

**MSC/Circ.798**  
(9 June 1997)

**Guidelines for performance and testing criteria and surveys of medium-expansion concentrates for fire-extinguishing systems**

1 The Maritime Safety Committee, at its sixty-eighth session (28 May to 6 June 1997), approved Guidelines for performance and testing criteria and surveys of medium-expansion foam concentrates for fire-extinguishing systems, given in the annex.

2 Member Governments are recommended to ensure that tests for type approval and periodical controls of the medium-expansion foam concentrates are performed in accordance with the annexed Guidelines.

Annex

**Guidelines for performance and testing criteria and surveys of medium-expansion foam concentrates for fire-extinguishing systems**

**1 General**

**1.1 Application**

These Guidelines apply to the foam concentrates for medium-expansion foam fire-extinguishing systems referred to in SOLAS regulation II-2/61.

**1.2 Definitions**

For the purpose of these Guidelines the following definitions apply:

**1.2.1** Foam (*fire fighting*): an aggregate of air filled bubbles formed from an aqueous solution of a suitable foam concentrate.

**1.2.2** Foam *solution*: a solution of foam concentrate and waters.

**1.2.3** Foam concentrate: the liquid which, when mixed with water in the appropriate concentration, gives a foam solution.

**1.2.4** *Expansion ratio*: the ratio of the volume of foam to the volume of foam solution from which it was made.

**1.2.5** *Spreading coefficient* a measurement of the ability of one liquid to spontaneously spread across another.

**1.2.6** *25% (50%) drainage time*: the time for 25% (50%) of the liquid content of a foam to drain out.

**1.2.7** *Gentle application*: application of foam to the surface of a liquid fuel via a backboard, tank wall or other surface.

**1.2.8** *Sediment*: insoluble particles in the foam concentrate.

## **2 Sampling procedure**

**2.1** The sampling method should ensure representative samples which should be stored in filled containers.

**2.2** The sample size should be:

- .1 30 / for type tests (see section 3); and
- .2 2 / for periodical controls (see section 4).

## **3 Tests for type approval of foam concentrates**

For foam concentrate type approval, the tests under 3.1 to 3.10 should be performed. They should be carried out at laboratories acceptable to the Administration.

### **3.1 Freezing and thawing**

**3.1.1** Before and after temperature conditioning in accordance with 3.1.2, the foam concentrate should show no visual sign of stratification, non-homogeneity or sedimentation.

#### **3.1.2 Freezing and thawing test**

- .1 Apparatus:
  - .1 freezing chamber, capable of achieving temperatures required as stated in .2.1 below;
  - .2 polyethylene tube, approximately 10 mm diameter, 400 mm long and sealed and weighted at one end, with suitable spacers attached (figure 1 of MSC/Circ.582 shows a typical form); and
  - .3 500 ml cylinder approximately 400 mm high and 65 mm in diameter.

.2 Procedure:

- .1 set the temperature of the freezing chamber to a temperature which is 10°C below the freezing point of the sample measured in accordance with BS 5117: section 1.3 (excluding 5.2 in the Standard);

To prevent the glass measuring cylinder from breaking, due to expansion of the foam concentrate on freezing, insert the tube into the measuring cylinder, sealed end downward, weighted if necessary to void floatation, the spacers ensuring it remains approximately on the central axis of the cylinder.

Place the sample in the cylinder in the chest, cool and maintain at the required temperature for 24 h. At the end of this period thaw the sample for not less than 24 h and not more than 96 h in an ambient temperature range of 20°C to 25°C.

- .2 repeat .2.1 above three times to give four cycles of freezing and thawing;
- .3 examine the sample for stratification and non-homogeneity; and
- .4 condition the sample for 7 days at 60°C followed by one day at room temperature.

### 3.2 *Heat stability*

An unopened 20 / container (or other standard shipping container) as supplied by the manufacturer from a production batch should be maintained for 7 days at 60°C, followed by one day at room temperature. Following this conditioning, the foam liquid after agitating/stirring will be subjected to the fire test as per 3.8, and comply with the requirements given in these Guidelines.

### 3.3 *Sedimentation*

**3.3.1** Any sediment in the concentrate prepared in accordance with section 2 should be dispersible through a 180 µm sieve, and the percentage volume of sediment should not be more than 0.25% when tested in accordance with 3.3.2.

3.3.2 The test should be carried out as follows:

- .1 Apparatus:
- .1 graduated centrifuge tubes;
  - .2 centrifuge operating at  $6,000 \pm 100 \text{ m/s}^2$ ;
  - .3 180 µm sieve complying with ISO 3310-1; and

.4 plastic wash bottle.

Note: A centrifuge and tubes complying with ISO 3734 are suitable.

.2 Procedure:

Centrifuge each sample for 10 min. Determine the volume of the sediment and determine the percentage of this volume with respect to the centrifuged sample volume. Wash the contents of the centrifuge tube onto the sieve and check that the sediment can or cannot be dispersed through the sieve by the jet from the plastic wash bottle.

Note: It is possible that the test method is not suitable for some non-Newtonian foam concentrates. In this case an alternative method, to the satisfaction of the Administration, should be used so that compliance with this requirement can be verified.

3.4 *Kinematic viscosity*

**3.4.1** The test should be carried out according to ASTM D 445-86 or ISO 3104. Kinematic viscosity should not exceed 200 mm<sup>2</sup>/s.

**3.4.2** The method for determining viscosity of non-Newtonian foam concentrates should be to the satisfaction of the Administration.

3.5 *pH value*

The pH value of the foam concentrate should be not less than 6 and not more than 10 at temperature of 20 + 2°C.

3.6 *Expansion ratio*

3.6.1 The test should be carried out in accordance with 3.6.2 with seawater at about 20°C. Simulated seawater with the characteristics stated under 3.6.3 may be used. The expansion ratio obtained with the foam generators used on board should be consistent with the expansion ratio obtained with the foam generators during the fire test.

3.6.2 Determination of the expansion ratio:

.1 Apparatus:

.1 plastic collecting vessel of volume (V), approximately 200 l and accurately known to + 2 l;

(An example of suitable vessel is given in ISO 7203-2)

.2 medium-expansion foam-making equipment which when tested with water has a flow rate not less than 3 + 0.1 l/min at a nozzle pressure of 5 + 0.1 bar.

(An example of suitable apparatus is given in ISO 7203-2).

## .2 Procedure:

- .1 wet the vessel internally and weight it ( $W_1$ ). Set up the foam equipment and adjust the nozzle pressure of 5 + 0.1 bar. With the discharge facility closed, collect the foam in the vessel. As soon as the vessel is full, stop collecting foam and strike the foam surface level with the rim. Weigh the vessel ( $W_2$ ). During the filling operation, keep the discharge facility in the bottom of the vessel closed until the total weight of the foam is determined;
- .2 calculate the expansion  $E$  from the equation:

$$E = \frac{V}{W_2 - W_1}$$

where it is assumed that the density of the foam solution is 1.0 kg/l;

$V$  is the vessel volume, in *ml*;

$W_1$  is the mass of the empty vessel, in grams; and

$W_2$  is the mass of the full vessel, in grams;

- .3 open the drainage facility and measure the 50% drainage time (see 3.7.1 below).

Determine the drainage either by having the vessel on a scale and recording the weight loss, or by collecting the drained foam solution in a measuring cylinder.

**3.6.3** Simulated seawater may be made up by dissolving:

- 25 g Sodium chloride (NaCl),
- 11 g Magnesium chloride ( $MgCl_2 \cdot 6H_2O$ ),
- 1.6 g Calcium chloride ( $CaCl_2 \cdot 2H_2O$ ),
- 4 g Sodium sulphate ( $Na_2SO_4$ ).

### 3.7 Drainage time

**3.7.1** The drainage time should be determined, after having determined the expansion ratio, in accordance with 3.6.2.3.

3.7.2 The test should be carried out with seawater at about 20°C. Simulated seawater with the characteristics stated in 3.6.3 may be used.

**3.7.3** Drainage time obtained with the foam generators used on board should be consistent with the drainage time obtained with the foam generators during the fire test.

### 3.8 *Fire tests*

Fire tests should be carried out in accordance with 3.8.1 to 3.8.7 below.

Note: The fire tests of section 3.8 are more expensive and time consuming than the other tests of these Guidelines. It is recommended that fire tests should be carried out at the end of the test programme, so as to avoid expense of unnecessary testing of foam concentrates which do not comply in other respects.

#### 3.8.1 Environmental conditions

- .1 Air temperature:  $15 \pm 5^{\circ}\text{C}$ .
- .2 Maximum wind speed: 3 m/s in proximity of the fire tray.

#### 3.8.2 Records

During the fire test, the following should be recorded:

- .1 indoor or outdoor test;
- .2 air temperature;
- .3 fuel temperature;
- .4 water temperature;
- .5 foam solution temperature;
- .6 wind speed; and
- .7 extinction time.

#### 3.8.3 Foam solution

- .1 Prepare a foam solution, following the recommendations from the supplier for concentration, maximum premix time, compatibility with the test equipment, avoiding contamination by other types of foam, etc.
- .2 The test should be carried out with seawater at about  $20^{\circ}\text{C}$ . Simulated seawater with the characteristics stated in 3.6.3 may be used.

#### 3.8.4 Apparatus

- .1 Fire tray:

Circular fire tray of steel with dimensions as follows:

diameter at rim: 1,480 + 15 mm

depth: 150 + 10 mm

normal thickness of steel wall: 2.5 mm

Note: The tray has an area of approximately  $1.73 \text{ m}^2$ .

- .2 Foam-making equipment:  
In accordance with subparagraph 3.6.2.1.

### 3.8.5 Fuel

An aliphatic hydrocarbon mixture with physical properties according to the following specification should be used:

- |    |   |                               |
|----|---|-------------------------------|
| .1 | distillation range:                                       | 84-105°                       |
| .2 | maximum difference between<br>initial and boiling points: | 10°C                          |
| .3 | maximum aromatic content:                                 | 1%                            |
| .4 | density at 15°:   | 707.5 + 2.5 kg/m <sup>3</sup> |
| .5 | temperature:  | about 20°C.                   |

*Note:* Typical fuels meeting this specification are *n*-heptane and certain solvent fractions sometimes referred to as commercial heptane.

The Administration may require additional fire tests using an additional test fuel.

### 3.8.6 Test procedure

**3.8.6.1** Place the tray directly on the ground and ensure that it is level. Add approximately 30 l of fresh water and 55 + 2 l of fuel, to give a nominal freeboard of 100 mm.

**3.8.6.2** Not later than 5 min after adding of a fuel, ignite the fuel and allow it to burn free for a period of not less than 180 s after the full involvement. Set up the foam equipment at a height which is equal to the upper edge of the rim as it is shown at figure 1. 200 + 5 s after full involvement of the surface into the fire, apply foam along the wall of the tray for a period of 120 + 2 s. Record the extinction time as the period from start of foam application to extinction.

### 3.8.7 Permissible limits

Extinction time % not more than 120 s.

### 3.9 Corrosiveness

The storage container shall be compatible with its foam concentrate, throughout the service life of the foam, such that the chemical and physical properties of the foam shall not deteriorate below the initial values accepted by the Administration.

### 3.10 Volumic mass

According to ASTM D 1298-85.

#### **4 Periodical controls of foam concentrates stored on board**

The attention of the Administration is drawn to the fact that particular installation conditions (excessive ambient temperature, incomplete filling of the tank, etc.) may lead to an abnormal ageing of the concentrates.

For the periodical control of foam concentrate, the tests under 4.1 to 4.5 should be performed. They should be carried out at laboratories acceptable to the Administration.

The deviations in the values obtained by these tests, in respect of those obtained during the type approval tests, should be within ranges acceptable to the Administration.

Tests under 4.1, 4.3 and 4.4 should be carried out on samples maintained at 60°C for 24 h and subsequently cooled to the test temperature.

##### **4.1** *Sedimentation*

According to 3.3 above.

##### **4.2** *pH value*

According to 3.5 above.

##### **4.3** *Expansion ratio*

According to 3.6 above.

##### **4.4** *Drainage time*

According to 3.7 above.

##### **4.5** *Volumic mass*

According to 3.10 above.

#### **5 Intervals of periodical controls**

**5.1** The first periodical control of foam concentrates stored on board should be performed after a period of 3 years and, after that, every year.

**5.2** A record of the age of the foam concentrates and of subsequent controls should be kept on board.