JOIFF

The Organisation for Emergency Services Management

THE JOIFF STANDARD

GUIDELINE

ON

FOAM

JOIFF in Partnership with

FULCRUM CONSULTANTS

JOIFF Guideline on Foam

INDEX

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INTRODUCTION

Experience has shown that there are divergences in the way that Organisations manage their Foam stocks.

A need was identified by JOIFF for a Guideline for JOIFF Members and others on the effective management and testing of Foam.

This Guideline has been developed by JOIFF Members who specialise in the use and management of Foam.

JOIFF hopes that this Guideline will be of assistance to those with responsibility for Foam in their Organisations to ensure that Foam stocks are managed to Best Industry Practice.

Disclaimer:
The information in this Guideline is intended to give guidance only. Its contents are not exhaustive nor are they intended to support the views or claims of any persons or Organisations. Neither JOIFF Ltd. nor its Secretariat Fulcrum Consultants nor the Working Group that drew up this Guideline approve, inspect or certify fire fighting equipment or materials, nor do they approve or evaluate testing laboratories. Neither JOIFF Ltd. nor its Secretariat Fulcrum Consultants nor the Working Group that drew up this Guideline assumes any responsibility for consequences resulting from the use of any information in this Guideline.

PART 1: THE MANAGEMENT OF FOAM STOCKS.

1.1 MANAGEMENT SYSTEM:

All Users of Foam should implement a system to manage their Foam Stocks. Such a system should take account of at least the following:

1.1.1 Storage:

- Foam Stocks should be stored and used in accordance with the manufacturer's instructions which should accompany each delivery of foam.
- Where different foam types are stored at a facility the storage containers should be clearly marked and visible for identification.
- The Material Safety Data Sheet (MSDS) for foam products should be readily and easily accessible to the storage location.
- In addition account should be taken of any statutory, regulatory and/or legal requirements applicable to the site for the storage of foam.
- Consideration should be given to avoid prolonged or extreme storage conditions.
- Requirements for minimum stock levels should be established and regularly reviewed. Procedures should be implemented to ensure that minimum stock levels are maintained. These procedures should take into account delivery times from suppliers.
- Some manufacturers recommend that to ensure longevity of product shelf life foam be removed from the original manufacturers packing and decanted into larger bulk storage tanks in accordance with the foam manufacturer's guidelines. Other manufacturers recommend that excluding bulk foam installations and dedicated vehicles, foam compounds generally are best left in their original containers as supplied by the manufacturer and subject to their recommendations, because unnecessary decanting of foam increases the risk of contamination, dilution or evaporation. Before taking any action on this, Users should seek advice from their supplier.
- Free air exchange between atmosphere and storage container/tank should always be minimised to prevent seasonal evaporation loss, contaminates and to support extended product shelf life for the foam.
- When refilling or topping up fire vehicles or large bulk storage tanks, the foam products that are used should be the same as existing foam or compatible as determined by the foam manufacturer. Before carrying out these actions, it is important to consult with and obtain agreement from the foam manufacturer.
- Before changing a foam from one type to another in a fire vehicle or large bulk storage tank the manufacturer of the "new" product should be consulted in advance on storage container suitability, cleaning measures filling requirements etc.

1.1.2 Inspection and Testing:

- Foam stocks should be subject to routine inspection and testing by qualified personnel.
- Intervals between inspection and testing should be based on the manufacturer's recommendations and any statutory and/or regulatory requirements applicable to the site.
    - Where no such inspection and testing guidance is available a minimum annual frequency is considered best practice.
- The programme of inspection and testing should include periodic test and inspection of foam producing equipment to the manufacturers' instructions.

- In testing Foam pumps, some systems use a procedure that circulates the foam from the foam concentrate reservoir through the system and back to the reservoir without any water being added. This may affect the quality of the foam. Those using this test should be aware of this and include in their quality system a requirement to check the quality of the foam after the test.
- Stocks of foam concentrates held in bulk tanks or drums should be assessed for continued satisfactory performance by taking samples from each batch and having these analysed at regular intervals by a competent person.
- When in doubt about satisfactory testing procedures or results it is recommended to consult with a qualified or certified third party testing service.

1.1.3 Compatibility of Foams:

Some types of foam are incompatible with others. Incompatible types of foam should be kept apart both in storage and in use. Mixing of incompatible foam products is likely to result in cross contamination and spoiling of foam stocks. This may nullify the manufacturer's warranty.

1.1.4 Foam used in vehicles/foam systems:

For foams used in vehicles/foam systems, it is essential that prior to new concentrate being used, all parts of the foam system in the vehicle/system are thoroughly cleaned.

- After every foam system operation, prior to the vehicle being returned to its station, the proportioning system, associated pipe work and equipment should be flushed thoroughly with fresh water to remove any stratified foam or foam solution.
- Stratified foam in parts of the proportioning system such as orifices and low point piping may present long term maintenance issues and therefore good house-keeping procedures are recommend to ensure proportioning systems and related equipment are always cleaned after use.

1.1.5 Induction Accuracy:

Foam generating systems should be routinely inspected and checked for proportioning accuracy. The periods between inspections and checks should take into account the proportioning equipment used i.e. hydraulic, electronic etc.

  - As a guide, induction accuracy should be validated on an annual basis

For environmental reasons the testing of the proportioning systems may be carried out by using water only, to simulate foam providing the equipment can operate correctly by this method.

1.1.6 Record keeping:

Organisations using Foam should maintain records relating to Foam Stocks. Such record keeping should include at least the following:

- Selection records i.e. how and why the Foam was chosen.
- Records showing that Foam stocks are rotated in a manner that allows for the oldest dated product to be utilised first.
- Product data sheet stating intended proportioning rates and application listings, ratings or approvals.
- Material Safety data sheet (MSDS).

- Manufacturers recommended storage information, shelf life conditions and materials for acceptable long term storage.
- Specification of each type of Foam on site including date purchased and from whom, copy of any test certification, receipt of all necessary user information etc.
- Certificate(s) of Conformity with the standard to which the Foam has been purchased should be provided by the Supplier with each batch of foam delivered. Certificate(s) of Conformance should be retained in a suitable location for reference and inspection.
- Ongoing record of amount of Foam held in stock including:
    - Dates of manufacture and packaging type;
    - Date of delivery;
    - Date of fire vehicle or bulk tank fill;
    - Manufacturer's product batch number(s);
    - Manufacturer's warranty policy and contact information;
    - Manufacturer's letters of conformity to delivery notes.
- Routine inspection and testing dates along with supporting test results.
- Method of controlling the use of foam stocks.
- List of extinguishing agents on site with which the foam is compatible and incompatible.
- List of fixed fire-fighting systems on site with which the foam is compatible and incompatible.
- Information on storage conditions/location.
- Method and any associated declaration stating disposal of out of date foam stock.

1.1.7 Risk Assessment:

- As with many activities carried out by Emergency Responders in both training and in Incidents, handling and using foam can be a hazardous activity. It is important that only personnel who have been given the correct training and can demonstrate on-going competence in the use of the foam and the equipment used on Site are allowed to participate in activities where foam is used.
- Before any activities using foam, a risk assessment should be undertaken and actions taken to reduce or eliminate risk identified by the risk assessment.
- It is important that all personnel engaged in the use of foam, have been trained and can demonstrate competence in Manual Handling on an on-going basis.
- To minimise the potential for personnel exposure and / or environmental impact the foam product Material Safety Data Sheet (MSDS) should be reviewed by experienced and qualified company representatives to ensure that all listed material compositions are acceptable for use on site.

1.2 FOAM PROPERTIES

Areas to be addressed when dealing with Foam should take account of at least the following:

1.2.1 Expansion ratio:

The amount of air entrained into a foam stream governs its expansion, which in turn will affect the fluidity of the finished foam and therefore the rate of spread over the surface of burning fuels.

1.2.2 Drainage time:

The rate at which foam solution drains from a foam blanket may be a partial consideration in the efficiency of the foam blanket in progressively controlling and extinguishing fires and subsequent post-fire security. Amongst other factors, the use of foam nozzles or branchpipes capable of producing aspirated foam of good consistency will be beneficial in prolonging foam drainage times.

- Fluid free flowing finished foam is a factor in control and extinguishment.
- Stable resilient long draining finished foam is a factor for post fire suppression and un-ignited fuel vapour suppression.

1.2.3 Foam concentrates compatibility with nozzles or branchpipes used:

With various foam types commercially available the selection of delivery systems such as nozzles or branchpipes is critical to overall foam quality performance as intended by the foam manufacturer.

Care should be taken during the selection process to ensure that the optimum combination of foam and equipment is chosen.

1.2.4 Foam Performance Levels, Specifications and Test Procedures

Foam in use should be of consistent good quality, fit for purpose, stored and used in accordance with manufacturers' recommendations.

- Foam performance listings, in most cases vary, when foam is used with fresh water to that of seawater or in extreme changes of temperature. Certification and performance listings should be sought from the foam manufacturer to ensure suitable ratings are achieved specific to water grade.
- Foam users should consider using a test protocol relevant to the industry in which they participate e.g. LASTFIRE for the Petro-chemical, ICAO for Aviation, UL for Engineering, IMO for Maritime, EN 1568 for Municipal Fire Services in the EU etc.
- If foam Users think that there is no test that suits their particular requirements and they may need a test designed specifically for their requirements, they should discuss with their Foam supplier the design of such a test.

1.2.5 Manufacturer's declaration:

The following information is the minimum that should be recorded for each batch delivered. This information is usually readily available from the websites of reputable manufacturers or on their Material Safety Data Sheets or from their technical support personnel. Where not available from these sources, the manufacturer should be requested to submit such information with each batch delivered.

- Any incompatibility with alternative foams and/or extinguishing agents in general use on the site, particularly with respect to simultaneous use on the same fire.
- Corrosive effects in storage and use in contact with materials normally used in the construction of fire extinguishing apparatus.
- Cleaning and removal of spilled extinguishing agents.
- Health hazards and side effects.
- Environmental consequences of use and/or disposal.

1.2.6 Certification:

Suppliers of foam concentrates should provide a certificate of assurance with each batch of foam delivered, to the effect that the concentrate supplied meets all requirements of the Purchaser. The criteria used to determine compliance should be applied consistently.

1.3 REGULAR ASSESSMENT OF FOAM:

A regular programme of inspection and test should be determined to assure continued conformance of each batch of foam with the manufacturer's declared original specification when measured according to relevant accepted national and international standards. This may include taking samples from each batch and having these analysed at regular intervals by a competent person.

Issues to be taken into account with this testing include at least the following:

- pH value i.e. the measurement used to express acidity or alkalinity on the scale 1 to 14, the reading 1 being the highest content of acidity and 14 being the highest content of alkalinity. In order to prevent the corrosion of component parts of fire fighting foam tanks and systems, the foam concentrate should be as neutral as possible i.e. in the range of 6 and 8.5.
- Viscosity: This gives an indication of the resistance to flow of the liquid through any pipework of a foam system. The viscosity of a foam concentrate at its lowest anticipated use temperature should not exceed 200 mm/s. Any higher viscosity will restrict flow and retard its adequate induction into the water stream unless special precautions are taken.
- Sediment/Undissolved Solids: Sediment formed in a foam concentrate may affect the performance of a foam proportioning system or negate its fire fighting efficiency. The volume of any deposit in a foam concentrate should not exceed 0.5% of sediment by volume.
- Expansion ratio – see clause 1.2.1 above.
- Drainage time -see clause 1.2.2 above.
- Film formation (if applicable) – Provides confirmation that the concentrate lowers the surface tension of the water significantly enough to produce a positive spreading coefficient.

PART 2: FOAM TEST PROCEDURES – SAMPLE ANALYSIS.

1. The analysing of foam samples is a complex procedure that should only be attempted by competent personnel. In most cases it may be considered preferable to send samples to the manufacturer of the foam for such tests.

2. Most Foam manufacturers guarantee their products and therefore have a vested interest in ensuring that they remain in good condition throughout their lifetime. Third party test facilities may not have the full specification of the foam in order to give a correct analysis of the foam. The foam manufacturer should be able to supply a Certificate of Analysis listing at least the following values:

- pH value.
- Viscosity.
- Sediment/Un-dissolved solids.
- Expansion ratio.
- Drainage time.
- Film formation (if applicable).

Records highlighting the important parameters should be maintained. .

3. The testing of induction equipment can be a complex process and therefore may produce inaccurate results. It is crucial to ensure the accurate mixing of foam compound in use.

PART 3: THE ENVIRONMENT AND FOAM DISCHARGE.

- In some Countries it is illegal to discharge some types of foam other than on fires.

- All precautions that are reasonably practicable in the circumstances should be taken to minimise the impact of foam discharge on the environment.

- Firefighting foams containing Perfluorooctane Sulfonate (PFOS) should not be used. PFOS is highly polluting. Foams containing PFOS should be disposed of by incineration. Some manufacturers believe that this ban should be extended to cover a wider range of chemicals contained in some foams. Whatever foam is used, the criteria to be followed is that when using foam, fire water run-off should be contained and any foams that cannot be removed for disposal should not be used.

- When purchasing an AFFF, FFFP or FP, short molecular chain fluorosurfactants of 6 hydrocarbons or less are considered to be less persistent and more environmentally acceptable than their longer chain variants
- Firewater should be prevented from entering surface drains, running into nearby watercourses (rivers and streams), foul drainage systems, or land.

- When flow testing systems, consideration should be given to testing them without releasing any foam concentrate to the environment. Recent developments have resulted in new products that provide an alternative non-foaming environmentally benign test liquid which is used in place of the foam concentrate stored in the system. Some of the manufacturers of these products claim that as the proportioned solution test is non-foaming and contains no environmentally harmful chemicals, it is usually acceptable for direct release to storm drains leading to municipal waste water treatment facilities. If using these products to flow test systems, it is very important that detailed information relative to the effluent released must be provided to local authorities having jurisdiction prior to the system test.

- Containment lagoons, tanks or systems to hold firewater should be constructed on waterproof surfaces.

- Containment systems from surface drains, watercourses, land or sewers should be isolated.

- Bund containment systems should be considered. This involves building a secondary barrier around the main containment system, to hold firewater if the main containment fails. The bund should be resistant to both heat, and the products being stored.

- Some Countries have legal requirements with regard to Foam and the Environment. Relevant legislation and regulations should be adhered to.

PART 4: COMPATIBILITY OF DIFFERENT TYPES OF FOAM.

Some types of foam are incompatible with others. It is the end Users responsibility to ensure that incompatible types of foam are kept apart both in storage and in use.

The end User should ensure that they develop and implement a policy to ensure the continuing separation of incompatible foams and other extinguishing media in storage and use.

Foam manufacturers warranties may become invalid if different types of foam concentrate are mixed.

If circumstances arise where there may be a practical reason to use foam concentrates from different manufacturers, manufacturers' guidance should be sought before such action is taken.

Care should be taken during fire pre-planning to ensure that only Mutual Aid Partners with compatible foam supplies are on the list of suitable responders.

APPENDIX A: FOAM TEST PROCEDURES – A SUGGESTED FIRE TEST.

INTRODUCTORY COMMENTS.

There are many ways that Foam can be tested. To assist JOIFF Members who may wish to carry out Foam tests procedures themselves, we set out in this Annex of the Guideline on Foam details of a test that was suggested to JOIFF during the preparation of this Guideline.

JOIFF does not in any way endorse or recommend the test described. The detail is being provided solely because it was felt that such information might be useful to those who have to carry out such tests.

The test procedure below and other foam test procedures may not be suitable for evaluating foams for use on for example aircraft rescue firefighting, or foams used in overhead fixed sprinkler systems etc. Test requirements for use of Foams for aircraft firefighting can be found in ICAO documentation. Other tests are available from other sources and JOIFF recommends that Users who require to carry out such tests seek advice from their Suppliers.

CAUTION:
A. Regardless of the test chosen, a Risk Assessment should be carried out before each test and based on this, action should be taken to ensure the health and safety of those persons carrying out the test and any observers present.

B. The Risk Assessment should include consideration of Environmental issues some of which are listed in Part 3 of this Guideline. In any event, any use of Foam should meet the environmental requirements of the Country in which it is used.

A.1 TEST LOCATION

In order to carry out the test described in this Part of the JOIFF Foam Guideline, a suitable indoor fire test facility and premix delivery system should be used. Suitable ventilation will be needed.

Before carrying out these tests, with the requirements of the local Environmental Agency should be ascertained. They may require control of exhaust gases, water run-off and disposal etc.

A.2 TEST EQUIPMENT:

The following equipment is required in order to carry out this test:

A.2.1 Nozzle:
Use a UNI-86 type nozzle, which is a long device, approximately 42 cm in extension and is widely accepted for use in testing.

A.2.2 Nozzle stand:
The test stand can be of any design that securely holds the nozzle and allows for height and tilt adjustment up to 45°.

A.2.3 Premix Delivery System
The premix delivery system can be either a pressure tank or pump system capable of delivering premixed foam solution to the nozzle at a constant flow and pressure.

A.2.4 Test Pan
Suggested dimensions of the test pan are a circular pan made of 80 mm (5/16") steel, 175 cm (5' 8") in diameter, with 60 cm (24") sidewalls. Raise the pan on 30 cm (12") legs with a drain on one side with a lifting eye opposite the drain to facilitate draining and cleaning of the pan. Two baffles, 21 cm (8 ½") wide by 60 cm (24") tall and made of 64 mm (¼") steel, should be placed 180° from each other in the pan.

A.2.5 Burn back sleeve:
30 cms. (12 inches) diameter sheet metal burn back sleeve. The area of the burn back sleeve should be 4% of the total pan area.

A.2.6 Other equipment:
Also required for this test is burning torch, water supply with hose and branch, a stop watch and recording facilities for the test.

A.3 TEST SET-UP:

A.3.1 Place the test pan in an appropriate test facility.

A.3.2 Fill the pan with 115 litres (approx. 30 US gallons) of n-Heptane and enough water to leave 45 cms (18 inches) of freeboard to the rim of the pan.

NOTE: The fuel to be used need not be Heptane. It can be any suitable fuel providing the foam is applied at a flow rate that brings the application rate close to the critical rate for that particular fuel.

A.3.3 Place the nozzle into the test stand at an angle of 40° with the open aspirating hole pointing to the side.

A.3.4 Adjust the height of the nozzle such that its tip is 30 cms (12 inches) below the rim of the pan and adjusted to point upwards to simulate a plunging "over the top" type application.

NOTE 1: To get the correct impact, the distance between the stand and the test pan will be different depending on which agent is being tested as the range of the nozzle varies by agent.
NOTE 2: The position of the test pan must be consistent to give consistent results.
NOTE 3: The foam stream should impact the surface at a position to allow for maximum flow through the fire area.

A.3.6 Prepare 45 litres (approx. 12 US gallons) of premix solution with the concentrate to be tested, ensuring that the solution is mixed correctly (some AR type foams are more difficult to mix than standard foam concentrates) place it into the premix delivery device, and pressurise it with nitrogen to the correct pressure to deliver 5 litres (approx 1.25 US GPM) to the nozzle. If using a pump system, set the pump output pressure to deliver 5 litres (approx 1.25 US GPM) of premix solution to the nozzle.

A.4 TEST PROCEDURE:

Prior to carrying out the test, record the following temperatures:

- premix solution temperature,
- air temperature in the test facility and
- temperature of the fuel.

A.4.1 Preburn the test pan for 1 to 3 minutes, dependant on the type of test being carried out.

A.4.2 Reset the stopwatch and begin 7 minute application with direct centre impact at 5 litres (approx 1.25 US GPM). Record the 90% control time and extinguishment time.

A.4.3 Immediately after the application, perform a torch test by passing a torch around the full circumference of the pan and making two crossing passes over the centre of the pan. The torch should be held approximately 25mm – 50mm above the foam blanket and continue passing the torch across the foam for at least 1 minute.

A.4.4 Record the time at which this is performed and note the time and duration of any flashover/flashback.

A.4.5 At 10 minutes after the end of the application, perform a second torch test using the same procedure as stated in clauses A.4.3 and A.4.4 above.

A.4.6 Insert the burn back sleeve and remove the foam from inside.

A.4.7 Light the burn back sleeve 12 minutes after the application period, allow it to burn for one minute, and then remove the sleeve.

A.4.8 Record the time and duration of any flashover.

A.4.9 When the sleeve is removed (13 minutes after application or a total of 20 minutes into the test) begin the burn back test and record the percentage of the pan surface re-involved at 1 minute intervals. Do this until 25% of the pan is re-involved or 8 minutes have passed, whichever comes first.

A.4.10 Record the time at which 25% re-involvement occurred or the percentage re-involved at 8 minutes.

A.4.11 Terminate the test after the burn back.

A.4.12 Perform duplicate 1000 ml foam quality tests as described in part 2 after the fire test and record the expansion and drain times on the test data sheet.

A.4.13 Allow a 25% drainage in 3minutes and then reset.
To reset the test, clean the foam off the fuel surface, drain the water substrate, cool the test pan to near ambient conditions, top the remaining fuel with ten gallons of fresh n-Heptane, and add water to bring the fuel up to the freeboard of the test pan.

A.4.14 After every test or when switching between foam concentrates, drain and thoroughly rinse the test pan to prevent excessive build up of soot. This can affect test results.

A.5 TEST RESULTS:

Below is a sample of the type of test results that might be obtained when carrying out the test described in clause A.4:

Sample results

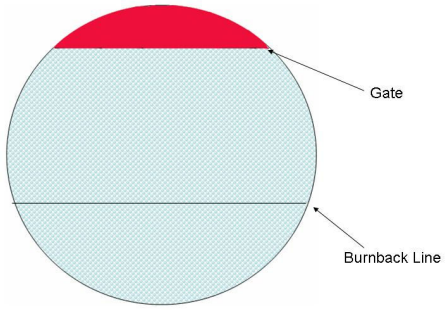
Test #	Ext. Time	Burnback	Air Temp
1	5:01	3:20	75
2	5:04	3:21	76
3	4:27	4:14	66
4	4:19	3:50	68
5	4:31	3:56	73
6	4:53	4:11	74
7	4:16	3:50	76
8	4:27	n/a	78
9	4:32	4:10	73

A.6 ALTERNTIVE BURNBACK METHODOLOGY

In order to measure the longevity of the foam blanket e.g. in the event that supplies of foam concentrate are fully used during a foam attack, a barrier in the form of a gate or a pot can be inserted on the test pan to prevent foam from flowing across a portion of the fuel.

When extinguishment is achieved to the barrier point, the fire can be considered as being extinguished. Then remove the barrier to allow the raw fuel and flame to impinge on the blanket and this will allow confirmation of complete extinguishment while not completely covering the fuel surface and mimicking the lack of concentrate resources. A thin wire or bar can be placed at an agreed fixed location and when the fire burns back to the line record the time.

If the volume of raw fuel is large enough the fuel surface will eventually become totally involved again. Using this procedure it will be possible to measure the time period for which the foam being tested will hold the fire back and to make comparisons by carrying out the same test using other foams.



A.7 CONTROLLING VAPOUR RELEASE OF NON BURNING FUELS

If the aim of the test is to ascertain the capability of a foam concentrate on non burning fuels (spill fires, sunken roofs, etc.) use a metal container with a lid. Apply a fixed volume of finished foam onto the fuel surface with a gentle application. After completion of the blanket evacuate the vapor space with a sample pump, test the atmosphere to confirm 0% with an explosive meter. Attach the lid, commence the timer, and wait until the explosive meter reaches the predetermined % of the LEL. It can also be done utilizing a flame to determine complete foam breakdown and the time of ignition.

A.8 GENERAL CAUTION ABOUT FLAMMABLE VAPOURS / STATIC FROM FOAM,

There are a number of recorded cases of fire ignition caused by static electricity generated during the application of foam from hand held nozzles and remote monitors. Also, it is suspected that one of the causes of re-ignition of fires after extinguishment, may be related to foam application. For these reasons, if a decision is made to apply foam when dealing with large exposed surfaces of refined product the following should be kept in mind:

- Use fixed pourers so as to apply foam as gently as possible, down the tank shell.
- Foam generated by monitors and hand held nozzles should be applied on the internal shell of the tank before being applied to the product.
- Never apply foam or water directly on the surface of hydrocarbon product.

APPENDIX B LASTFIRE

LASTFIRE – the letters of which stand for "Large Atmospheric Storage Tank Fires" - is a consortium of International Oil Companies reviewing the risks associated with fires in storage tanks and developing Best Industry Practice to mitigate these risks. The objective of LASTFIRE is to have the role as the established recognised International Oil and Petrochemical Industry forum on Best Practices of Fire Hazard Management of Storage Tanks.

The LASTFIRE Group was set up in the early 1990s when it was recognised that there was no truly rigorous test for performance testing of foam concentrate specifically aimed at the requirement for tank fires, which suitably simulated the special considerations for tank incidents such as forceful foam impact, hot tank walls and distorted tank shells. The original LASTFIRE project, which was limited to open top floating roof tanks was completed in June 1997. This resulted in the LASTFIRE Group developing a special test, called the LASTFIRE test, which assesses the specific performance aspects required for major tank incidents.

The main features of the LASTFIRE test which make it particularly relevant to storage tank application are:

- *Relatively long preburn time (3 minutes compared to 1 minute or less with other tests.)*
- *High freeboard allowing hot metal surfaces to develop.*
- *Obstructions in the path of foam flow to create swirling of the foam and simulate areas of tank deformation during a fire.*
- *Realistic application techniques simulating the equipment available on the market.*
- *Critical application rates.*

There is one set of official LASTFIRE test nozzles but several companies – manufacturers and end users – have copied them so they can carry out their own assessments. The official nozzles are used to test any concentrate requiring batch testing. Any certificate is issued for a specific batch, it is not a type certificate.

Ideally, only one type of foam concentrate should be kept on site to avoid the possibility of cross-contamination and to simplify foam application. Whilst the LASTFIRE test is aimed specifically at determining the suitability of foams for the applications stated above, LASTFIRE advises Users that it should always be remembered that this may not be the only application or indeed the most critical to consider in the overall selection of foam concentrate.

As work on the original project progressed, it was recognised that there have been significant developments in risk reduction options and additional experience in tank fire response and the need for further work by the Group was identified. The current concentration of the LASTFIRE Group is boilover studies which aims to provide Emergency Responders with better information on time to boilover, boilover consequences, fire fighting foam application strategies etc..

LASTFIRE is the recognised Oil and Petrochemical Industry forum and it is the intention that the Group will continue its work on deliverables for the Industry, e.g.

- An *incident database* establishing incident frequency statistics related to fires in open top floating roof storage tanks.
- A *Risk Reduction Options* document which discusses the various options available to an operator to reduce risk.
- A *Risk Workbook* which allows an operator to develop site specific risk based Fire Hazard Management policies.
- A *test protocol* for the evaluation of a fire fighting foam and its performance related to the specific requirements of a storage tank fire.
- A *training video*, made by fire fighters for fire fighters, describing the strategies and tactics for responding to rimseal fires in open top floating roof tanks.

For further information on LASTFIRE contact the Project Coordinator, Resource Protection International, at www.resprotint.co.uk/lastfire.htm

APPENDIX C USEFUL CONVERSIONS

LENGTH

LENGTH Centimetres (cm)	Cm or inches	Inches (in)
2.54	1	0.394
5.08	2	0.787
7.62	3	1.181
10.16	4	1.575
12.70	5	1.969
15.24	6	2.362
17.78	7	2.756
20.32	8	3.150
22.86	9	3.543
25.40	10	3.937
50.80	20	7.874
76.20	30	11.811
101.60	40	15.748
127.00	50	19.685
152.40	60	23.622
177.80	70	27.559
203.20	80	31.496
228.60	90	35.433
254.00	100	39.370

VOLUME

VOLUME litres	Litres or Imperial gallons	Imperial Gallons
4.546	1	0.220
9.092	2	0.440
13.638	3	0.660
18.184	4	0.880
22.730	5	1.100
27.276	6	1.320
31.822	7	1.540
36.368	8	1.760
40.914	9	1.980
45.460	10	2.200
90.919	20	4.399
136.379	30	6.599
181.839	40	8.799
227.298	50	10.998
272.758	60	13.198
318.217	70	15.398
363.677	80	17.598
409.137	90	19.797
454.596	100	21.997

VOLUME U.S. gallons	Imperial Gallons	Litres
1	0.83	3.79
2	1.67	7.57
3	2.50	11.36
4	3.33	15.14
5	4.16	18.93
6	5.00	22.71
7	5.83	26.50
8	6.66	30.28
9	7.49	34.07
10	8.33	37.85
20	16.65	75.71
30	24.98	113.56
40	33.31	151.42
50	41.63	189.27
60	49.96	227.12
70	58.29	264.98
80	66.61	302.83
90	74.94	340.69
100	83.27	378.54

CONVERSION FACTORS

To convert	Into	X = multiply / = divide		To convert	into	X = multiply / = divide
acres	sq. kilometres	x 0.247		acres	sq. miles	/ 640
acres	sq. Metres	x 4047		acres	hectares	x 0.4047
barrels oil	Imp. Gallons	x 34.97		barrels oil	US Gallons	x 42
barrels oil	Litres	x 159				
centimetres	Inches	/ 2.54		centimetres	feet	/ 30.48
centimetres	Millimetres	x 10		centimetres	metres	/ 100
cubic cm	cubic inches	x 0.06102		cubic cm	litres	/ 1000
cubic feet	cubic metres	x 0.0283				
feet	Centimetres	x 30.48		feet	metres	x 0.3048
fl ozs Imp	fl ozs USA.	x 0.961		fl ozs USA	fl ozs imp	x 1.041
inches	Centimetres	x 2.54				
kilograms	Pounds	x 2.2046		kilograms	Tons (Imp)	/ 1016
kilograms	tons USA	/ 907				
kilometres	Miles	x 0.6214				
litres	gallons Imp	x 0.2200		litres	gallons USA	x 0.2642
litres	pints Imp	x 1.760		litres	pints USA	x 2.113
metres	Yards	/ 0.9144				
miles	Kilometres	x 1.609				
millimetres	Inches	/ 25.4				
pounds	Kilograms	x 0.4536				

APPENDIX D ABOUT JOIFF

The Organisation for Emergency Services Management

The overall aim of JOIFF is to work to improve standards of safety and of the working environment in those sectors in which its members operate. Full Membership of JOIFF is open to any organisation which is a high hazard industry and/or has nominated personnel as emergency responders who provide cover to industrial/commercial organisations. Corporate Membership is open to Organisations which do not fully comply with the requirements for full membership but who wish to support JOIFF. The member is represented in JOIFF by nominated personnel.

Membership of JOIFF offers the following:

1. Shared Learning: JOIFF aims to fill the information vacuum that exists in the Industrial/ Commercial Sectors represented by its members, by sharing valuable information through its email cascade amongst all its membership and to work to ensure that members benefit from the misfortunes of some to ensure that the same mistakes are not repeated. An archive of all this information is available to Members for reference purposes through a password system, on the JOIFF website.

2. Accredited Training: Through its Training Standards Committee, JOIFF has developed a series of training courses/programmes which it has accredited. Courses/programmes are carried out at JOIFF approved training establishments and in modular form on company sites under the supervision of JOIFF approved instructors. All Courses must be consistent with the agreed JOIFF syllabi, site and instructor requirements.

3. Information dissemination:
JOIFF publishes a quarterly newsletter called The Catalyst which can be downloaded from the JOIFF website. JOIFF organises seminars, conferences and workshops on subjects of interest to JOIFF Members. The members section of the JOIFF website is regularly updated with matters of interest to Members.

4. Technical Advisory Group:
JOIFF participates in advising Governments and other organisations on policy making matters that effect its members with a view to improving standards of safety and of the working environment in Industry worldwide.

JOIFF welcomes applications for Full and Corporate Membership.

JOIFF Secretariat:
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