INTERNATIONAL MARITIME ORGANIZATION

E

4 ALBERT EMBANKMENT
LONDON SE1 7SR
Telephone: +44 (0)20 7735 7611 Fax: +44 (0)20 7587 3210

Ref. T4/4.01

MSC.1/Circ.1384
10 December 2010

GUIDELINES FOR THE TESTING AND APPROVAL OF FIXED HIGH-EXPANSION FOAM SYSTEMS

1 The Maritime Safety Committee, at its eighty-eighth session (24 November to 3 December 2010), having considered the proposal by the Sub-Committee on Fire Protection, at its fifty-fourth session, approved the Guidelines for testing and approval of fixed high-expansion foam systems, set out in the annex.

2 Member Governments are invited to apply the annexed Guidelines when approving fixed high-expansion foam systems in accordance with the revised chapter 6 of the FSS Code*, which is expected to be adopted at MSC 90 (May 2012), and bring them to the attention of ship designers, shipowners, equipment manufacturers, test laboratories and other parties concerned.

3 This circular supersedes MSC.1/Circ.1271, except that fire and component tests previously conducted in accordance with MSC.1/Circ.1271 remain valid for the approval of new systems.

***

* The draft revised chapter 6 of the FSS Code was approved by MSC 88, and is contained in the report of the Committee (MSC 88/26/Add.2, annex 8). Equipment manufacturers should prepare in advance for the adoption of the new chapter 6.

ANNEX

GUIDELINES FOR THE TESTING AND APPROVAL OF FIXED HIGH-EXPANSION FOAM SYSTEMS

1 GENERAL

1.1 Scope

1.1.1 These Guidelines specify the test procedures for the type approval of fixed high-expansion foam systems. The procedures consist of the following parts:

.1 appendix 1: fire test procedures for evaluating the fire-extinguishing effectiveness of the foam system;

.2 appendix 2: component manufacturing test procedures intended to ensure the operability of the system components in the marine environment; and

.3 appendix 3: procedures for determining the discharge capacity of the high-expansion foam generators.

1.1.2 These Guidelines are not intended for testing the performance of high-expansion foam concentrates.

1.1.3 Appendix 4 to the Guidelines is an optional small scale test intended to verify the fire-extinguishing effectiveness of high-expansion foam when made with hot, smoke-laden inside air. This test is recommended for quality control of foam concentrates, and may also be used to compare the extinguishing performance of foam concentrates made with freshwater to those made with seawater.

1.2 Product consistency

The manufacturer should be responsible for implementing a quality control programme to ensure that production continuously meets the requirements in the same manner as the originally tested samples.

1.3 Application

1.3.1 These Guidelines should be applied to both inside air foam systems and to systems using outside air.

1.3.2 All foam generators should be subjected to the fire tests and foam generator capacity tests described in appendices 1 and 3.

1.3.3 Only inside air foam generators should be subjected to the component manufacturing tests in appendix 2.

APPENDIX 1

FIRE TEST METHOD FOR FIXED HIGH-EXPANSION FOAM SYSTEMS

1 SCOPE

The test method is intended for evaluating the extinguishing performance of high-expansion foam fire-extinguishing systems. System approval should be based on the nominal filling rate, water pressure and other conditions used during the specified tests.

2 SAMPLING

The components to be tested should be supplied by the manufacturer together with design and installation criteria, operational instructions, drawings and technical data sufficient for the identification of the components.

3 FIRE TESTS

3.1 Test principles

This test procedure enables the determination of design criteria and the effectiveness of high-expansion foam fire-extinguishing systems against spray and pool fires, which are obstructed by a simulated engine. The test procedures are intended for the approval of foam systems for the protection of machinery spaces, cargo pump-rooms, vehicle and ro-ro spaces, special category spaces and cargo spaces.

3.2 Test description

3.2.1 ***Test enclosure***

3.2.1.1 The tests should be performed in a room having an ambient temperature of 10ºC to 25ºC at the start of each test. Details of the test hall geometry, the ventilation conditions and environmental conditions should be given in the fire test report.

3.2.1.2 The fire-extinguishing tests of the system should be carried out using the following test compartments:

.1 Test compartment 1

The test should be performed in a 100 m^2 room with 5 m ceiling height and ventilation through a 2 m x 2 m door opening according to figure 2. The engine mock-up should be designed according to figures 1 and 3. The door opening to the test compartment may be covered during the test at the same rate as the foam layer is building up in the compartment to avoid foam leakage through the door opening.

.2 Test compartment 2

The test should be performed in a test compartment having a volume greater than 1,200 m^3, but not greater than 3,500 m^3, and a ceiling height exceeding 7.5 m. The ventilation of the test compartment should be achieved by a 2 m x 2 m door opening at floor level (as in test compartment 1) combined with a maximum 20 m^2 total ventilation area, distributed in the ceiling and/or

along the walls, just below the ceiling. The door opening to the test compartment may be covered during the test at the same rate as the foam layer is building up in the compartment to avoid foam leakage through the door opening.

3.2.2 ***Simulated engine***

The fire test should be performed in a test apparatus consisting of:

.1 a simulated engine* of size (width x length x height) 1 m x 3 m x 3 m constructed of sheet steel with a nominal thickness of 5 mm. The simulated engine is fitted with two steel tubes of 0.3 m in diameter and 3 m in length, which simulate exhaust manifolds and a grating. At the top of the simulated engine a 3 m^2 tray is arranged (see figures 1 and 3); and

.2 a floor plate system of 4 m x 6 m and 0.5 m in height surrounding the simulated engine with a tray (4 m^2 in area), underneath (see figure 1).

3.2.3 ***Test programme***

The fire test should be carried out using the following fire scenarios:

.1 combination of the following fire programmes (Test fuel: commercial fuel oil or light diesel oil):

.1 low-pressure spray on top of the simulated engine centred with nozzle angled upward at a 45° angle to strike a 12 mm to 15 mm diameter rod 1 m away; and

.2 fire in trays under (4 m^2) and on top (3 m^2) of the simulated engine;

.2 high-pressure horizontal spray fire on top of the simulated engine. (Test fuel: commercial fuel oil or light diesel oil);

.3 low pressure concealed horizontal spray fire on the side of the simulated engine with oil spray nozzle positioned 0.1 m in from the end of the simulated engine and 0.1 m^2 tray positioned 1.4 m in from the engine end at the inside of floor plate. (Test fuel: commercial fuel oil or light diesel oil); and

.4 flowing fire 0.25 kg/s from top of mock-up (see figure 3) (Test fuel: heptane).

* Safety precaution – appropriate drains or overpressure relief capability should be provided to reduce the risk of explosion from fuel leakage inside the engine mock-up.

Table 1 – *Oil spray fire test parameters*

Fire type	Low pressure	High pressure
Spray nozzle	Wide spray angle (120° to 125°) full cone type	Standard angle (at 6 bar) full cone type
Nominal oil pressure	8 bar	150 bar
Oil flow	0.16 ± 0.01 kg/s	0.050 ± 0.002 kg/s
Oil temperature	20 ± 5°C	20 ± 5°C
Nominal heat release rate	5.8 ± 0.6 MW	1.8 ± 0.2 MW

3.2.4 ***Foam generator installation requirements for tests***

3.2.4.1 *General*

3.2.4.1.1 Foam generators and foam delivery duct outlets should not be installed above the simulated engine in such a way that the foam flow directly hits the test fires. The generators and foam delivery duct outlets should also not be located near the door or ventilation openings.

3.2.4.1.2 The inlet foam solution supply pressure to the foam generators should be maintained within the acceptable range determined in appendix 3, throughout the tests.

3.2.4.1.3 The number and spacing of foam generators and foam delivery duct outlets should be based on the manufacturer's system design and installation manual.

3.2.4.1.4 The mounting arrangement and orientation of the foam generators should be in accordance with the manufacturers' instruction.

3.2.4.2 *Inside air foam systems*

3.2.4.2.1 Foam generators should be installed inside the test room at the uppermost level of the space. The vertical distance between the generators and test room ceiling and floor should be recorded and reflected in the manufacturer's design manual.

3.2.4.3 *Systems using outside air*

3.2.4.3.1 For systems where the foam generators will be located outside the protected space, the test generators should be located outside the test room and arranged to supply foam through ducts of equivalent size or diameter as the foam generator. The length and configuration of the foam delivery ducts should be the maximum length to be used on board as specified by the manufacturer, but in no case less than 5 m vertically and 5 m horizontally. Foam delivery duct outlets should be located near the ceiling, or if located on a side wall, within 1 m of the ceiling. The locations of the foam delivery duct outlets should be recorded and reflected in the manufacturer's design manual.

3.2.4.3.2 For systems where the foam generators will be located inside the protected space and supplied by fresh air ducts, the test generators should be located on the manufacturer's instructions.

4 TEST PROCEDURE

4.1 Preparation

4.1.1 Combination fire (paragraph 3.2.3.1 above): the 4 m^2 fire tray below the engine mock-up should be filled with at least 50 mm fuel on a water base with a freeboard of 150 ± 10 mm. The 3 m^2 fire tray on top of the engine should be filled with at least 50 mm fuel on a water base with a freeboard of 40 ± 10 mm (this requires that the notch on the side of the 3 m^2 fire tray is blocked off by an appropriate means, e.g., steel plate).

4.1.2 Low pressure concealed fire and 0.1 m^2 tray fire (paragraph 3.2.3.3 above): the 0.1 m^2 tray should be filled with at least 50 mm fuel on a water base with a freeboard of 150 ± 10 mm.

4.1.3 Flowing fire (paragraph 3.2.3.4 above): the 4 m^2 fire tray below the engine mock-up should be filled with a 50 mm water base and the 3 m^2 fire tray on top of the engine mock-up should be filled with a 40 mm water base. The fuel should be ignited when flowing down the side of the mock-up, approximately 1 m below the notch. The pre-burn time should be measured from the ignition of the fuel.

4.1.4 Freshwater may be used for practical reasons if it is shown that seawater provides the same level of performance. This should be done either by repeating the freshwater test with the longest time to extinguishment with seawater to ensure that the minimum performance requirements are still fulfilled, or to use the small scale test method in appendix 4 to these Guidelines. If the system is tested in more than one test compartment, the seawater test should be performed in test compartment 2.

4.2 Measurements

The following should be measured during the test:

.1 oil flow and pressure in the oil system;

.2 foam concentrate flow and pressure, and water flow and pressure in the extinguishing system;

.3 oxygen concentration in the test compartment. The sampling point should be located 4.5 m from the centre of the engine mock-up on the exhaust pipe side and 2.5 m from floor level (the measurement may be terminated when the foam fills up to the oxygen sampling point);

.4 temperatures at the fire locations. Thermocouples should be located 1 m in front of the spray nozzles and 0.5 m above the tray fuel surface, to provide additional information about time to extinguishment;

.5 temperatures at the inside air foam generators. Thermocouples should be located to measure the air temperature at the foam generator air inlet, 0.1 m to 0.2 m behind the water/premix nozzles;

.6 foam solution pressure at the inlet to one of the foam generators; and

.7 air supply pressure at the inlet to one of the foam generators for outside air systems.

4.3 Pre-burn

After ignition of all fuel sources, a 2 min pre-burn time is required for the tray fires, and 15 s for the spray fires and flowing heptane fires before the extinguishing agent is discharged.

4.4 Duration of test

The overall time to extinction should not exceed 15 min. The oil spray and heptane, if used should be shut off 15 s after the fire has been judged extinguished. The foam system should be operated for a minimum of 1 min after fire extinguishment.

4.5 Observations before the fire test

Temperature of the test room, fuel and the simulated engine should be measured and recorded.

4.6 Observations during the fire test

The following observations should be recorded:

.1 start of ignition procedure;

.2 start of the test (ignition);

.3 time when the system is activated;

.4 time when inside air foam generators begin producing foam;

.5 foam transit time from outside air generators to the delivery duct outlets;

.6 time when the fire is extinguished;

.7 time when the fire is re-ignited, if any;

.8 time when the oil flow for the spray fire is shut off;

.9 time when the fire-extinguishing system is shut off; and

.10 time when the test is finished.

4.7 Observations after fire test

The following should be recorded:

.1 damage to any system components; and

.2 level of fuel in the tray(s) to ensure that no limitation of fuel occurred during the test.

5 CLASSIFICATION CRITERIA

The overall time to extinction should not exceed 15 min, and at the end of discharge of foam and fuel, there should be no re-ignition or fire spread.

6 TEST REPORT

The test report should include the following items:

.1 name and address of the test laboratory;

.2 date and identification number of the test report;

.3 name and address of client, manufacturer and/or supplier of the system;

.4 purpose of the test;

.5 name or other identification marks of the product;

.6 description and specifications of the tested system and foam concentrate;

.7 date of the test;

.8 test methods;

.9 drawing of each test configuration and test compartment;

.10 identification of the test equipment and instruments used (including type and manufacturer of the foam concentration);

.11 nominal flow rate, nominal application rate and nominal filling rate;

.12 foam mixing rate;

.13 foam expansion;

.14 water supply pressure;

.15 foam supply pressure and air supply pressure, if applicable, at inlet to foam generator;

.16 temperatures at the inside air foam generators;

.17 ventilation conditions;

.18 conclusions;

.19 deviations from the test method, if any;

.20 test results including observation and measurement before, during and after the test; and

.21 date and signature.

7 APPLICATION OF TEST RESULTS

7.1 Systems that have been successfully tested to the provisions of section 3 may be installed in different size spaces according to the following:

.1 the extinguishing system configuration and filling rate used for the test compartment 1 tests may be applied to systems for the protection of shipboard spaces of equal or less volume than 500 m^3;

.2 the extinguishing system configuration and filling rate used for the test compartment 2 tests may be applied to systems for the protection of shipboard spaces of equal or greater volumes than that of test compartment 2; and

.3 for the protection of shipboard spaces with volumes between test compartments 1 and 2, linear interpolation of the filling rates obtained for test compartments 1 and 2, respectively, should be applied. Despite the above, the filling rate used for the test compartment 2 tests may be applied to systems for the protection of small spaces within protected machinery spaces having volumes less than test compartment 2, such as workshops and similar spaces not containing combustion engines, boilers, purifiers and similar equipment.

7.2 If freshwater is used in the fire tests, any differences in expansion ratios between freshwater and simulated seawater (nominal expansion ratio measured according to standard EN13565-1, annex G, and expansion ratio measured according to "small scale test method") should be reflected in the manufacturer's installation guide. If the foam expansion ratios differ between freshwater and simulated seawater, the nominal application rate used in the fire tests should be adjusted to the level that corresponds to the nominal filling rate based on the lower expansion ratio.

Example: The fire tests were performed using freshwater with nominal filling rate of 2 m/min, corresponding to a nominal application rate of 4 //min/m^2 and nominal expansion ratio with freshwater of 500. Tests according to "small scale test method" and standard EN 13565-1, annex G, showed that the lowest expansion ratio is 425 with seawater. The design application rate should in this case be at least: 4.0*(500/425) = 4.7 //min/m^2.

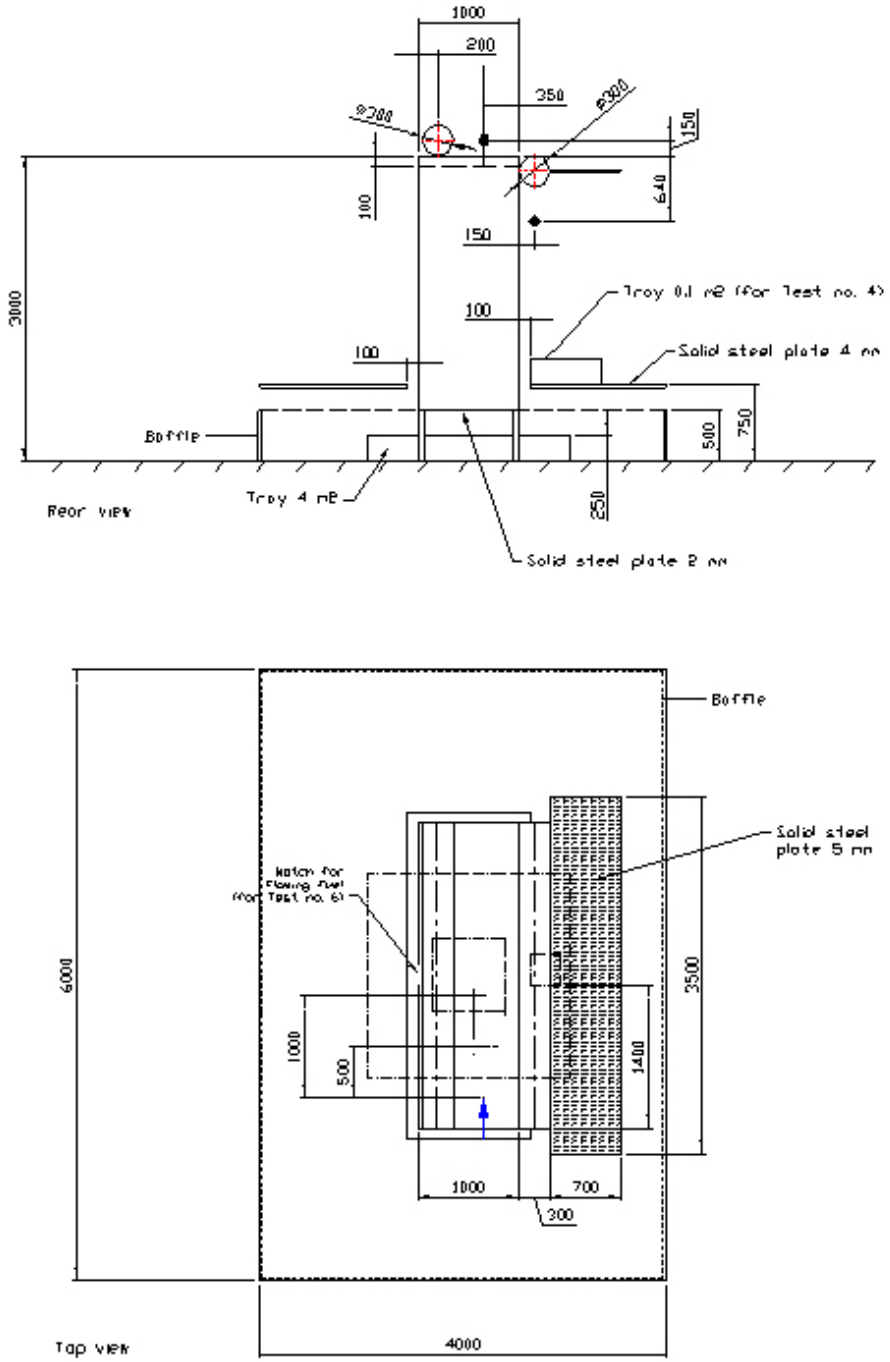

1000
200
350
ø288
ø380
150
100
640
150
3000
100
Tray 0.1 m2 (for Test no. 4)
100
Solid steel plate 4 mm
Baffle
500
750
Tray 4 m2
250
Rear view
Solid steel plate 2 mm
Baffle
Solid steel plate 5 mm
Notch for flowing fuel (for Test no. 6)
6000
3500
1000
500
1400
1000
700
300
Top view
4000

Figure 1

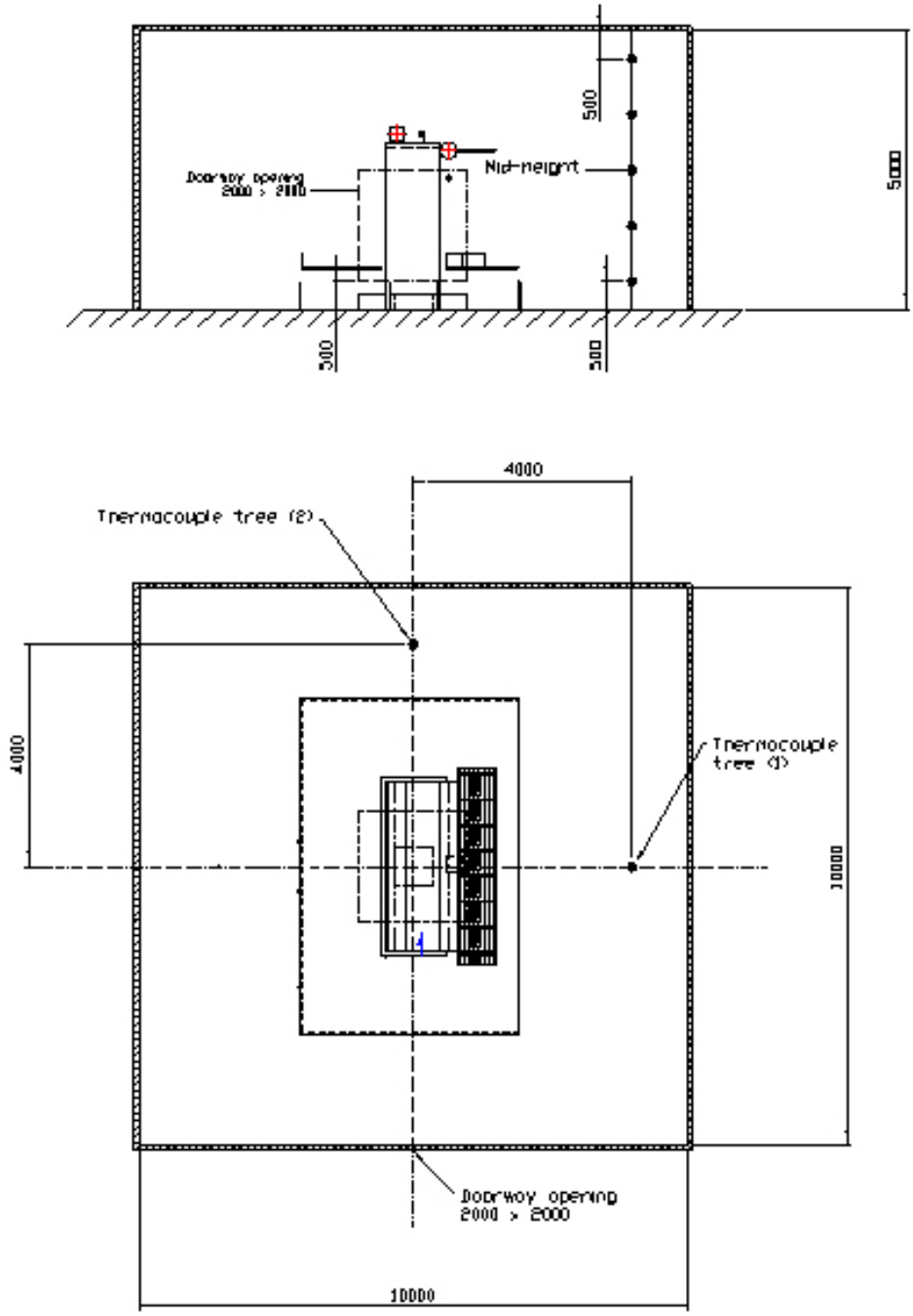
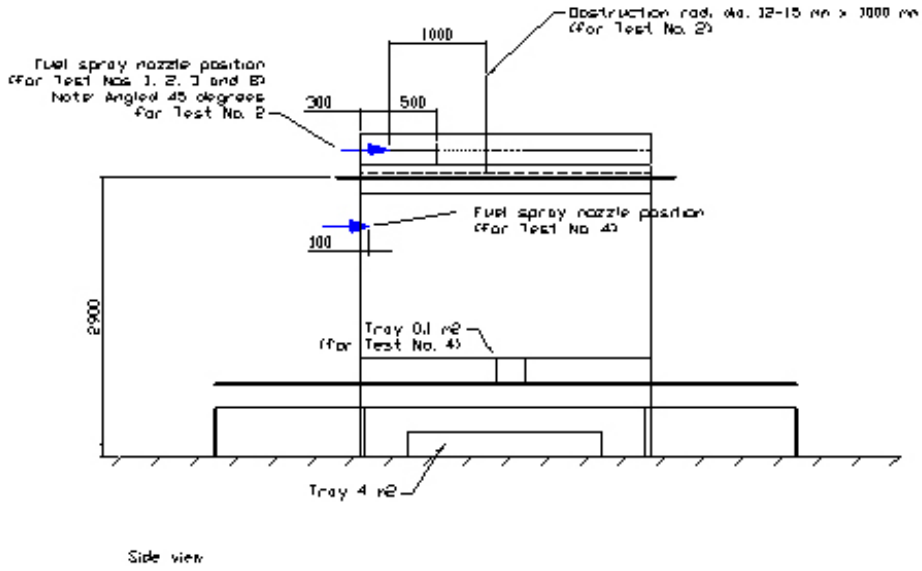

500
Doorway opening
2000 x 2000
Mid-height
5000
500
500
4000
Thermocouple tree (2)
4000
Thermocouple
tree (1)
10000
Doorway opening
2000 x 2000
10000

Figure 2


Obstruction rod, dia. 12-15 mm x 3000 mm
(For Test No. 2)
1000
Fuel spray nozzle position
(For Test Nos. 1, 2, 3 and 8)
Note: Angled 45 degrees
for Test No. 2
300
500
Fuel spray nozzle position
(For Test No. 4)
100
2900
Tray 0.1 m2
(For Test No. 4)
Tray 4 m2
Side view

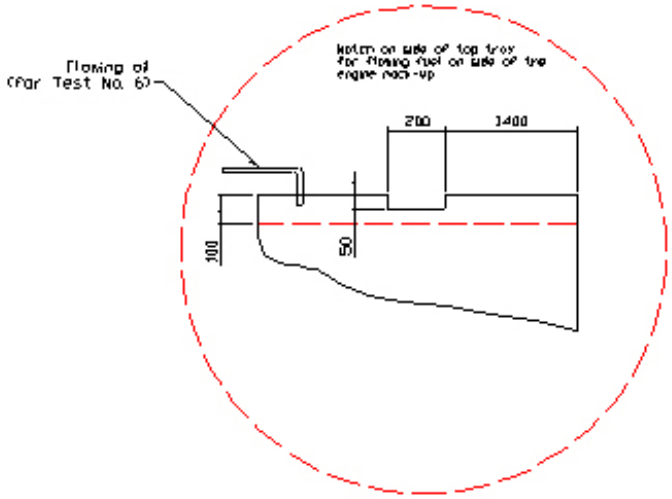

Flowing oil
(For Test No. 6)
Notch on side of top tray
for flowing fuel on side of the
engine rack-up
200
1400
100
50

Figure 3

APPENDIX 2

COMPONENT MANUFACTURING STANDARDS FOR HIGH-EXPANSION FOAM SYSTEM GENERATORS

1 All foam generator nozzles should be tested in accordance with the following items stipulated in the indicated paragraphs of the Guidelines developed by the Organization*:

.1 paragraph 3.1 – Dimensions;

.2 paragraph 3.11.1 – Stress corrosion;

.3 paragraph 3.11.2 – Sulphur dioxide corrosion: Visual inspection only may be carried out;

.4 paragraph 3.11.3 – Salt spray corrosion: The test may be carried out at NaCl concentration of 5%. Paragraph 3.14.2 in appendix A to MSC/Circ.1165, as amended by MSC.1/Circ.1269, need not apply;

.5 paragraph 3.15 – Resistance to heat: Where the components are made of steel, this test need not be applied;

.6 paragraph 3.17 – Impact test; and

.7 paragraph 3.22 – Clogging test: where the diameter of the opening of the nozzle exceeds 2.5 mm, this test need not be applied.

2 Foam generators should also be tested in accordance with the following items stipulated in standard EN 13565-1; where applicable, a representative sample of components from the generator may be used:

.1 clause 4: general construction requirements (4.1 (connections), 4.5 (corrosion resistance of metal parts) and 4.8 (heat and fire resistance));

.2 clause 5: discharge coefficients;

.3 clause 6: quality of foam (6.2 (high-expansion components)); and

.4 clause 9: components for medium and high-expansion foam systems.

Foam generators should also be able to withstand the effects of vibration without deterioration of their performance characteristics when tested in accordance with paragraph 4.15 of appendix A of MSC/Circ.1165, as amended by MSC.1/Circ.1269, except that three foam generators should be subjected to the vibration test and the test duration should be 2 h. The mounting arrangement and orientation of the foam generators should be in accordance with the manufacturers' instruction. After the vibration test, the generators should show no visible deterioration. The generator should be connected to a suitable water supply and operated at the maximum

* Refer to appendix A to the Revised Guidelines for the approval of equivalent water-based fire-extinguishing systems for machinery spaces and cargo pump-rooms (MSC/Circ.1165, as amended by MSC.1/Circ.1269).

operating pressure for 15 min to demonstrate that the generator did not suffer damages. Equivalent alternative testing standards may be used as determined by the Administration. The mounting arrangement and orientation of the foam generators should be in accordance with the manufacturers' instruction.

APPENDIX 3

FOAM GENERATOR CAPACITY TESTS

1 Representative foam generators should be tested to demonstrate their nominal foam production rate over the manufacturer's specified range of inlet pressures. The results of the testing should be reflected in the manufacturer's design and installation manual.

2 The generator should be connected to a suitable water and foam concentrate supply through a pressure regulating device. The generator should then be operated throughout a pressure range of 50% to 150% of the nominal operating pressure in 1 bar increments.

3 The generator should be used to fill a fixed volume container at each tested pressure. The time to fill the container should be recorded and used to calculate the generator output in m^3/min.

4 The nominal foam production rate of the generator should be recorded at all test pressures.

5 The nominal foam production rate of the generator should be greater than or equal to the manufacturer's specified rating.

APPENDIX 4

OPTIONAL SMALL SCALE TEST METHOD FOR HIGH-EXPANSION FOAM CONCENTRATES TO BE USED WITH INSIDE AIR

1 SCOPE

1.1 This fire test method is intended for evaluating and documenting high-expansion foam properties under elevated temperatures. The data could be used for quality control of foam concentrates, as the results from the tests can be compared to results from earlier tests. Therefore, the test method can also be used during the development of new foam concentrates. The test method can also be used for evaluating the influence of using seawater compared to freshwater.

1.2 The test method is NOT intended to serve as a system verification test. Such tests need to be conducted in large scale, using realistic fire conditions and actual foam generators, as the content of the combustion gases also might influence foam production.

Note 1: A high-expansion foam system for inside air consists of both the foam generators and the foam concentrate. When measuring the foam expansion ratio of the system, the actual foam generators should be used. As the actual foam generators in practice are much larger, with higher flow rates, than the foam generator used in this small-scale test method, the method is not intended for determination of the foam expansion of the system. For determination of nominal foam expansion ratio of the system the foam concentrate, using actual foam generator, should be tested according to standard EN 13565-1, annex G (or equivalent).

Note 2: Presently, there are no requirements related to the results given in the test method. However, such criteria could be established in order to test if the foam concentrate has acceptable resistance to heat. The minimum criteria should specify that the foam expansion ratio should be above a certain limit under some specific test conditions in relation to "cold" foam expansion. In that case the test method could be a part of an approval. However, in order to choose sufficient requirements, additional pre-normative tests need to be undertaken.

2 DEFINITIONS

2.1 *Drainage time* is the time taken for the original premix to drain out of the generated foam.

2.2 *Expansion ratio* is the ratio of the volume of foam to the volume of the premix from which it was made.

2.3 *Foam concentrate* is the liquid which, when mixed with water in the appropriate concentration, gives a premix.

2.4 *Premix* is the solution of foam concentrate and water.

3 SAMPLING

The foam concentrate for the tests should be supplied by the manufacturer along with documentation that includes the brand name of the product, manufacturer, the manufacturing site, date of manufacture and batch number.

4 METHOD OF TEST

4.1 Principle

4.1.1 The foam properties of the foam concentrate should be determined using the following two evaluation parameters:

.1 the expansion ratio as a function of gas temperature; and

.2 the drainage time measured at ambient temperature.

Note: Pre-normative testing has verified that drainage time is usually very difficult to record at elevated temperatures.

4.1.2 Normally the foam properties should be measured both with freshwater and with simulated seawater specified in standards ISO 7203-2, annex F, and EN 1568-2, annex G.

4.2 Test equipment

The following test equipment is necessary for the tests:

.1 fire test compartment, as described within this document;

.2 propane gas burner, as described in standard ISO 9705;

.3 high-expansion foam generator, as described within this document;

.4 foam collector vessel for expansion and drainage measurements, as described in standards ISO 7203-2, annex F, and EN 1568-2, annex G;

.5 premix pressure vessel;

.6 air compressor;

.7 load cell; and

.8 stopwatch.

4.3 Tolerances

Unless otherwise stated, the following tolerances should apply:

.1	length:	± 2% of value;
.2	volume:	± 5% of value;
.3	time:	± 5 s; and
.4	temperature:	± 2% of value.

The tolerances are not applicable to the evaluation parameters.

5 THE FIRE TEST COMPARTMENT

5.1 General

5.1.1 The fire test compartment should be constructed using 45 mm by 90 mm wood studs (or equivalent) and non-combustible wall boards, having a nominal thickness of between 10 and 15 mm. The walls and the ceiling should not be insulated.

5.1.2 The compartment should be fitted with a doorway opening, to allow easy access. This doorway should be sealed closed during the tests.

5.1.3 The compartment should be reasonably airtight and, if considered necessary, all gaps between parts of the compartment should be sealed using high-temperature resistant sealant.

5.2 Dimensions

5.2.1 The inner dimensions of the compartment should be:

.1 length: 2,400 mm;

.2 width: 1,200 mm; and

.3 height: 2,400 mm.

5.2.2 The bottom of the walls should be positioned 150 mm above floor level, in order to provide a gap around the bottom perimeter of the compartment, to allow the inflow of fresh air.

5.3 Flame screen

5.3.1 The top part of the test compartment should be fitted with a flame screen, in order to prevent flames and hot combustion gases from flowing directly in to the high-expansion foam generator.

5.3.2 The screen should be made from a perforated (approximately 50% free area) steel sheet. It should cover the width of the test compartment and should extend 600 mm down from the ceiling.

5.4 Position of the high-expansion foam generator

The high-expansion foam generator should be positioned centrically through one of the short sides of the fire test compartment, with its centreline 200 mm below the ceiling. The cone end of the generator should be located 360 mm outside the short side of the fire test compartment.

5.5 Position of the propane gas burner

5.5.1 The propane gas burner should be positioned at the opposite part of the test compartment, relative to the position of the high-expansion foam generator.

5.5.2 The horizontal distance measured from the back and long side walls, should be 600 mm. The propane gas burner should be elevated, such that its top is 500 mm above floor level.

6 PREMIX PRESSURE VESSEL AND PIPING

6.1 A pressure vessel should be used for propelling the premix. The pressure vessel should be connected to an air compressor, via a pressure regulation valve. The outlet should be connected to the high-expansion foam generator, via a shut-off valve.

6.2 The piping to the generator should be connected to a valve arrangement making it possible to switch from water to premix.

7 THE HIGH-EXPANSION FOAM GENERATOR

High-expansion foam generator should have a flow rate of approximately 3 //min at a pressure of 6 bar.

8 INSTRUMENTATION, MEASUREMENTS AND MEASUREMENT EQUIPMENT

8.1 Gas temperature measurements

The gas temperature inside the test compartment should be continuously measured and recorded during the tests. The individual thermocouples should be positioned as follows:

.1 one thermocouple 150 mm behind the foam generator; and

.2 five thermocouples, respectively, at vertical distances of 100 mm, 200 mm, 300 mm, 600 mm and 1,200 mm from the ceiling. The thermocouple tree should be positioned 500 mm from the front side wall (for informative reasons only).

All thermocouples should be of type K (chromel-alumel) and made from 0.5 mm wire welded together.

8.2 Foam system and water pressure

8.2.1 The system pressure at the inlet to the fire test compartment should be monitored using a pressure gauge.

8.2.2 The pressure gauge should have an accuracy of ± 0.05 bar.

9 FIRE TEST PROCEDURES

9.1 Test conditions

The following test conditions should apply:

.1 the ambient temperature, measured inside the fire test compartment, prior to the start of a test should be 20 ± 5°C;

.2 the water temperature, measured prior to the test, should be 15 ± 5°C; and

.3 the premix temperature, measured prior to the test, should be 17.5 ± 2.5°C.

9.2 Verification of the temperature in the test compartment

9.2.1 Prior to any testing, the propane gas burner should be adjusted to provide the following gas temperatures, respectively, measured using the thermocouple 150 mm behind the foam generator. The approximate Heat Release Rate (HRR) used in pre-normative testing is given as a guide (see note below).

Ambient conditions (propane gas burner not in use)	Approximate Heat Release Rate (HRR)
+ 100°C	18 kW
+ 150°C	28 kW
+ 200°C	42 kW
+ 300°C	90 kW

9.2.2 The temperature should be reached within 3 min to 6 min and the temperature increase should be less than 5% per min after the desired temperature is reached. It might be necessary to adjust the HRR slightly during the temperature rise.

9.2.3 During the verification of the temperature, the generator should be connected to the water source. The flowing water pressure should be 6 ± 0.1 bar. The flowing water will cool down the pipes, connectors and the generator during the temperature rise and provides airflow through the generator and the test compartment.

Note: During pre-normative testing it has been concluded that the above temperatures at given HHR are reached within 3 min to 6 min.

9.3 Fire test procedures

9.3.1 The fire test procedure should be applied as follows:

.1 the ambient temperature, the water temperature and the premix temperature should be measured and recorded;

.2 start the water flow through the generator. The flowing water pressure should be within 10% of the nominal/design water pressure;

.3 the temperature measurements should be started;

.4 the propane gas burner should be lit by means of a torch or a match;

.5 when the desired gas temperature is reached, the valve for the water delivery should be shut and the valve for the premix should be opened;

.6 adjust the foam system pressure to within 10% of the nominal/design pressure;

.7 the determination of the foam properties should be undertaken (see section 10); and

.8 the test is terminated.

9.3.2 The procedure is repeated at each temperature level, as described in subsection 9.2.

10 DETERMINATION OF FOAM PROPERTIES

10.1 Principle

For the determination of the foam properties, it is essential that all foam and any possible unexpanded premix is collected.

10.2 Foam expansion ratio and drainage time at ambient conditions

10.2.1 The expansion ratio and drainage time should be measured in accordance with standards ISO 7203-2, annex F, or EN 1568-2, annex G, with the deviation that the foam generator is replaced by the foam generator as described within this document.

10.2.2 The expansion ratio and drainage time should be measured both with fresh and with simulated seawater specified in standards ISO 7203-2, annex F, and EN 1568-2, annex G.

10.3 Foam expansion as a function of temperature

10.3.1 The foam expansion should be measured by collecting the foam in the foam collector vessel during 20 s, or until it is full. Record the volume of the collected foam, or the filling time. Calculate the foam expansion ratio:

$$E = \frac{V}{Qt}$$

where:

V is the volume of the collected foam;
Q is the premix flow rate from the foam generator; and
t is the time for collecting the foam.

Note: If the foam expansion is high (> 508) the vessel will be full before the 20 s has elapsed. In these cases, the time should be recorded when the vessel is full.

10.3.2 The expansion ratio at each temperature should be measured with both freshwater and simulated seawater specified in standards ISO 7203-2, annex F, and EN 1568-2, annex G.

10.3.3 The results should be presented in diagrams with expansion ratio as a function of temperature.

11 TEST REPORT

The test report should include the following information:

.1 name and address of the test laboratory;

.2 date and identification number of the test report;

.3 name and address of client;

.4 purpose of the test;

.5 method of sampling;

.6 name and address of manufacturer or supplier of the product;

.7 name or other identification marks of the product;

.8 description of the tested product;

.9 date of supply of the product;

.10 date of test;

.11 test method;

.12 identification of the test equipment and used instruments;

.13 conclusions;

.14 deviations from the test method, if any;

.15 test results including observations during and after the test; and

.16 date and signature.

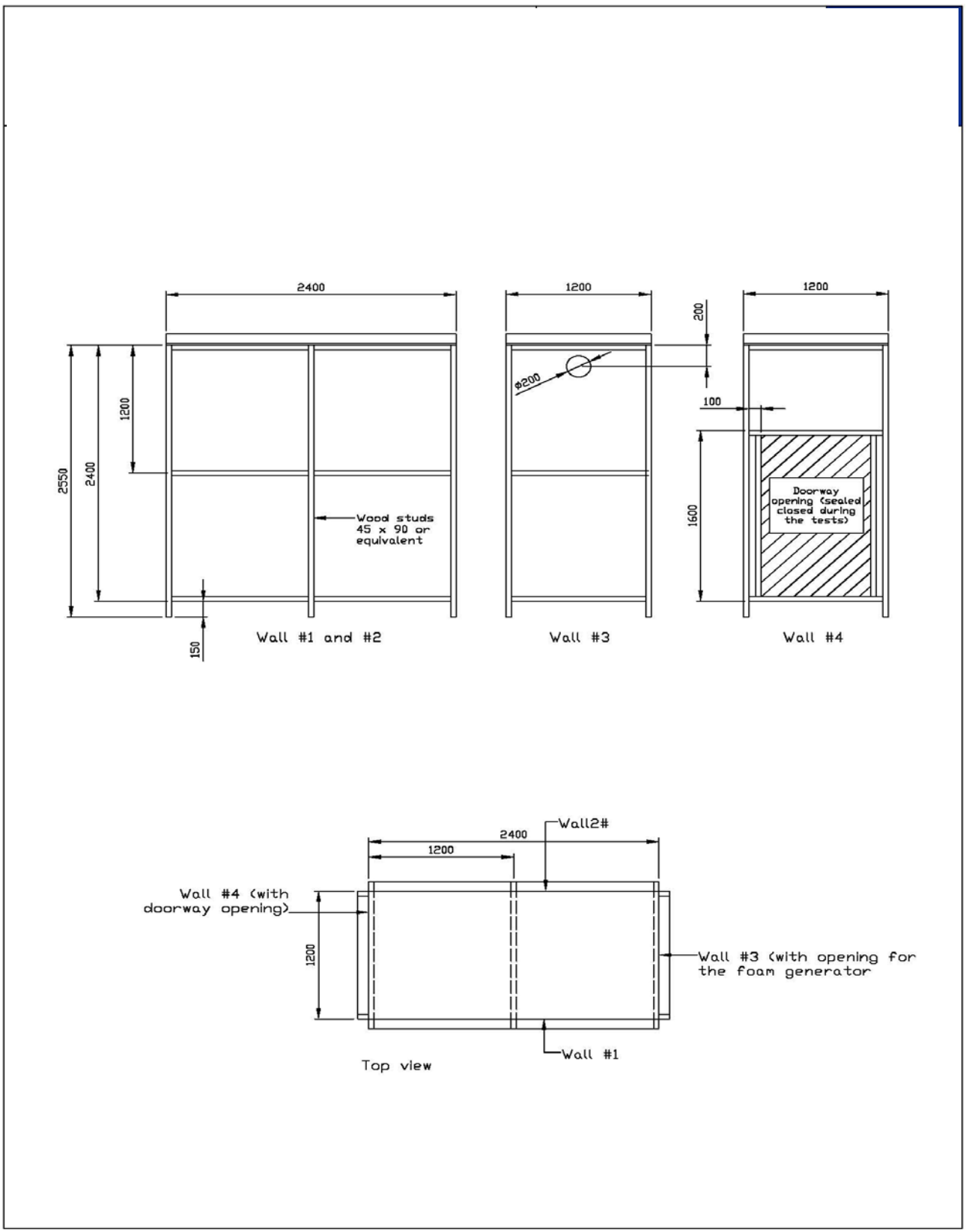
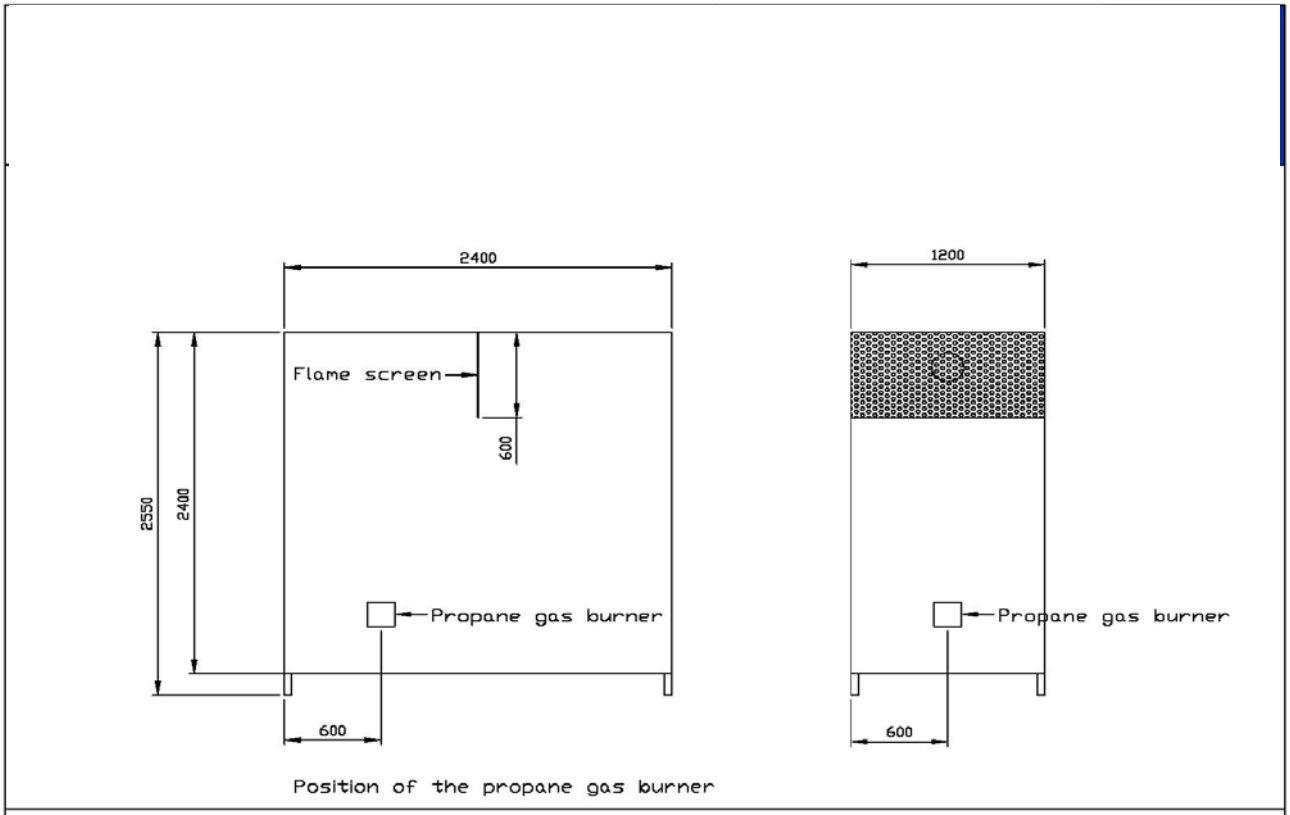
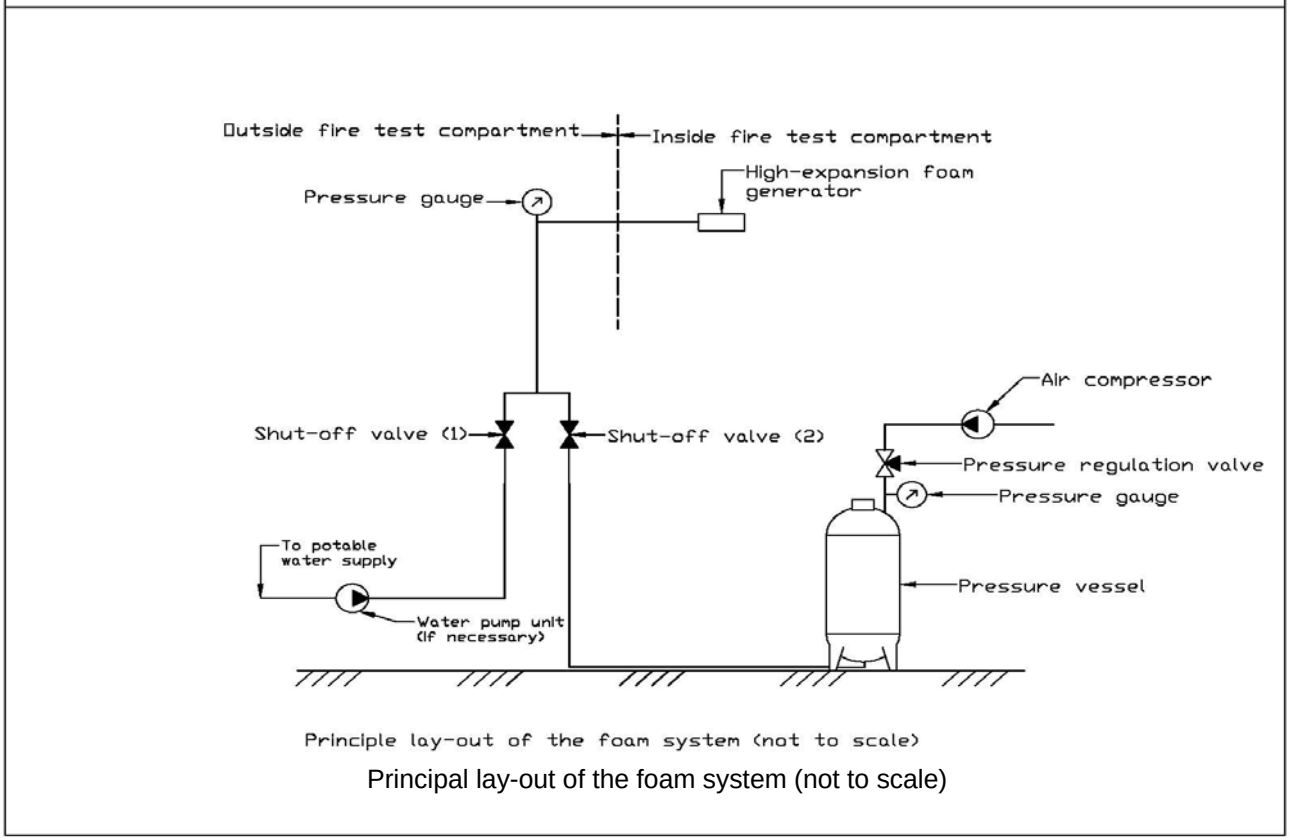


Figure 1 – Fire test compartment





Principal lay-out of the foam system (not to scale)

Figure 2 – Interior of fire test compartment with principal layout of the foam system