Guidance Note

Fire Industry Association

# Guidance on Regular Testing of Fire Fighting Foam Concentrates and Discharged Foam Solutions

## SCOPE

Foam systems consist of supplies of foam concentrate and water feeding into a proportioner which mixes them in a predetermined ratio, before the resulting foam solution flows through pipework to discharge nozzles. The key constituents – the foam concentrate and the foam proportioner, need to be tested, at least annually, to verify that the foam is up to specification and the proportioner is working accurately.

This guide has been prepared to provide clear information for owners of foam systems and for fire system technicians involved in the testing of foam systems. It will provide information on:

- What testing needs to be carried out.
- How and where foam samples should be taken.
- How samples should be analysed.
- What reports should be provided, and
- How to understand and action the contents of these reports.

Foam system standards require that the concentrate is tested by a competent laboratory, to establish that it remains effective as a fire fighting foam. The laboratory will issue a report on the properties and condition of the foam concentrate samples tested.

In addition, it is also necessary to verify that the foam proportioner continues to mix the foam concentrate and water in the correct ratio within permitted tolerance. This involves the proportioner producing foam solution when operating within its intended pressure and flow range. Samples of the foam solution produced are collected and its ratio of foam concentrate in water measured. This may be done using field instruments by a competent technician or at a foam testing laboratory, and a report produced.

# INTRODUCTION

### *Who requires testing?*

Testing of foams is required by:
- Owners and operators of foam systems.
- Organisations in the testing of foam systems.

### *Who collects samples?*

- Any person designated to do so, in line with the recommendations of this fact file.

### *Who conducts field testing?*

- Persons with the requisite knowledge and experience in the testing of foam systems.

### *Who conducts lab testing?*

- Foam concentrate manufacturers.
- Foam equipment manufacturers.
- Specialist testing laboratories.

### *Why test?*

- **Foam concentrates** and **foam solutions** deteriorate over time.
- Standards and codes require regular testing of foams and foam equipment.
- To establish the continued performance of the foam systems as designed.

### *What is tested?*

- All fire fighting foams and equipment.
- Foam used for vapour suppression.
- New foam and new system commissioning.
- Stored foams and in service equipment.

### *Current standards*

A review of current standards provides varying recommended periods for regular testing of foam agents but generally at least annually.
- NFPA 11: Standard for low, medium and high expansion foam.
- EN 13565-2.
- EN 1568.
- ISO 7206.
- IMO in MISC 1/Circ 1312 (marine applications).

## WHAT ARE THE TESTS DESIGNED TO DO?

The tests are intended for:

a. Regular assessment of foam concentrate and foam solution.

Required sampling of stored foam agent and the analysis of physical properties (and perhaps a fire test) should be carried out at laboratories or authorised service suppliers acceptable to the end-users or operators. The use of recognised laboratories ensures:

- Trained and competent staff.
- Established procedures.
- Constant temperature and controlled conditions.
- Repeatable testing.

b. Regular foam system quality testing.

Carried out by suitably trained personnel, whether they be end users, operators, or authorised service suppliers. Test methodologies for determination of *proportioning ratio, expansion ratio and drain time* are detailed under a number of standards (2.4). The physical properties and test protocols for foams are generally as per NFPA 11 and EN 1568.

***Sampling***

***How to take a sample***

***Produced foam***

Produced foam samples should be taken from as close as possible to the point where the foam reaches the designated discharge area.

Before taking a sample, activate the foam system long enough to remove standing columns of water (which otherwise would contribute to a diluted produced foam sample), and sample when the system is in equilibrium.

Sample size for foam proportioning systems at least;

- One litre of foam concentrate.
- One litre of Induction water.
- 0.5 litre of produced foam.

Sample size for premix foam systems at least;

- Two litre of premixed foam

***Collecting samples from nozzles, monitors and overhead sprinklers:***

- Collect sample from the point of impact in the discharge area.

***Collecting samples from foam pourers:***

- Insert sample container into the edge of produced foam stream and take a sample.

***Foam concentrate***

**Samples required:**

For each report, please provide at least:

• One litre of foam concentrate.

***Collecting samples from foam tank***

If a foam concentrate is contaminated or degraded, samples taken from the top and bottom of a storage tank are likely to have different physical properties. For this reason, we recommend concentrates should not be circulated prior to sampling.

Normally, two samples per storage tank are taken:

• One sample from the bottom (one litre).

• One sample from the top (one litre).

If you have access to a tank sampling jar with removable bung, we recommend taking an additional one litre sample from the middle of the tank.

**The contents of a tank should not be circulated where dilution or contamination of the foam concentrate is suspected to have occurred.** We also recommend that the tank is labelled with 'awaiting foam test results' and the date that the sample was taken.

Once the samples have been taken, the tank should not be circulated until the samples have been tested and the results obtained. However, if it is only possible to take one sample, then circulate the tank to obtain a 'composite sample' prior to taking a one litre sample.

***Taking a foam concentrate sample from the bottom of a tank***

When taking a sample from the bottom of a foam storage tank, it is important that any sludge, sediment, rust, scale etc, is removed before collection of the sample.

To do this, draw off at least 5-10L of product before taking a sample. Once it runs clear, any excess sample may be returned to the top of the tank.

***Sampling foam concentrate from a drum***

• Take a one litre sample from the top of the drum.

If there are multiple batches, it is desirable to take a sample from each batch.

If the results are adverse, then mix the contents of the drum and take an additional one litre sample.

***How to label samples***

Ensure that the labels are completed immediately after filling the sample container. To be able to interpret the test results correctly, all the label information must be accurate.

The container should be labelled with the following information at a minimum:

• Company name.

• Foam type.

• Brand name.

• Concentration (ie 1%, 3%, 6%).

• Date of sample collection.

• Sample source (tank or drum number, top, middle or bottom and any other relevant information).

## LABORATORY TESTING

Tests carried out on foam concentrate samples are on the whole determined by the laboratory chosen to do the assessment. This means that there is no standard suite of tests to which a foam sample is subjected, although many of the tests and particularly those measuring physico-chemical properties are duplicated between different laboratories.

Furthermore, the tests chosen may not follow a specified standard procedure such as ASTM or BS EN, and this is particularly so where it is not an intrinsic property of the foam concentrate being measured. Thus for the more performance related tests, it is likely that the procedure will be specific to the laboratory undertaking the testing.

Consequently, it can be difficult to make meaningful inter-laboratory comparisons of results and especially so if a second opinion is being sought.

### *Physico-chemical properties*

Typical properties that are routinely tested in this category include pH, viscosity, freezing point, specific gravity and undissolved solids, but this list is not exhaustive. A brief description of some of the tests is given below:

- Appearance (visual).
- *pH* – a measure of the acidity/alkalinity of the sample and done with a combination electrode. (BS EN 1568 and BS 1647).
- *Viscosity* – typically measured by u-tube viscometer for Newtonian samples or Brookfield viscometer for non-Newtonian samples.
- *Freezing point* – simply measured by thermometer in a freezing bath or by a dedicated freezing point apparatus.
- *Specific gravity* – a measure of the strength of the sample and done by hydrometer (Newtonian samples) or density bottle (non-Newtonian samples).
- *Undissolved solids (sludge)* – a centrifuge is used to separate the sample into liquid and solid phases.
- Refractive index (according to international standard NFA11 11 – 71 D2.1.1).
- Surface tension (according to international standard ASTM D-971).

Depending on the end use of the foam some tests may be omitted.

### *Performance tests*

An assessment of the physico-chemical properties can give useful information as to the condition of a foam concentrate sample, but ultimately its continued suitability for use depends on how effective it is at extinguishing flammable liquid fires.

To determine this, the ability of a foam concentrate sample to produce an expanded foam at a given induction rate is tested. Practical foaming testing is always included to measure both the amount of expanded foam produced (expansion ratio) from a solution, and the longevity of that foam (25% drainage time).

Dependent on the foam type, the assessment of foam properties may be made using low, medium or high expansion foam generating apparatus.

It should be noted that small scale laboratory foam generators tend to be highly efficient and therefore may not be truly representative of what full scale equipment can achieve. Consequently, whilst the result can be used to ascertain whether the foam sample is in satisfactory condition, it may not accurately reflect what the customer's foam equipment is capable of producing.

As well as measuring foam properties, a test which examines fire fighting effectiveness is also included.

This may involve the direct application of expanded foam to a small fire tray containing a representative burning hydrocarbon or polar solvent.

Alternatively, it may be done indirectly by measuring some other attribute that can be related to fire performance, such as aqueous film formation or oil repellency.

Dependent on the result of the small scale tests, full scale fire testing may be required.

The type of foam concentrate will generally determine which test is most appropriate.

Clearly like all other foam types, the ability to generate stable, expanded foam is crucial and so foam properties can be measured as has previously been discussed. The problem arises when deciding upon a laboratory performance test that will accurately reflect and predict in-service fire fighting use. This issue is particularly pertinent when testing the continued effectiveness of these products on hydrocarbon fires.

• 25% drainage (according to international standards BS EN 1568 G and NFPA 11 Annex D).

## FIELD TESTING

***General***

Field testing is carried out in order to:

• To establish that the system is performing in accordance with the system design.

Field testing is carried out:

a) When any new foam system is installed.

b) For regular performance assessment of existing systems.

Tests comprise as minimum:

• Measurement of foam solution concentration

In addition, the following may also be carried out:

• Measurement of expansion ratio and

• Measurement of 25% drain time.

The results from the commissioning tests should be recorded and used as comparison for the regular testing.

Due to the nature of field testing, ie in an uncontrolled environment, it is recommended that samples are also sent to a laboratory for confirmation of the results.

Data relating to the site and conditions should be recorded; such data should include but not be limited to:

• Date.

• Location.

• Time of day.

• Ambient temperature.

• Precipitation.

• Wind speed/direction.

• Water source – fresh/salt.

• Water temperature.

• System/equipment details.

• Proportioning method.

• Discharge device(s).

• Type of foam agent.

• Manufacturer and brand name.

• Batch No/manufacturing date.

***Test Equipment:***

Most foam concentrate manufacturers/suppliers offer foam quality test equipment which usually includes:

Battery operated scale (usually 0.1g accuracy).

Measuring cylinders – 100/250ml capacity.

Stopwatches.

Refractomer/conductivity meter.

Thermometer.

Solution containers – minimum 100ml capacity.

Some may also offer pH meter, foam collection containers and the foam collection board.

NFPA 11 and EN 1568 documents both have good descriptions and drawings of the collection beakers and collection board so that an end-user or service company can manufacture their own.

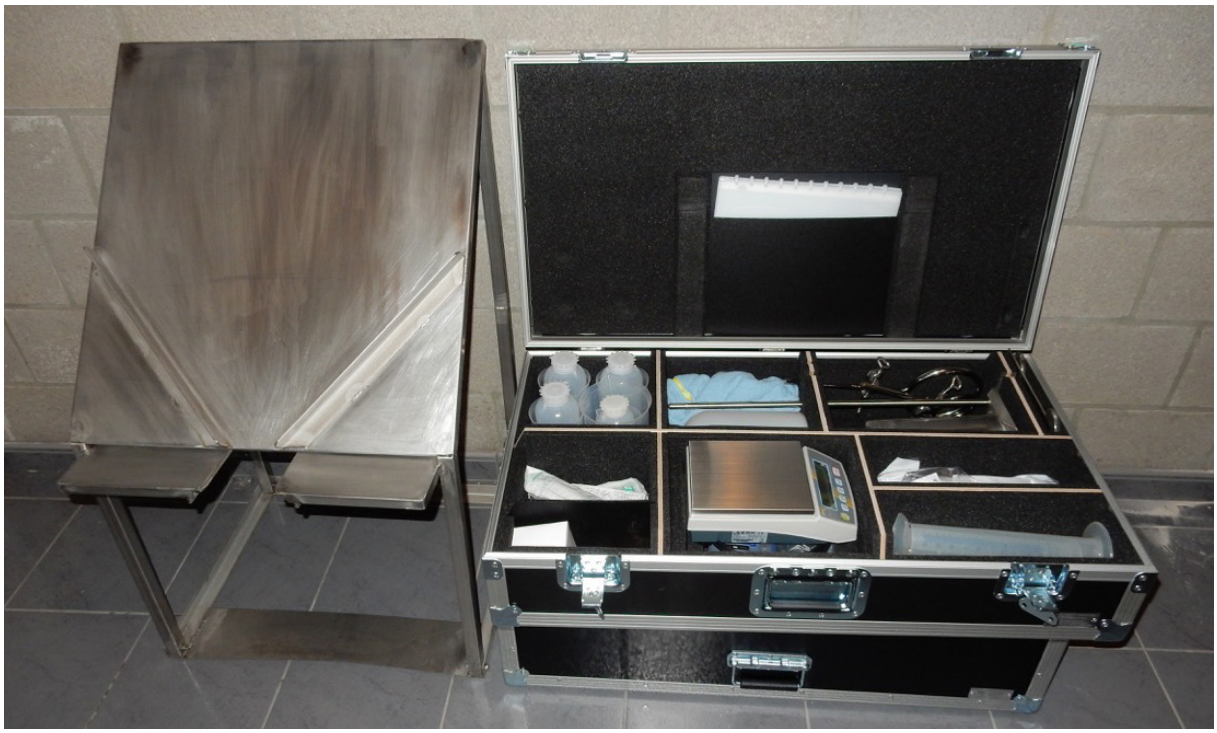

*Figure 1: Typical field test kits from a foam manufacturer.*

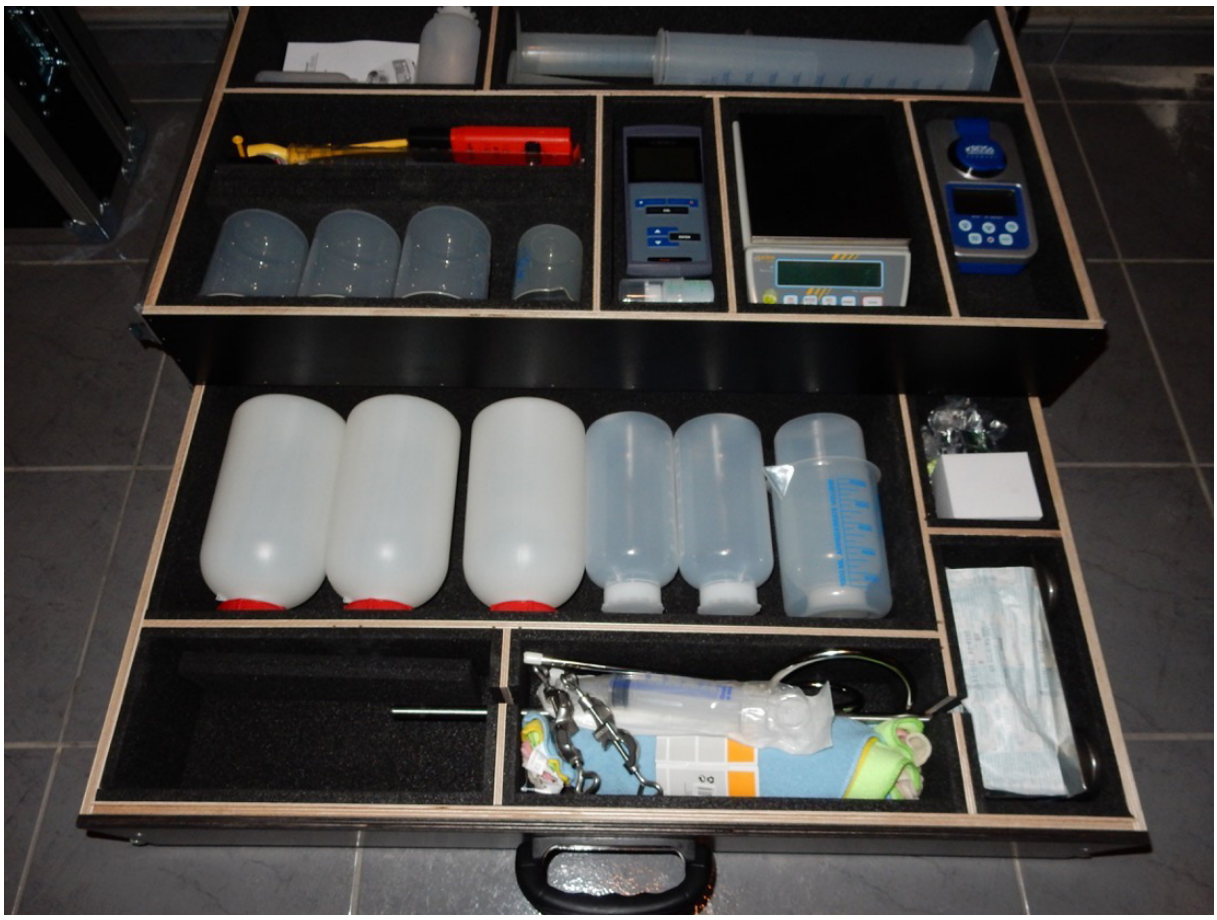

*Figure 2: Typical test kits from a foam manufacturer.*

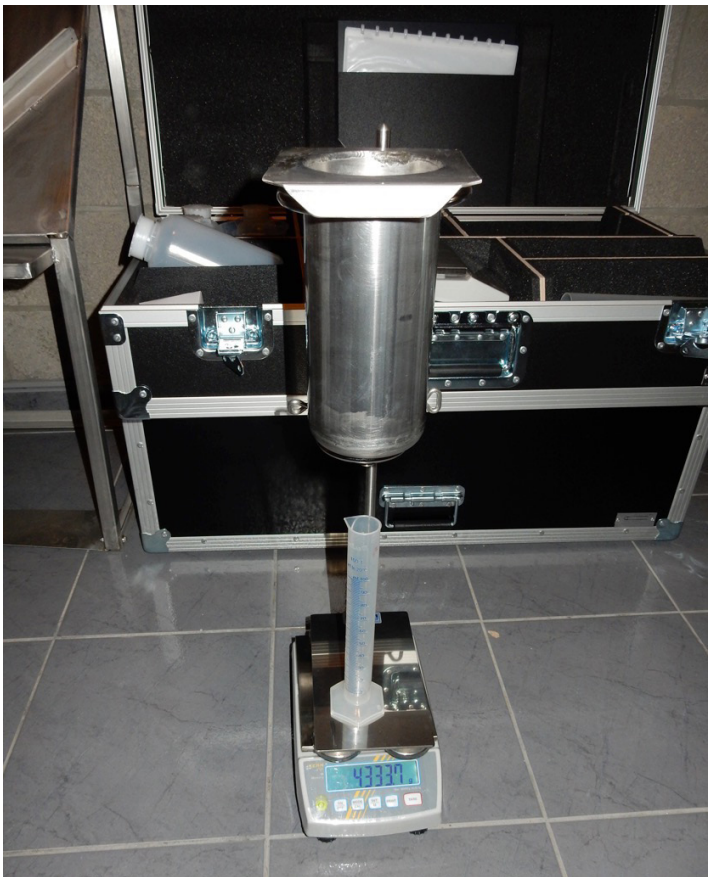

*Figure 3: Collection container, stand and scale.*

The two commonly accepted methods for measuring foam concentrate percentage in water are:

- The **refractive index** method, and
- The **conductivity** method (recommended in fresh water only).

Both methods are based on the comparison of foam solution test samples in the field, with calibration samples prepared using the same foam concentrate and water as in the system being tested. The measurements from the calibration samples are plotted onto a graph of per cent concentration versus instrument reading, and this is used as the baseline against which the sample from the system test is analysed.

There are limitations to both methods, although better quality refractometers and temperature compensating conductivity meters have helped the testing. Other issues to be aware of are that samples should be taken an adequate distance from the proportioning system, and also after an adequate time for stable flow to be achieved. This is particularly notable when using pseudo-plastic foam concentrates such as alcohol resistance AFFFs, FFFPs, and many of the fluorine-free type foam concentrates.

In addition, the measurement of the foam concentration can be achieved via a colorimeter.

# TEST REPORTS

### *Foam concentrate test report*

#### *Content*

As in the case of the test protocols employed, there is no standard format for reporting the results and conclusions. Rather each one is individual to the particular laboratory doing the test.

A typical report will reference the sample type and identifier as submitted by the customer. It will list the individual tests that have been carried out, and against each will display the measured value as recorded for the sample in question.

It will specify the method of production used (ie branchpipe).

It may also state the manufacturers'/laboratories' expected criteria against which the sample is being judged.

Finally, there will be a concluding statement as to the suitability of the sample for continued use, and in some cases a tentative identification of foam type, where this has not been forthcoming from the customer upon submission.

An example report is given in annex A.

The most important part of any report is whether the sample is deemed to be in satisfactory condition and can therefore continue in service.

This decision rests upon the interpretation of the test results overall and whether the sample is truly representative of the stock from which it was taken.

#### *Interpretation of results*

Satisfactory/unsatisfactory criteria are normally specific to the test laboratory, although sometimes they will reflect national standards.

Judgements on whether the performance is considered acceptable are usually made from experience of what a particular foam type can be expected to achieve, and what the typical physico-chemical properties should be. However, some elements of the test programme may carry more weight than others and this may be particularly so in the case of the performance related tests.

For example, if the pH was unexpectedly high or low, then it would not necessarily result in the immediate failure of the sample. Rather, a cautionary note might be added to the report to alert the customer to the fact and advise them of the possible consequences.

However, if a sample had displayed reduced foam stability on polar solvents, then this would certainly prompt a failure, since it would mean that there was a fundamental deficiency in its fire fighting effectiveness.

As well as deciding whether or not a sample is in satisfactory condition, it is also sometimes possible to assign an unknown sample a particular categorisation (eg AFFF, FFFP-AR etc).

By considering particular aspects of the sample such as visual appearance, specific gravity, viscosity and surface tension, many samples may be correctly identified. In fact, the ability to do this is crucial if 'fitness for purpose' is then to be decided upon.

***Proportioned foam solutions report***

***content***

A typical report will reference the sample type and identifier as submitted by the customer. It will list the test carried out and include the calibration graph with the measured value as recorded for the sample in question.

Interpretation of results

Pass/fail criteria will be judged against the appropriate standard (NFPA/EN/ISO).

***Premix (ready to use) foam test report***

***Content***

A typical report will reference the sample type and identifier as submitted by the customer. It will list the individual tests that have been carried out, and against each will display the measured value as recorded for the sample in question. Different to foam concentrate solutions, the tests will be limited to foam properties.

***Interpretation of results***

Satisfactory/unsatisfactory criteria are normally specific to the test laboratory, although sometimes they will reflect national standards.

## ENVIRONMENTAL CONSIDERATIONS

Foam testing should be done in an environmentally responsible manner.

Non-essential discharges should be avoided.

Suitable foam concentrate substitutes may be used or, where discharge is necessary, the foam solutions should be contained, collected and disposed of in accordance with local authority guidelines.

# ANNEX A

*[EXAMPLE FOAM TEST REPORT – PRODUCED FOAM]*

**FIRE FIGHTING FOAM TEST REPORT**

**IMPORTANT – REPORTS ATTACHED**

**FOR THE ATTENTION OF:**

| | | | |
|---|---|---|---|
| **CONTACT:** | | **POSITION:** | |
| **COMPANY:** | | **LOCATION:** | |
| **DATE:** | | | |

**Number of pages (including this sheet):**

Please find enclosed our test report(s) [.....] relating to your fire

fighting foam samples received on the [.....].

We would like to draw your attention to the comments made in the area of the test report marked 'conclusion'.

**Please note:** the results of this analysis are solely representative of the sample(s) submitted to our laboratory.

Thank you for placing your foam testing requirements with our laboratory. Should you require any further information, please do give me a call on [number].

Yours sincerely

[SIGNED]

Foam testing laboratory

PS: We will retain your foam samples for a period of three months before disposal unless we hear from you.

**If you have any queries regarding this report, please contact the foam test laboratory:**

**Tel: [.....]** **Email: [.....]** **Web: [.....]**

# [EXAMPLE FOAM TEST REPORT – PRODUCED FOAM]

**FIRE FIGHTING FOAM TEST REPORT**

**PRODUCED FOAM**

| | | | |
|---|---|---|---|
| **CUSTOMER:** | | **CUSTOMER REF. NO.:** | |
| **LOCATION:** | | **SAMPLE POINT:** | |
| **FOAM TYPE:** | | | |
| **LABORATORY REF. NO.:** | | **DATE:** | |

**TEST RESULTS**

| **TEST DESCRIPTION** | **RESULT** |
|---|---|
| **APPEARANCE:** | |
| **SEDIMENT (% v/v)** | |
| **INDUCTION MEASURED (% v/v)** | |

*NOTE: Acceptable ranges for produced foam*

NFPA guidelines recommend that produced foam results be compared with the results obtained when your system was first commissioned.

The two recognised commissioning standards are:

> NFPA 11 2010 Edition, Clause 11.6.4 > EN 13565-2, (clause) 11.3.2.4

The 'acceptable ranges for proportioning percentage' found in these standards are:

| **PRODUCED FOAM** | **NFPA 11** | **EN 13565-2** |
|---|---|---|
| **1%** | 1.0-1.3% | 1.0-1.25% |
| **3%** | 3.0-3.9% | 3.0-4.0% |
| **6%** | 6.0-7.0% | 5.0-6.0% |

**CONCLUSION**

The submitted sample has been tested according to international standards NFPA 11 and BS 5306 and was found to be in a [……] condition.

**[SIGNED]**

**Tel: [……]** **Email: [……]** **Web: [……]**

## EXAMPLE FOAM TEST REPORT – PRODUCED FOAM]

**FIRE FIGHTING FOAM TEST REPORT**

**PRODUCED FOAM TEST REPORT GLOSSARY**

The purpose of a produced foam test report is to determine the suitability and accuracy of a foam system's proportioning and induction equipment.

Each produced foam test report shows the calculated % induction obtained from the sample provided. This result is compared against the two Internationally recognised foam standards:

> NFPA 11 2010 Edition, Clause 11.6.4

> EN 13565-2, (clause) 11.3.2.4

***Results outwith these ranges mean your foam sample will be deemed unsatisfactory.***

| TEST DESCRIPTION | WHAT IS THIS? |
|---|---|
| **APPEARANCE:** | How the foam concentrate sample looks – checking for colour, visible sediment and homogeneity. |
| **SEDIMENT (% v/v)** | The measure of insoluble or particulate matter in the foam concentrate sample. |
| **INDUCTION PERCENT MEASURED** | Calculation of the % induction of the produced foam sample supplied. Evaluation is made by comparing samples made up at different percentages using the supplied samples of induction water and foam concentrate. |

*Note: the results obtained are based entirely on the samples sent which may or may not be representative.*

WHAT SAMPLES ARE REQUIRED?

For each produced foam test report, we require:

> 1 litre of foam concentrate

> 1 litre of induction water

> 0.5 litre of produced foam

**Free sample bottles are available on request – please contact us for further information.**

## [EXAMPLE FOAM TEST REPORT – FOAM CONCENTRATE]

**FIRE FIGHTING FOAM TEST REPORT**

**IMPORTANT – REPORTS ATTACHED**

**FOR THE ATTENTION OF:**

| | | | |
|---|---|---|---|
| **CONTACT:** | | **POSITION:** | |
| **COMPANY:** | | **LOCATION:** | |
| **DATE:** | | | |

**Number of pages (including this sheet):**

Please find enclosed our test report(s) [.....] relating to your fire fighting foam concentrate samples received on the [.....].

We would like to draw your attention to the comments made in the area of the test report marked 'conclusion'.

Please note: the results of this analysis are solely representative of the sample(s) submitted to our laboratory.

Thank you for placing your foam testing requirements with our laboratory. Should you require any further information, please do give me a call on [number].

Yours sincerely

[SIGNED]

Foam testing laboratory

PS: We will retain your foam samples for a period of three months before disposal unless we hear from you.

**If you have any queries regarding this report, please contact the foam test laboratory:**

**Tel: [.....]** **Email: [.....]** **Web: [.....]**

# [EXAMPLE FOAM TEST REPORT – FOAM CONCENTRATE]

**FIRE FIGHTING FOAM TEST REPORT**

**FOAM CONCENTRATE**

| | | | |
|---|---|---|---|
| **CUSTOMER:** | | **CUSTOMER REF. NO.:** | |
| **LOCATION:** | | **SAMPLE POINT:** | |
| **FOAM TYPE:** | | | |
| **LABORATORY REF. NO.:** | | **DATE:** | |

**TEST RESULTS**

| **TEST DESCRIPTION** | **RESULT** |
|---|---|
| **APPEARANCE (VISUAL)** | |
| **SPECIFIC GRAVITY @ 20˚C** | |
| **pH @ 20˚C (BS EN 1568, BS 1647-2)** | |
| **SURFACE TENSION @ 20˚C (N/m) (ASTM D-971, ISO 304)** | |
| **SEDIMENT (% v/v)** | |
| **VISCOSITY @ 20˚C (mPa.S)** | |
| **FREEZE POINT (˚C)** | |
| **¼ DRAINAGE TIME (UK Defence Std branchpipe) (BS EN 1568 G, NFPA 11 ANNEX D)** | |
| **EXPANSION RATIO (UK Defence Std branchpipe) (BS EN 1568 G, NFPA 11 ANNEX D)** | |
| **FIRE EXTINGUISHMENT PERFORMANCE (SMALL SCALE TEST)** | |

**CONCLUSION**

**The submitted sample was tested and found to be in a […….] condition.**

Please note this result is only our opinion and has been reached without sight of your foam supplier's sales sheet.

It is strongly recommended that these results are compared with the physical properties listed on your foam supplier's sales sheets – if you require any assistance, please do call our foam test laboratory.

[SIGNED]

**Tel: […….]** **Email: […….]** **Web: […….]**

# EXAMPLE FOAM TEST REPORT – FOAM CONCENTRATE]

**FIRE FIGHTING FOAM TEST REPORT**

**FOAM CONCENTRATE TEST REPORT GLOSSARY**

**A quick guide to the different tests and why they are important.**

The features listed below are tested as part of your foam concentrate test report.

We strongly recommend that these results are compared with the original manufacturer's specifications. If they do not match, it can indicate any of the following issues:

> contamination > evaporation > dilution

> degradation > decomposition

**If you require any assistance, please do not hesitate to call our foam test laboratory.**

| TEST DESCRIPTION | WHAT IS THIS? |
|---|---|
| **APPEARANCE** | How the foam concentrate sample looks – checking for colour, visible sediment and homogeneity. |
| **SPECIFIC GRAVITY** | The ratio of a given value of liquid compared to the weight of an equal volume of water. |
| **pH** | The alkalinity or acidity of the foam concentrate sample. |
| **SURFACE TENSION** | An indication of how well the foam will spread across the surface of a fire in use. |
| **SEDIMENT** | The measure of insoluble or particulate matter in the foam concentrate sample. |
| **VISCOSITY** | The thickness of the foam concentrate sample in comparison with water. |
| **FREEZE POINT** | The temperature at which the foam concentrate sample changes from a liquid to a solid phase (crystallises). |
| **¼ DRAINAGE TIME** | The speed at which water drains from the foam; also known as the 25% drainage test. Test done using a UK Defence Std branchpipe, application rate of five litres per minute at 5.5 bar (AFFF foams) or 7.0 bar (AR & Protein foams). This is a critical indication of a foam's stability. |
| **EXPANSION RATIO** | The ratio of foam produced compared with the volume of concentrate used, eg a ratio of 7:1 means one litre of foam concentrate produces seven litres of foam. Test done using a UK Defence Std branchpipe. |
| **FIRE EXTINGUISHMENT** | An indicative test of the foam's performance in extinguishing fires using a small scale test pan. |

**Note:** the results obtained are based entirely on the samples sent which may or may not be representative.

**WHAT SAMPLES ARE REQUIRED?**

For each foam concentrate test report, we require: >1 litre of foam concentrate

**Free sample bottles are available on request – please contact us for further information.**

*DISCLAIMER*
*The information set out in this document is believed to be correct in the light of information currently available but it is not guaranteed and neither the Fire Industry Association nor its officers can accept any responsibility in respect of the contents or any events arising from use of the information contained within this document.*

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