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Ref. T4/4.03

MSC/Circ.848
8 June 1998

REVISED GUIDELINES FOR THE APPROVAL OF EQUIVALENT FIXED GAS FIRE-EXTINGUISHING SYSTEMS, AS REFERRED TO IN SOLAS 74, FOR MACHINERY SPACES AND CARGO PUMP-ROOMS

1 The Maritime Safety Committee, at its sixty-seventh session (2 to 6 December 1996), approved Guidelines for the approval of equivalent fixed gas fire-extinguishing systems, as referred to in SOLAS 74, for machinery spaces and cargo pump-rooms, as MSC/Circ.776.

2 The Sub-Committee on Fire Protection, at its forty-second session (8 to 12 December 1997), recognized the need of technical improvement to the Guidelines contained in MSC/Circ.776 to assist in their proper implementation and, to that effect, prepared amendments to the Guidelines.

3 The Committee, at its sixty-ninth session (11 to 20 May 1998), approved revised Guidelines for the approval of equivalent fixed gas fire-extinguishing systems, as referred to in SOLAS 74, for machinery spaces and cargo pump-rooms, as set out in the annex, to supersede the Guidelines attached to MSC/Circ.776.

4 Member Governments are invited to apply the annexed Guidelines when approving equivalent fixed gas fire-extinguishing systems for use in machinery spaces of category A and cargo pump-rooms.

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ANNEX

REVISED GUIDELINES FOR THE APPROVAL OF EQUIVALENT FIXED GAS FIRE-EXTINGUISHING SYSTEMS, AS REFERRED TO IN SOLAS 74, FOR MACHINERY SPACES AND CARGO PUMP-ROOMS

General

1 Fixed gas fire-extinguishing systems for use in machinery spaces of category A and cargo pump-rooms equivalent to fire-extinguishing systems required by SOLAS regulations II-2/7 and II-2/63 should prove that they have the same reliability which has been identified as significant for the performance of fixed gas fire-extinguishing systems approved under the requirements of SOLAS regulation II-2/5. In addition, the system should be shown by test to have the capability of extinguishing a variety of fires that can occur in a ship's engine-room.

Principal requirements

2 All requirements of SOLAS regulations II-2/5.1, 5.3.1, 5.3.2 to 5.3.3, except as modified by these guidelines, should apply.

3 The minimum extinguishing concentration should be determined by a cup burner test acceptable to the Administration. The design concentration should be at least 20% above the minimum extinguishing concentration. These concentrations should be verified by full-scale testing described in the test method, as set out in the appendix.

4 For systems using halocarbon clean agents, 95% of the design concentration should be discharged in 10 s or less. For inert gas systems, the discharge time should not exceed 120 s for 85% of the design concentration.

5 The quantity of extinguishing agent for the protected space should be calculated at the minimum expected ambient temperature using the design concentration based on the net volume of the protected space, including the casing.

5.1 The net volume of a protected space is that part of the gross volume of the space which is accessible to the free extinguishing agent gas.

5.2 When calculating the net volume of a protected space, the net volume should include the volume of the bilge, the volume of the casing and the volume of free air contained in air receivers that in the event of a fire is released into the protected space.

5.3 The objects that occupy volume in the protected space should be subtracted from the gross volume of the space. They include, but are not necessarily limited to:

- auxiliary machinery;
- boilers;
- condensers;
- evaporators;
- main engines;
- reduction gears;

- tanks; and
- trunks.

5.4 Subsequent modifications to the protected space that alter the net volume of the space shall require the quantity of extinguishing agent to be adjusted to meet the requirements of this paragraph and paragraph 6.

6 No fire suppression agent should be used which is carcinogenic, mutagenic, or teratogenic at concentrations expected during use. No agent should be used in concentrations greater than the cardiac sensitization NOAEL (No Observed Adverse Effect Level), without the use of controls as provided in SOLAS regulations II-2/5.2.5.1 and 5.2.5.2. In no case should an agent be used above its LOAEL (Lowest Observed Adverse Effects Level) nor ALC (Approximate Lethal Concentration) calculated on the net volume of the protected space at the maximum expected ambient temperature.

7 The system and its components should be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging, and corrosion normally encountered in machinery spaces or cargo pump-rooms in ships.

8 The system and its components should be designed and installed in accordance with international standards acceptable to the Organization[1] and manufactured and tested to the satisfaction of the Administration. As a minimum, the design and installation standards should cover the following elements:

.1 safety:

- toxicity;
- noise, nozzle discharge; and
- decomposition products;

.2 storage container design and arrangement:

- strength requirements;
- maximum/minimum fill density, operating temperature range;
- pressure and weight indication;
- pressure relief; and
- agent identification and lethal requirements;

.3 agent supply, quantity, quality standards;

.4 pipe and fittings:

- strength, material, properties, fire resistance; and
- cleaning requirements;

[1]Until international standards are developed, national standards acceptable to the Administration should be used. Available national standards include, e.g., Standards of Australia, the United Kingdom and NFPA 2001.

.5 valves:

- testing requirements;
- corrosion resistance; and
- elastomer compatibility;

.6 nozzles:

- height and area testing requirements; and
- corrosion and elevated temperature resistance;

.7 actuation and control systems:

- testing requirements; and
- backup power requirements;

.8 alarms and indicators:

- predischarge alarm, agent discharge alarms as time delays;
- abort switches;
- supervisory circuit requirements; and
- warning signs and audible and visual alarms should be located outside each entry to the relevant space as appropriate;

.9 agent flow calculation:

- approval and testing of design calculation method; and
- fitting losses and/or equivalent length;

.10 enclosure integrity and leakage requirements:

- enclosure leakage;
- openings; and
- mechanical ventilation interlocks;

.11 design concentration requirements, total flooding quantity;

.12 discharge time; and

.13 inspection, maintenance, and testing requirements.

9 The nozzle type, maximum nozzle spacing, maximum height and minimum nozzle pressure should be within limits tested to provide fire extinction per the proposed test method.

10 Provisions should be made to ensure that escape routes which are exposed to leakage from the protected space are not rendered hazardous during or after discharge of the agent. Control stations and other locations that require manning during a fire situation should have provisions to keep HF and HCl below 5 ppm at that location. The concentrations of other products should be kept below concentrations considered hazardous for the required duration of exposure.

11 Agent containers may be stored within a protected machinery space if the containers are distributed throughout the space and the provisions of SOLAS regulation II-2/5.3.3 are met. The arrangement of containers and electrical circuits and piping essential for the release of any system should be such that in the event of damage to any one power release line through fire or explosion in the protected space, i.e. a single fault concept, at least five-sixths of the fire-extinguishing charge as required by paragraph 5 of this annex can still be discharged having regard to the requirement for uniform distribution of medium throughout the space. The arrangements in respect of systems for spaces requiring less than 6 containers should be to the satisfaction of the Administration.

12 A minimum agent hold time of 15 min should be provided.

13 The release of an extinguishing agent may produce significant over and under pressurization in the protected space. Measures to limit the induced pressures to acceptable limits should be provided.

14 For all ships, the fire-extinguishing system design manual should address recommended procedures for the control of products of agent decomposition. The performance of fire-extinguishing arrangements on passenger ships should not present health hazards from decomposed extinguishing agents, e.g., on passenger ships, the decomposition products should not be discharged in the vicinity of muster (assembly) stations.

APPENDIX

TEST METHOD FOR FIRE TESTING OF FIXED GAS FIRE-EXTINGUISHING SYSTEMS

1 Scope

1.1 This test method is intended for evaluating the extinguishing effectiveness of fixed gas fire-extinguishing systems for the protection of machinery spaces of category A and cargo pump-rooms.

1.2 Fire-extinguishing systems presently covered in SOLAS regulation II-2/5, as amended, are excluded.

1.3 The test method covers the minimum requirements for fire-extinguishing.

1.4 This test method is applicable to gases, liquefied gases and mixtures of gases. The test method is not valid for extinguishant gases mixed with compounds in solid or liquid state at ambient conditions.

1.5 The test programme has two objectives: (1) establishing the extinguishing effectiveness of a given agent at its tested concentration, and (2) establishing that the particular agent distribution system puts the agent into the enclosure in such a way as to fully flood the volume to achieve an extinguishing concentration at all points.

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 Method of test

3.1 Principle

This test procedure enables the determination of the effectiveness of different gaseous agent extinguishing systems against spray fires, pool fires and class A fires.

3.2 Apparatus

3.2.1 Test room

The tests should be performed in 100 m^2 room, with no horizontal dimension less than 8 m, with a ceiling height of 5 m. The test room should be provided with a closable access door measuring approximately 4 m^2 in area. In addition, closable ventilation hatches measuring at least 6 m^2 in total area should be located in the ceiling.

3.2.2 Integrity of test enclosure

The test enclosure is to be nominally leak tight when doors and hatches are closed. The integrity of seals on doors, hatches, and other penetrations (e.g., instrumentation access ports) must be verified before each test.

3.2.3 Engine mock-up

.1 An engine mock-up of size (width x length x height) 1 m x 3 m x 3 m should be constructed of sheet steel with a nominal thickness of 5 mm. The mock-up should be fitted with two steel tubes diameter 0.3 m and 3 m length that simulate exhaust manifolds and a solid steel plate. At the top of the mock-up a 3 m^2 tray should be arranged. See figures 1, 2 and 3.

.2 A floor plate system 4 m x 6 m x 0.75 m high shall surround the mock-up. Provision shall be made for placement of the fuel trays, described in table 1, and located as described in table 2.

3.2.4 Instrumentation

Instrumentation for the continuous measurement and recording of test conditions should be employed. The following measurements should be made:

.1 temperature at three vertical positions (e.g., 1, 2.5, and 4.5 m)

.2 enclosure pressure

.3 gas sampling and analysis, at mid-room height, for oxygen, carbon dioxide, carbon monoxide, and relevant halogen acid products, e.g., hydrogen iodide, hydrofluoric acid, hydrochloric acid

.4 means of determining flame-out indicators

.5 fuel nozzle pressure in the case of spray fire

.6 fuel flow rate in the case of spray fires

.7 discharge nozzle pressure

3.2.5 Nozzles

3.2.5.1 For test purposes, nozzles should be located within 1 m of the ceiling.

3.2.5.2 If more than one nozzle is used they should be symmetrically located.

3.2.6 Enclosure temperature

The ambient temperature of the test enclosure at the start of the test should be noted and serve as the basis for calculating the concentration that the agent would be expected to achieve at that temperature and with that agent weight applied in the test volume.

3.3 Test fires and programme

3.3.1 Fire types

The test programme, as described in table 3, should employ test fires as described in table 1.

Table 1
Parameters of Test Fires

Fire	Type	Fuel	Fire Size, MW	Remarks
A	76 - 100 mm ID Can	Heptane	0.0012 to 0.002	Tell tale
B	0.25 m^2 Tray	Heptane	0.35	
C	2 m^2 Tray	Diesel /Fuel Oil	3	
D	4 m^2 Tray	Diesel /Fuel Oil	6	
E	Low pressure spray	Heptane 0.16 ± 0.01 kg/s	5.8	
F	Low pressure, low flow spray	Heptane 0.03 ± 0.005 kg/s	1.1	
G	High pressure spray	Diesel /Fuel Oil 0.05 ± 0.002 kg/s	1.8	
H	Wood Crib	Spruce or Fir	0.3	See Note 2
I	0.10 m^2 tray	Heptane	0.14	

Notes to table 1:

1 Diesel/Fuel Oil means light diesel or commercial fuel oil.

2 The wood crib should be substantially the same as described in ISO/TC 21/SC5/WG 8 ISO Draft International Standard, *Gaseous fire extinguishing systems, Part 1: General Requirements*. The crib should consist of six, trade size 50 mm x 50 mm by 450 mm long, kiln dried spruce or fir lumber having a moisture content between 9% and 13%. The members should be placed in 4 alternate layers at right angles to one another. Members should be evenly spaced forming a square structure.

Achieve ignition of the crib by burning commercial grade heptane in a square steel tray 0.25 m^2 in area. During the pre-burn period the crib should be placed centrally above the top of the tray a distance of 300 to 600 mm.

Table 2
Spray fire test parameters

Fire type	Low pressure(E)	Low pressure, Low flow(F)	High pressure(G)
Spray nozzle	Wide spray angle (120 to 125E) full cone type	Wide spray angle (80E) full cone type	Standard angle (at 6 Bar) full cone type
Nominal fuel pressure	8 Bar	8.5 Bar	150 Bar
Fuel flow	0.16 $\pm$ 0.01 kg/s	0.03 $\pm$ 0.005 kg/s	0.050 $\pm$ 0.002 kg/s
Fuel temperature	20 $\pm$ 5EC	20 $\pm$ 5EC	20 $\pm$ 5EC
Nominal heat release rate	5.8 $\pm$ 0.6 MW	1.1 $\pm$ 0.1 MW	1.8 $\pm$ 0.2 MW

3.3.2 Test programme

The fire test programme should employ test fires singly or in combination, as outlined in table 3.

Table 3
Test Programme

Test No.	Fire Combinations (See Table 1)
1	A: Tell tales, 8 corners. See note 1.
2-a See Note 2	B: 0.25 m^2 heptane tray under engine mockup E: Horizontal LP spray directed at 15-25 mm rod 0.5 m away G: HP diesel/fuel oil spray on top of engine mock-up Total Fire Load: 7.95 MW
2-b See Note 2	B: 0.25 m^2 heptane tray under mock-up I: 0.10 m^2 heptane tray on deck plate located below solid steel obstruction plate Total Fire Load: 0.49 MW
3	C: 2 m^2 diesel/fuel oil tray on deck plate located below solid steel obstruction plate H: Wood crib positioned as in Figure 1 F: Low pressure, low flow horizontal spray - concealed - with impingement on inside of engine mock-up wall. Total Fire Load: 4.4 MW
4	D: 4 m^2 Diesel tray under engine mock-up Total Fire Load: 6 MW

Note to table 3:

1 Tell-tale fire cans should be located as follows:

(a) in upper corners of enclosure 150 mm below ceiling and 50 mm from each wall;
(b) in corners on floors 50 mm from walls.

2 Test 2-a is for use in evaluating extinguishing systems having discharge times of 10 seconds or less.

Test 2-b is for use in evaluating extinguishing systems having discharge times greater than 10 seconds.

3.3.2.1 All applicable tests of table 3 should be conducted for every new fire extinguishant gas, or mixture of gases.

3.3.2.2 Only Test 1 is required to evaluate new nozzles and related distribution system equipment (hardware) for systems employing fire extinguishants that have successfully completed the requirements of 3.3.2.1. Test 1 should be conducted to establish and verify the manufacturer's minimum nozzle design pressure.

3.4 Extinguishing system

3.4.1 System installation

The extinguishing system should be installed according to the manufacturer's design and installation instructions. The maximum vertical distance should be limited to 5 m.

3.4.2 Agent

3.4.2.1 Design concentration

The agent design concentration is that concentration (in volume per cent) required by the system designer for the fire protection application.

3.4.2.2 Test concentration

The concentration of agent to be used in the fire extinguishing tests should be the design concentration specified by the extinguishing system manufacturer, except for Test 1 which should be conducted at 83% of the manufacturer's recommended design concentration but in no case at less than the cup burner extinguishing concentration.

3.4.2.3 Quantity of agent

The quantity of agent to be used should be determined as follows:

3.4.2.3.1 Halogenated agents

$$W = (V/S) \times C/(100 - C)$$

where:

W = agent mass, kg
V = volume of test enclosure, m^3
S = agent vapour specific volume at temperature and pressure of the test enclosure, kg/m^3
C = gaseous agent concentration, volume per cent.

3.4.2.3.2 Inert gas agents

$$Q = V\,[294/(273 + T)]\,C\,(P/1.013)\,C\,\ln[100/(100 - C)]$$

where:

Q = volume of inert gas, measured at 294 K and 1.013 bar, discharged, m^3
V = volume of test enclosure, m^3
T = test enclosure temperature, Celsius
P = test enclosure pressure, bar
C = gaseous agent concentration, volume per cent.

3.5 Procedure

3.5.1 Fuel levels in trays

The trays used in the test should be filled with at least 30 mm fuel on a water base. Freeboard should be 150 ± 10 mm.

3.5.2 Fuel flow and pressure measurements

For spray fires, the fuel flow and pressure should be measured before and during each test.

3.5.3 Ventilation

3.5.3.1 Pre-burn period

During the pre-burn period the test enclosure should be well ventilated. The oxygen concentration, as measured at mid-room height, shall not be less than 20 volume per cent at the time of system discharge.

3.5.3.2 End of pre-burn period

Doors, ceiling hatches, and other ventilation openings should be closed at the end of the pre-burn period.

3.5.4 Duration of test

3.5.4.1 Pre-burn time

Fires should be ignited such that the following burning times occur before the start of agent discharge:

.1 sprays - 5 to 15 s
.2 trays - 2 min
.3 crib - 6 min

3.5.4.2 Discharge time

.1 halogenated agents should be discharged at a rate sufficient to achieve delivery of 95% of the minimum design quantity in 10 s or less.

.2 inert gas agents should be discharged at a rate sufficient to achieve 85% of the minimum design quantity in 120 s or less.

3.5.4.3 Soak time

After the end of agent discharge the test enclosure should be kept closed for 15 min.

3.5.5 Measurements and observations

3.5.5.1 Before test

.1 temperature of test enclosure, fuel and engine mock-up
.2 initial weights of agent containers
.3 verification of integrity agent distribution system and nozzles
.4 initial weight of wood crib.

3.5.5.2 During test

.1 start of the ignition procedure
.2 start of the test (ignition)
.3 time when ventilating openings are closed
.4 time when the extinguishing system is activated
.5 time from end of agent discharge
.6 time when the fuel flow for the spray fire is shut off
.7 time when all fires are extinguished
.8 time of re-ignition, if any, during soak period
.9 time at end of soak period
.10 at the start of test initiate continuous monitoring as per 3.2.4.

3.5.6 Tolerances

Unless otherwise stated, the following tolerances should apply:

.1	length	±2% of value
.2	volume	±5% of value
.3	pressure	±3% of value
.4	temperature	±5% of value
.5	concentration	±5% of value.

These tolerances are in accordance with ISO standard 6182/1, February 1994 edition [4].

4 Classification criteria

4.1 Class B fires must be extinguished within 30 s of the end of agent discharge. At the end of the soak period there should be no reignition upon opening the enclosure.

4.2 The fuel spray should be shut off 15 s after extinguishment. At the end of the soak time, the fuel spray should be restarted for 15 s prior to reopening the door and there should be no reignition.

4.3 At the end of the test fuel trays must contain sufficient fuel to cover the bottom of the tray.

4.4 Wood crib weight loss must be no more than 60%.

5 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 system components;
.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;
- drawings
- descriptions
- assembly instructions
- specification of included materials
- detailed drawing of test set-up;

.9 date of supply of the product;
.10 date of test;
.11 test method;
.12 drawing of each test configuration;
.13 identification of the test equipment and used instruments;
.14 conclusions;
.15 deviations from the test method, if any;
.16 test results including measurements and observations during and after the test; and
.17 date and signature.

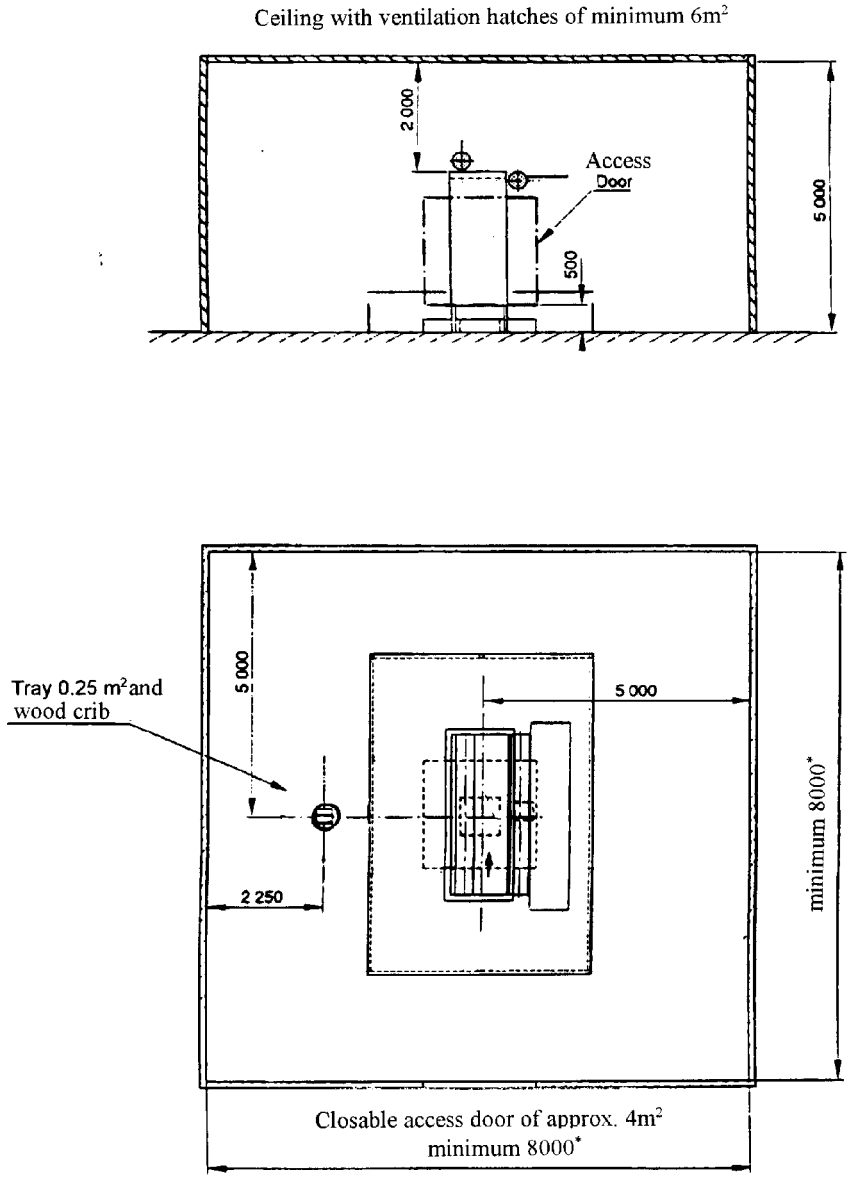

Figure 1

*The area should be 100m²

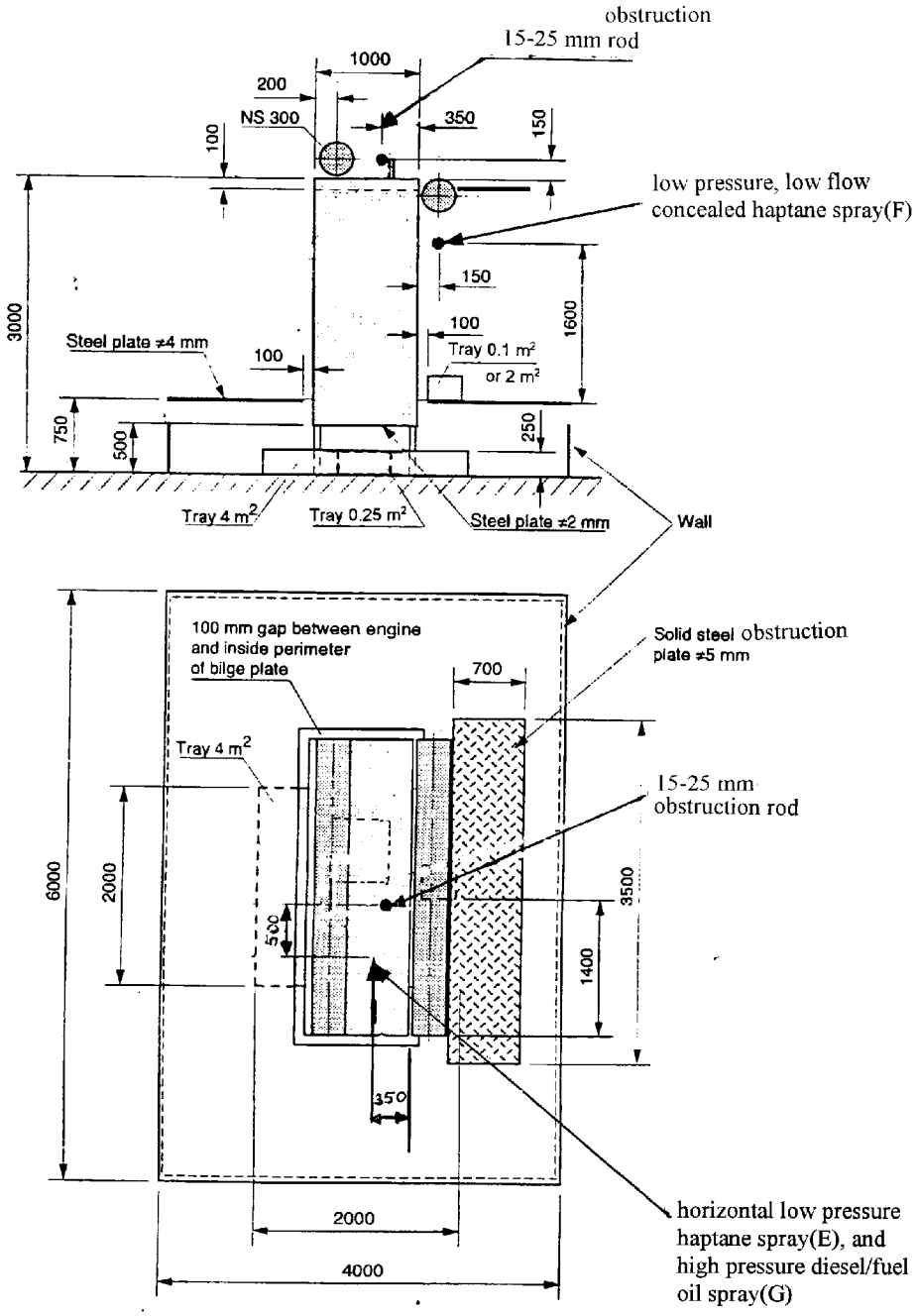
obstruction
15-25 mm rod
1000
200
NS 300
350
150
100
low pressure, low flow
concealed haptane spray(F)
150
100
Tray 0.1 m²
or 2 m²
1600
3000
Steel plate ≠4 mm
100
750
500
250
Tray 4 m²
Tray 0.25 m²
Steel plate ≠2 mm
Wall
100 mm gap between engine
and inside perimeter
of bilge plate
Solid steel obstruction
plate ≠5 mm
700
Tray 4 m²
15-25 mm
obstruction rod
6000
2000
500
3500
1400
350
2000
4000
horizontal low pressure
haptane spray(E), and
high pressure diesel/fuel
oil spray(G)

Figure 2

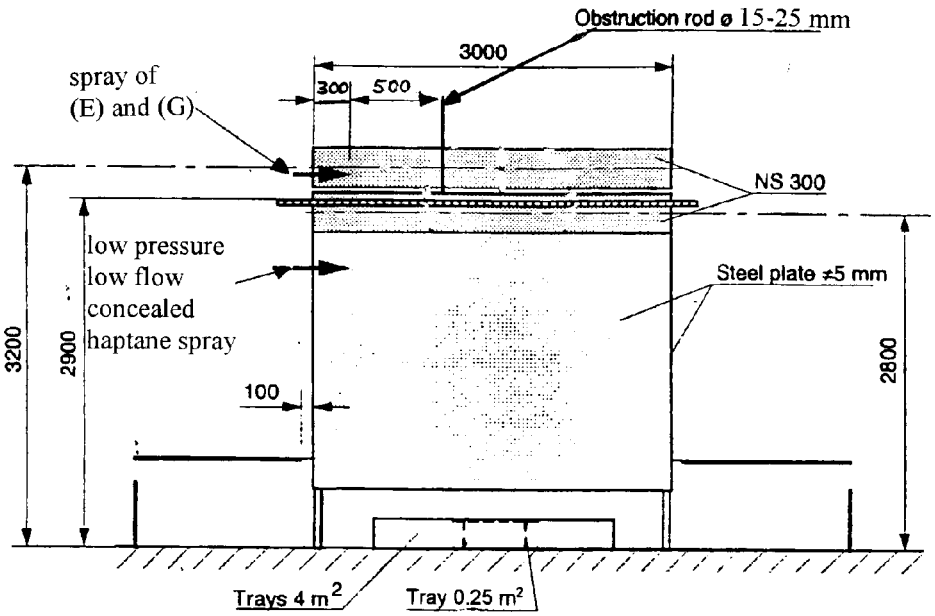
Obstruction rod ø 15-25 mm
3000
300
500
spray of
(E) and (G)
NS 300
low pressure
low flow
concealed
haptane spray
Steel plate ≠5 mm
3200
2900
2800
100
Trays 4 m2
Tray 0.25 m2

Figure 3