalidation of the LASTFIRE test protocol against "real life" performance of new generation foams. (As part of the original LASTFIRE study in 1993-7 a critical foam performance test was developed to simulate tank fire application. This was validated against proven foams that had performed well in real incidents at typical standard application rates.)
- Validating the industry accepted strategy for large bund fires using a "section by section" approach. (Although a recognised practice described in standards such as NFPA 11, the principle of applying foam to large bund areas is relatively unproven in real incidents, although it has been used in some cases.)
- Assessing the accuracy of typical foam concentrate proportioning devices with the new generation foams. (Carried out as part of the overall goal to determine if new generation foams are true drop in replacements for existing systems.)

- Developing a LASTFIRE Group preferred vendor list for those companies which recognise LASTFIRE requirements and commit to working with the group to gain knowledge and improve tank firefighting efficiency.

Funding and Supplier Involvement.

LASTFIRE research is funded from the annual subscriptions of members. Due to the high cost and the need to work with suppliers, in this case suppliers were requested to take part in the test series and help fund the work through a contribution towards the fuel costs. Many suppliers were approached but only 5 agreed to submit foam samples for testing and to make a contribution to fuel costs. The following suppliers joined the programme.

- Angus International
- Auxquimia
- Bio-Ex
- Dr. Sthamer
- Tyco

A total of 6 Fluorine Fee foams and 2 C6 based products were tested.

All other direct costs were met by LASTFIRE. GESIP, a France based consortium of fuel storage and processing companies developing best practice standards in facility safety provided a test facility, foam application equipment and logistical and manpower support for the large scale tank application tests. They also assisted in the development of the tank test protocol and carried out initial small scale tests to establish burning characteristics of the fuel being used. ACAF Systems Inc. provided specialist Compressed Air Foam (CAF) hardware in the form of special small throughput test equipment and proprietary hardware for the larger scale tests. (The latter was relatively unique in terms of testing as a compressor was used rather than air cylinders so that a continuous flow of foam could be provided.) Firedos, a LASTFIRE Associate member provided a water driven proportioning unit for all the test series and incorporated special design features to adjust and measure concentrate flows from it. CTD, France, provided a metered flow pumped proportioner that was also used during the test work at GESIP. LASTFIRE is very grateful to all parties that made a contribution in manpower or resources to this work. These companies have shown a major commitment to working with industry to help solve their current concerns.

Test Protocols and Locations

The test series was carried out on an anonymous basis with each manufacturer supplying $2m^3$ of their foam concentrate from one production batch. The same samples were used throughout the test series. The samples had all identification markings removed and replaced with a simple reference label. Samples included Fluorine Free and C6 fluorosurfactant based concentrates.

Representative samples of C8 fluorosurfactant foams previously available and used extensively at facilities were included in the test series as proven reference samples for comparison with newer types.

After some initial test protocol development work, the main test programme was initiated. The first series of tests was carried out in Hungary at the test facilities of FER, a LASTFIRE member that operates the emergency response capability at the MOL Szazhalombatta refinery. These tests consisted of standard LASTFIRE Tests and “small” (~4.5 m^2) and “large” (~20 m^2) simulated bund spill fires.

The standard LASTFIRE test pan

Application rates consistent with LASTFIRE testing were generally used so typically represented approximately 50-60% of typical NFPA 11 design application rates.

Different devices using simulating non-aspirating, aspirating, Medium Expansion and CAF application were used.

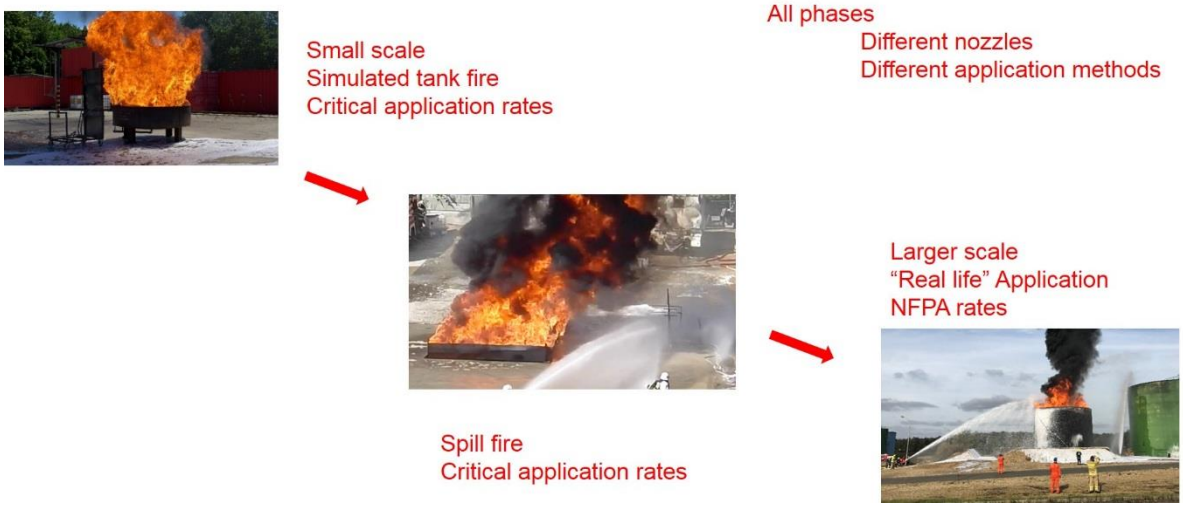
The "large" bund fire test

The second series of tests was carried out at the facilities of GESIP, Vernon, France. These involved application of foam using standard rates as per NFPA 11 guidance with proprietary equipment including aspirated and non-aspirated monitors, a fixed system pourer and a compressor driven CAF unit onto a 100 m^2 (~11 m diameter) 10 m high tank fire. Sufficient fuel depth was used to ensure that foam applied forcefully from ground level equipment did not penetrate though to the water substrate.

Prior to the test there was much debate about whether a "real life" situation using a high tank or a less realistic tank at low level should be used. Obviously application to the high tank would result in

greater foam losses. Recognising that all the earlier work had been done at low level so the base performance level of different foams had already been established and also wishing to represent real World conditions as much as possible, the decision was made to use the high tank. This was undoubtedly the correct decision as it showed up some issues that had not been identified with the earlier work including that dropout rate is very much dependent on the foam type as well as the application equipment.

Thus, these larger scale tests represented true life situations although relatively short preburn times were used due to site environmental constraints.



The progression from small scale tests to the "real World" testing on an 11m diameter

Drones were used to record the test fires and the resultant records proved extremely useful in analysing the data to a much greater degree than other records would have allowed. It was concluded that such devices could play a critical role in real incidents allowing more efficient application of foam and better monitoring of fire control and extinguishment.

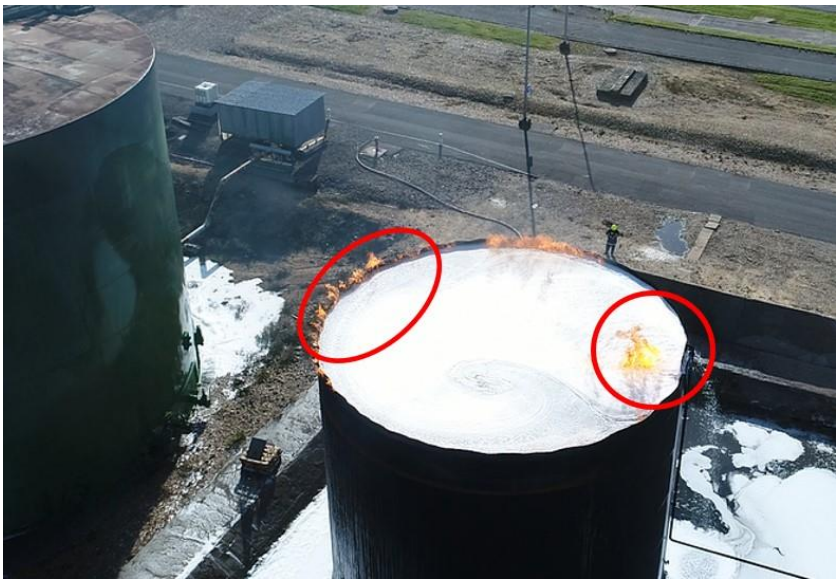
In addition to the test described above some small-scale tests using a modified EN1568 foam test protocol were carried out.

A selection of photographs from tank fire tests

Monitor application to tank fire – note build-up of foam from "rear" wall

Poorer quality foam struggling to control impact point with monitor application

System application. (Pourer circled in red) Note control from "near side".



Poorer quality foam with system application. Note issues sealing at edges and control of impact point.

CAF Application. Note control process similar to monitor application

Test Results and Overall Conclusions

The full report and test results are currently only available to LASTFIRE members and the participating providers of equipment, concentrates and services but the following are the main conclusions drawn from the work. It should be emphasised that this should be considered as one part of the ongoing work being carried out by LASTFIRE.

- The LASTFIRE test still continues to be relevant to all foam types for assessing the performance of foams using different application devices. However, some modifications and clarifications will be made to a new issue of the protocol.
- None of the new generation foams should be considered as a straightforward "drop in" replacement for any current foam concentrate being used. Even if appropriate fire performance can be shown for the specific hazard it is still necessary to check that the concentrate is compatible with the proportioning systems and other system components.
- From the samples tested, some concentrates of both C6 and FF formulations demonstrated adequate levels of fire performance for bund spill fires and small tank fires using standard NFPA application rates although generic conclusions cannot be drawn from this. The performance capability is very specific to the particular formulation and also to the type of application equipment used.
- There are different levels of performance within each generic type of foam. It is not possible to state, for example, that all C6 foams demonstrate better performance than all FF foams or vice versa. This emphasises the need for batch testing.
- There is no reason to doubt that adequate performance can be achieved for larger tanks than those tested but the flow capability over longer distances still needs to be checked. Strictly

speaking this statement applies to all new generation foams but it is recognised that fluorosurfactant based foams are less likely to have an issue with this than FF types.

- The sectional application approach to bund fires can be effective but responders should be made aware of potential edge/hot object sealing issues and the need for constant monitoring and top up of any areas controlled when the main application is moved to other areas.
- It is important to note that full environmental data for foam types is required prior to developing strategies for application, containment, remediation and disposal. It must be recognised that all foams have some environmental effect. With the current state of development of FF foams in particular it is not possible to be generic in drawing conclusions about what environmental effects a foam has. LASTFIRE is working with the industry group PERF (www.perf.org) on this subject.
- It is considered that current standards do not give sufficient emphasis to the importance of the combination of foam type and the application device performance and consequent foam quality. It is important to get this combination right to optimise overall performance. There is great scope for developing more efficient systems achieving similar performance to those designed in accordance with current standard. Note: NFPA 11 has set up a Task Force to look at the issues of Fluorine Free foam. LASTFIRE consider this to be a great opportunity to develop Performance Based standards for the long term future.
- CAF application, if engineered correctly, can be very forgiving of foam concentrate quality. (Note that the application rates used with CAF were in the order of 30-40% of those used with conventional equipment.)
- Detailed performance based specifications are critical to achieving appropriate long term performance and to managing foam stocks correctly. Such specifications need to request environmental data and materials compatibility data as well as fire performance standards appropriate to the hazards.

Next Phases of Work

Recognising that there is still considerable work to do to have full confidence in new generation foams and to have sufficient information so that specific sites can make informed decisions on foam selection and management, LASTFIRE intends to carry out the following work:

- Tests to demonstrate the ability of new generation foams to travel over longer distances than have been tested to date.
- Further develop typical performance based specifications that can be modified to suit specific site operating conditions and requirements.
- Carrying out a series of small scale tests to determine effect of properties such as expansion and drainage time with new generation foams and to assess effectiveness on other fuels.
- Gaining additional knowledge of the environmental effects of new generation foam through other industry bodies such as PERF.

- Work with standard writing authorities, regulators, suppliers and any other stake holders to develop sustainable long term policies for foam application and management on a Cradle to Grave approach.

This test work has undoubtedly added immensely to the knowledge base on new generation foams of both Fluorine Free and “high purity” C6 types and highlighted the need for end-user drive testing and research work. LASTFIRE will continue to focus on the outstanding issues that must be addressed before finalising best practice guidance on sustainable policies for the future. The momentum will be maintained and LASTFIRE will continue to work with regulators and suppliers over coming months to achieve their end goal.

The research reported here represents only one part only of LASTFIRE’s work in developing best practice standards in Storage Tank Fire Hazard Management. For further information on the LASTFIRE Project contact theProject Coordinator on info@lastfire.org