Maritime and Coastguard Agency

MERCHANT SHIPPING NOTICE

MSN 1666 (M)

The Merchant Shipping (Fire Protection) Regulations 1998: Fixed fire detection alarm and extinguishing systems

Notice to Shipowners, Shipbuilders, Masters, Certifying Authorities and Surveyors

Summary

This Notice advises all Shipowners, Shipbuilders, Masters, Certifying Authorities and Surveyors of the new 1998 Fire Protection Regulations for fixed fire detection alarm and extinguishing systems.

Key Points:-

- This Notice forms an integral part of the Merchant Shipping (Fire Protection: Large Ships) Regulations 1998 and the Merchant Shipping (Fire Protection: Small Ships) Regulations 1998.
- Schedules contained in this Notice are invoked by those Regulations and are therefore a statutory obligation.

LIST OF SCHEDULES

In this Merchant Shipping Notice -

(1) references to regulations in the Schedules unless otherwise stated, refer to regulations in the Merchant Shipping (Fire Protection: Large Ships) Regulations 1998;

(2) a reference to a numbered paragraph is, unless otherwise stated, a reference to the paragraph of that number in that Schedule;

(3) a reference to a numbered Schedule is, unless otherwise stated, a reference to the Schedule of that number in this Merchant Shipping Notice.

In this Notice the following expressions have the following headings respectively –

" "A" Class division" means a bulkhead or part of a deck which is -

(a) constructed of steel or other equivalent material;

(b) suitably stiffened;

(c) so constructed as to be capable of preventing the passage of smoke and flame to the end of the 60 minute standard fire test; and

(d) so insulated where necessary with suitable non-combustible materials that if the division is exposed to a standard fire test the average temperature on the unexposed side of the division shall not increase more than 139°C above the initial temperature nor shall the temperature at anyone point, including any joint, rise more than 180° above the initial temperature within the time listed below:-

"A-60" standard, 60 minutes
"A-30" standard, 30 minutes
"A-IS" standard, 15 minutes
"A-O" standard, 0 minutes:

"accommodation spaces" means:-

(a) public spaces;
(b) corridors and lobbies;
(c) stairways;
(d) lavatories;
(e) cabins;
(f) offices;
(g) hospitals;
(h) hairdressing salons;
(i) pantries not containing cooking appliances;
(j) lockers;
(k) games and hobbies' rooms; and
(l) spaces similar to any of the foregoing and trunks to such spaces allocated to passengers or crew:

"approved" means approved by the Secretary of State or in relation to any equipment or arrangement mentioned in Merchant Shipping Notice No. M.164S any person specified in that Notice in relation to such equipment or arrangement;

"cargo area" means that part of the ship which contains

(a) the cargo tanks, slop tanks and cargo pump rooms; and

(b) the following spaces when they are adjacent to the cargo tanks; namely, pump rooms other than cargo pump rooms, cofferdams, ballast spaces and void spaces;

"cargo ship" means any ship which is not a passenger ship, pleasure vessel or fishing vessel;

"cargo spaces" are all spaces used for cargo including cargo oil tanks, slop tanks and trunks to such spaces;

"closed ro-ro space" means a ro-ro cargo space which is not an open ro-ro space and not a weather deck;

"control stations" means spaces in which radio or main navigating equipment, or the emergency source of power, or the central fire recording equipment, or fire control equipment, or fire extinguishing installations are located, or a control room located outside a propelling machinery space;

"machinery space" means a space which contains propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilising, ventilation and air conditioning machinery and similar spaces and, where the context so admits, any trunk to such a space;

"machinery space of Category A" means a machinery space which contains -

(a) internal combustion type machinery used either for main propulsion purposes or for other purposes where such machinery has in the aggregate a total power output of not less than 373 kilowatts; or
(b) any oil-fired boiler or oil fuel unit;

and any trunks to such a space;

"passenger ship" means a ship carrying more than 12 passengers.

regulations 55(2)(b); 58(9); 59(4); 62(2)(a); 64(1)(a)(i); 64(3); 64(5)(a); 82(2)

SCHEDULE 1

AUTOMATIC SPRINKLER, FIRE DETECTION AND FIRE ALARM SYSTEMS

General design and layout

1. (a) Every automatic sprinkler, fire detection and fire alarm system shall be capable of immediate operation at all times and no action by the crew shall be necessary to set it in operation. It shall be of the wet pipe type but small exposed sections may be of the dry pipe type where this is a necessary precaution. Any parts of the system which maybe subjected to freezing temperatures in service shall be suitably protected against freezing. The system shall be kept charged at the necessary pressure and shall have provision for a continuous supply of water as required in this Schedule.

(b) (i) Each section of sprinklers shall include means for giving a visual and audible alarm signal automatically at one or more indicating units whenever any sprinkler comes into operation. Such alarm systems shall be such as to indicate if any fault occurs in the system.

(ii) In passenger ships such units shall give an indication of any fire and its location in any space served by the system and shall be centralised on the navigating bridge or in the main fire control station, which shall be so manned or equipped as to ensure that any alarm from the system is immediately received by a responsible member of the crew.

(iii) In cargo ships such units shall indicate in which section served by the system fire has occurred and shall be centralised on the navigating bridge and in addition, visible and audible alarms from the unit shall be placed in a position other than on the navigating bridge, so as to ensure that the indication of fire is immediately received by the crew.

2. (a) Sprinklers shall be grouped into separate sections, each of which shall contain not more than 200 sprinklers. In passenger ships any section of sprinklers shall not serve more than two decks and shall not be situated in more than one main vertical zone. However, such a section of sprinklers may be permitted to serve more than two decks or be situated in more than one main vertical zone, if it is satisfied that the protection of the ship against fire will not thereby be reduced.

(b) Each section of sprinklers shall be capable of being isolated by one stop valve only. The stop valve in each section shall be readily accessible and its location shall be clearly and permanently indicated. Means shall be provided to prevent the operation of the stop valves by any unauthorised person.

(c) A gauge indicating the pressure in the system shall be provided at each section stop valve and at a central. station.

(d) The sprinklers shall be resistant to corrosion by marine atmosphere. In accommodation and service spaces the sprinklers shall come into operation within the temperature range from 68°C to 79°C, except that in locations such as drying rooms, where high ambient temperatures might be expected, the operating temperature may be increased by not more than 30°C above the maximum deckhead temperature.

(e) A list or plan shall be displayed at each indicating unit showing the spaces covered and the location of the zone in respect of each section. Suitable instructions for testing and maintenance shall be available.

(f) Sprinklers shall be placed in an overhead position and spaced in a suitable pattern to maintain an average application rate of not less than 5 litres per square metre per minute over the nominal area covered by the sprinklers. Alternative distribution arrangements or sprinklers providing other amounts of water may be permitted providing the arrangements are no less effective.

(g) Sprinklers shall be spaced not more than 4 metres apart and not more than 2 metres from a bulkhead. They shall be placed as clear as possible of beams or other objects likely to obstruct the projections of water and in such positions that combustible material in the space concerned will be well sprayed.

(h) At least six space sprinklers shall be provided for each section.

Pressure tank and pumps

3. (a) A pressure tank having a volume equal to at least twice that of the charge of water specified in this subparagraph shall be provided. The tank shall contain a standing charge of fresh water, equivalent to the amount of water which world be discharged in one minute by the pump referred to in subparagraph 4(b) and the arrangements shall provide for maintaining an air pressure in the tank such as to ensure that where the standing charge of fresh water in the tank has been used the pressure will be not less than the working pressure of the sprinkler, plus the pressure exerted by a head of water measured from the bottom of the tank to the highest sprinkler in the system. Suitable means of replenishing the air under pressure and of replenishing the fresh water charge in the tank shall be provided.

(b) The pressure tank shall be fitted with an efficient relief valve and with a water gauge glass and a pressure gauge. Stop valves or cocks shall be provided at each of the gauge connections. Means shall be provided to prevent the inadvertent admission of sea water into the tank.

4. (a) An independent power pump shall be provided solely for the purpose of continuing automatically the discharge of water from the sprinklers. The pump shall be brought into action automatically by the pressure drop in the system before the standing fresh water charge in the pressure tank is completely exhausted.

(b) The pump and the piping system shall be capable of maintaining the necessary pressure at the level of the highest sprinkler to ensure a continuous output of water sufficient for the simultaneous coverage of a minimum area of 280 square metres at the application rate specified in subparagraph 2(f).

(c) The pump shall have fitted on the delivery side a test valve with a short open-ended discharge pipe. The effective area through the valve and pipe shall be adequate to permit the release of the required pump output while maintaining the pressure in the system specified in subparagraph 3(a).

(d) The pump shall have a suction direct from the sea which shall be independent of any other suction and which shall be in the space containing the pump. The sea inlet to the pump shall be so arranged that when the ship is afloat it will not be necessary to shut off the supply of sea water to the pump for any purpose other than the inspection or repair of the pump.

5. The sprinkler pump and tank shall be situated in a position reasonably remote from any machinery space of Category A and shall not be situated in any space required to be protected by the sprinkler system.

Power Supply

6. (a) Not less than two sources of power supply for the sprinkler pump, air compressor and automatic alarm and detection system shall be provided in passenger ships and cargo ships built before 1994. Where the sources of power are electrical one shall be an emergency source. One supply for the pump shall be taken from the main switchboard and one from the emergency switchboard by separate feeders reserved solely for that purpose. The feeders shall be arranged so as to avoid galleys, machinery spaces and other enclosed spaces of high fire risk except in so far as it is necessary to reach the appropriate switchboards and shall be run to an automatic changeover switch situated near the sprinkler pump. This switch shall permit the supply of power from the main switchboard so long as a supply is available therefrom, and be so designed that upon failure of that supply it will automatically change over to the supply from the emergency switchboard. The switches on the main and emergency switchboards shall be clearly labelled and normally kept closed. No other switch shall be permitted in the feeders concerned. One of the sources of power supply for the alarm and detection system shall be an emergency source. Where one of the sources of power for the pump is an internal combustion type engine it shall, in addition to complying with the provisions of paragraph 5, be so situated that a fire in any protected space will not affect the air supply to the machinery.

(b) In cargo ships built on or after 1 September 1984 there shall not be less than two sources of power supply for the sea water pump and automatic alarm and detection system. If the pump is electrically driven it shall be connected to the main source of electrical power, which shall be capable of being supplied by at least two generators. The feeders shall be so arranged as to avoid galleys, machinery spaces and other enclosed spaces of high fire risk except in so far as it is necessary to reach the appropriate switchboards. One of the sources of power supply for the alarm and detection system shall be an emergency source. Where one of the sources of power for the pump is an internal combustion engine it shall, in addition to complying with the provisions of paragraph 5, be so situated that a fire in any protected space will not affect the air supply to the machinery.

External Connections

7. Every sprinkler system shall have a connection from the ship's fire main provided with a screw-down valve and non-return valve at the connection which will prevent a back flow from the sprinkler system to the fire main. In addition, there may be fitted hose couplings with shut-off valves and non-return valves situated close to the couplings for the purpose of coupling to a shore supply, but no other external connection shall be fitted. The sprinkler system shall be a self contained unit. Shut off valves for the shore supply and the ship's fire mains connections shall be clearly and permanently marked to show their purpose and shall be capable of being locked in the closed position.

Provisions for Testing

8. (a) A test valve shall be provided for testing the automatic alarm for each section of sprinklers by a discharge of water equivalent to the operation of one sprinkler. The test valve for each section shall be situated near the stop valve for that section.

(b) Means shall be provided for testing the automatic operation of the pump on reduction of pressure in the system.

(c) Switches shall be provided at one of the indicating positions referred to in subparagraph l(b)(i) which will enable the alarm and the indicators for each section of sprinklers to be tested.

regulations 7(1)(a)i 20(1)(a)i 21(c)
Small ship regulations 8(1)(a)i 26(1)

SCHEDULE 2

FIXED PRESSURE WATER-SPRAYING SYSTEMS FOR MACHINERY SPACES AND CARGO PUMP ROOMS

1. Every fixed pressure water-spraying system shall be provided with a pump, piping system, control valves, and spraying nozzles. The pump provided for machinery space protection shall not be used for another purpose except that the pump may be used for supplying cargo pump room or cargo space water spraying systems where such systems are permitted. For cargo pump room protection the water supply may be from the ship's main fire pumps provided such pumps comply with the requirements of this Schedule.

2. The spraying nozzles shall be of such a type, sufficient in number and so arranged as to ensure an effective average distribution of water in accordance with the following table -

Protected area	Application rate	
	litres per sq. metre / min.	gallons per sq. ft. / min.
Boiler fronts or roof firing areas, oil fuel units, centrifugal separators (not oily water separators), oil fuel purifiers and clarifiers.	20	0.4
Hot oil fuel pipes near exhaust pipes or similar heated surfaces on main or auxiliary diesel. engines.	10	0.2
Tank top areas and oil tanks not forming part of the Ship's structure.	5	0.1
Cargo pump rooms	10	0.2

3. Spraying nozzles shall be fitted above bilges, tank tops and other areas over which oil fuel is liable to spread and above other main fire hazards in the spaces to be protected.

4. The water-spraying system may be divided into sections and shall be controlled from distribution manifolds, the valves of which shall be capable of being operated from easily accessible positions outside the spaces to be protected and which will not be readily cut off by an outbreak of fire within the protected space.

5. The water-spraying system shall be kept charged at the necessary pressure and the pump supplying the water for the system shall be automatically put into action by a pressure drop in the system.

6. The pump may be driven by independent internal combustion type machinery but if it is dependent upon power being supplied from the emergency generator fitted in compliance with the Merchant Shipping (Passenger Ship Construction) Regulations 1996 or the Merchant Shipping (Cargo Ship Construction) Regulations 1995, the generator shall be arranged to start automatically in case of main power failure so that power for the pump is immediately available. When the pump is driven by independent internal combustion type machinery it shall be so situated that a fire in the protected space will not affect the air supply to the machinery and the pump compartment.

7. The pump shall be capable of supplying water at the necessary pressure simultaneously to all sections of the water spraying system in anyone compartment to be protected. The pump and its controls shall be installed outside the space or spaces to be protected. It shall not be possible for a fire in the space or spaces protected by the water-spraying system to put the system out of action.

8. Means shall be provided which will prevent nozzles from becoming clogged by impurities in the water or corrosion of piping, nozzles, valves and pump.

9. No part of the water-spraying system shall be situated forward of the collision bulkhead in any passenger ship.

10. Operating instructions in clear and permanent lettering shall be affixed to every water-spraying system or in a position adjacent thereto.

**regulations 5(4); 5(5);5(6); 18(3)(b)
18(4); 18(5); 18(6); 65(c); 66(b)**

SCHEDULE 3

FIXED PRESSURE WATER-SPRAYING SYSTEMS FOR CARGO SPACES

1. Every fixed pressure water-spraying system shall be provided with a pump, piping system, control valves, and spraying nozzles.

2. The nozzles shall be of an approved full bore type and shall be arranged so as to secure an effective distribution of water in the spaces which are to be protected.

3. The system shall be such as will provide water application at a rate of at least 3.5 litres per square metre per minute for spaces with a deck height not greater than 2.5 metres and at least 5 litres per square metre per minute for spaces with a deck height greater than 2.5 metres.

4. Precautions shall be taken to prevent the nozzles from becoming clogged by impurities in the water.

5. The system shall cover the full breadth of the protected space except that in ships where the protected space is subdivided with longitudinal Class “A” divisions the breadth of the sections may be reduced accordingly. In ships of Classes I, II, VII or VIII and in ships of Classes II(A) or VIII(A) of 76 metres or over in length or where the length of the enclosed part of the protected space is 50 metres or over, the system may be divided into sections provided they are at least 20 metres in length. In ships of other classes the length of a section may be less than 20 metres but shall be not less than 10 metres provided the capacity of the pumps are capable of supplying the two largest adjacent sections simultaneously at the application rate referred to in paragraph 3.

6. The distribution valves for the system shall be situated in an easily accessible position adjacent to, but outside, the space to be protected which will not readily be cut off by a fire within the space. Direct access to the distribution valves from the protected spaces and from outside the spaces shall be provided. Adequate ventilation shall be fitted in the space containing the distribution valves.

7. The water supply to the system shall be provided by a pump or pumps, other than the ship's required fire pumps which shall additionally be connected to the system by a lockable non-return valve which will prevent a back flow from the system into the fire main.

8. The principal pump or pumps shall be capable of supplying simultaneously, at all times, at the required pressure all nozzles in the protected spaces, or two adjacent sections if this is less, a quantity of water in accordance with paragraphs 2 and 3.

9. The principal pump or pumps shall be capable of being brought into operation by remote control, which may be manually actuated, from the position at which the distribution valves are situated.

10. In ships of Class I and II, and in ships of Class II(A) of 76 metres or over in length or where the length of the enclosed part of the protected space is 50 metres or over the principal. pump or pumps shall be situated in a position reasonably remote from the protected space and from any machinery space of Category A. In ships of other Classes the principal pump or pumps shall be situated outside the protected space but may be situated within any machinery space.

11. In ships of Classes I and II, and in ships of Class II(A) of 76 metres or over in length or where the length of the enclosed part of the protected, space is 50 metres or over, if the principal pump or pumps are electrically driven there shall be two sources of power, one of which shall be the emergency generator. In ships of other Classes there shall be two sources of power which may be

two of the auxiliary generators provided they are independently driven. If the principal pump or pumps are driven by independent internal combustion type machinery they shall be so situated that a fire in the protected space will not affect the air supply to the machinery and the pump compartment.

12. When a fixed pressure water spraying system is provided for the machinery spaces in accordance with Schedule 2 the pump required for that system may also be used for the purpose of complying with this Schedule.

13. The sea suction of the pump shall be so arranged that, when the ship is afloat, it will not be necessary to shut off the supply of sea water to the pump for any purpose other than the inspection or repair of the pump.

14. The pump suction and discharge valves and any other valves requiring to be operated to bring the pump into operation shall be locked open or be operable from any control position of the system. A pressure gauge shall be provided at such control positions to show when water is available.

15. A waste valve with a short open ended pipe shall be fitted between the pump discharge and section control valves for testing purposes.

16. The pipes of the system shall be solid drawn or welded steel or equivalent and they shall be hydraulically tested by the manufacturers to twice the working pressure but not less than 2 MPa and be galvanised internally to prevent corrosion.

17. Fittings such as self-aligning swivel joints and flexible pipes situated within the protected space shall not be readily rendered ineffective by heat and where such fittings are used at least one spare of each type fitted shall be carried.

regulations 5(1); 5(3); 5(5); 7(1)(b)
18(3)(a); 18(6); 20(1)(b); 21(c); 32(2)(a); 66(b)
Small ship regulations 8(1)(b); 26(1); 26(1)(a)

SCHEDULE 4

FIXED GAS FIRE-EXTINGUISHING SYSTEMS

General

1. (a) Fire-extinguishing systems shall not contain an extinguishing medium which either itself or under expected conditions of use gives off toxic gases in such quantities as to endanger personnel.

(b) No part of the control, storage or generating arrangement of any fixed fire-extinguishing system shall be situated forward of the collision bulkhead in any passenger ship.

(c) (i) In every such system provided for the injection of fire-extinguishing medium into any compartment for fire-extinguishing purposes, the pipes for conveying the medium shall be provided with control. valves or cocks which shall be so placed that they will be easily accessible and not readily cut-off from use by an outbreak of fire within the protected compartment. Such control valves or cocks shall be permanently marked to indicate clearly the compartments to which the pipes are led.

(ii) Where cargo spaces fitted with a gas extinguishing system for fire protection are used as passenger spaces the extinguishing connection shall be blanked during service as a passenger space.

(iii) Suitable provisions shall be made to prevent inadvertent admission of the medium to any compartment.

(d) The piping for the distribution of fire-extinguishing medium shall be arranged and discharge nozzles so positioned that a uniform distribution of medium is obtained.

(e) Means shall be provided to close all openings which may admit air to or allow gas to escape from a protected space.

(f) Where the volume of free air contained in air receivers in any space is such that, if released in such space in the event of fire, such release of air within that space would seriously affect the efficiency of the fixed fire-extinguishing system, an additional quantity of fire-extinguishing medium shall be provided.

(g) Means shall be provided for automatically giving audible warning of the release of fire-extinguishing medium into any space in which personnel normally work or to which they have access. The alarm shall operate for a suitable period before the medium is released.

(h) The means of control of any fixed gas fire-extinguishing system shall be readily accessible and simple to operate and shall be grouped together in as few locations as possible in positions not likely to be cut off by a fire in a protected space. At each location there shall be clear instructions relating to the operation of the system having regard to the safety of personnel.

(i) Automatic release of fire-extinguishing medium shall not be permitted except as provided by subparagraph 4(c)(v) and in respect of local automatically operated units referred to in subparagraphs 4(d) and (e).

(j) Where the quantity of extinguishing medium is required to protect more than one space, the quantity of medium available need not be more than the largest quantity required for anyone space so protected.

(k) Except as otherwise permitted by subparagraphs 4(c), 4(d) and 4(e), pressure containers required for the storage of fire-extinguishing medium shall be located outside protected spaces in accordance with paragraph 2.

(l) The storage containers and associated pressure components shall be constructed of suitable material and shall be of efficient design and sufficient strength having regard to their locations and maximum ambient temperatures expected in service.

(m) Spare parts for the system shall be stored on board.

2. When the fire-extinguishing medium is stored outside a protected space, it shall be stored in a room which shall be situated in a safe and readily accessible position and effectively ventilated. Any entrance to such a storage room shall be from the open deck and in any case shall be independent of the protected space. Access doors shall open outwards, and bulkheads and decks including doors and other means of closing any opening there in, which form the boundaries between such rooms and adjoining enclosed spaces shall be gastight. For the purpose of the application of the integrity tables such storage rooms shall be treated as control stations.

Carbon dioxide systems

3. (a) When carbon dioxide is used as the extinguishing medium in cargo spaces, the quantity of gas available shall be sufficient to give a minimum volume of free gas equal to 30 per cent of the gross volume of the largest cargo compartment in the ship which is capable of being sealed.

(b) When carbon dioxide is used as the extinguishing medium in cargo spaces containing motor vehicles with fuel in their tanks for their own propulsion or in closed ro-ro spaces or closed ro-ro spaces used for bulk stowage of cargo, the quantity of gas available shall be sufficient to give a minimum volume of free gas equal to 45 per cent of the gross volume of the largest such cargo space which is capable of being effectively sealed.

(c) When carbon dioxide is used as an extinguishing medium for machinery spaces or pump rooms, the quantity of gas available shall be sufficient to give a minimum of free gas equal to the larger of the following quantities, either

(i) 40 per cent of the gross volume of the largest space, such volume being measured up to the level at which the horizontal area of the casing is 40 per cent or less of the gross area of such space measured midway between the tank top and the lowest part of the casing; or

(ii) 35 per cent of the gross volume of the largest space including the casing:

provided that the aforesaid percentages may be reduced to 35 per cent and 30 per cent respectively for ships of under 2,000 tons, not being passenger ships, provided also that if two or more machinery spaces are not entirely separate they shall be considered as forming one space.

(d) The volume of carbon dioxide shall be calculated at 0.56 cubic metre per kilogramme.

(e) (i) When carbon dioxide is used as the extinguishing medium for machinery spaces or pump rooms the arrangements shall be such that 85 per cent of the gas required to provide the concentration referred to in subparagraph 3(c) when applied to the space concerned can be discharged into that space within two minutes.

(ii) When carbon dioxide is used as the extinguishing medium in cargo spaces containing motor vehicles with fuel in their tanks for their own propulsion or in closed ro-ro spaces the arrangements shall be such as to ensure that at least two-thirds of the gas required for the space can be introduced within 10 minutes.

(f) Safe means shall be provided for the crew to check the quantity of medium within the containers.

(g) **Carbon dioxide systems installed on or after 1 October 1994** shall comply with the following requirements -

(i) two separate controls shall be provided for releasing carbon dioxide into a protected space and to ensure the activation of the alarm. One control shall be used to discharge the gas from its storage containers. A second control shall be used for opening the valve of the piping which conveys the gas into the protected space.

(ii) the two controls shall be located inside a release box clearly identified for the particular space. If the box containing the controls is to be locked, a key to this box shall be in a break-glass type enclosure conspicuously located adjacent to the box.

Halogenated hydrocarbon systems

4. (a) The use of halogenated hydrocarbons as fire-extinguishing media is only permitted in machinery spaces, pumprooms and in cargo spaces intended solely for the carriage of vehicles which are not carrying any cargo. New installations of halogenated hydrocarbon systems shall be prohibited on all ships.

(b) When halogenated hydrocarbons are used as the fire-extinguishing media in total flooding systems -

(i) the system shall be arranged for manual initiation of power release only and such means shall be provided outside the protected space.

(ii) where the charge of halogenated hydrocarbon is required to supply more than one space, the arrangements for its storage and release shall comply with subparagraph 4(b)(ix) or 4(b)(x) for each such space.

(iii) means shall be provided for stopping automatically all ventilation fans serving the protected space before the medium is released.

(iv) means shall be provided to close manually all dampers in the ventilation system serving a protected space.

(v) the arrangements shall be such that the liquid phase of the minimum quantity of medium required by subparagraphs 4(b)(ix) or 4(b)(x) when applied to the space concerned can be discharged into that space within 20 seconds or less.

(vi) the system shall be designed to operate within the temperature range likely to be experienced in service.

(vii) discharge nozzles shall be so positioned that a uniform distribution of fire-extinguishing medium is obtained and the discharge does not endanger personnel engaged on maintenance of machinery or equipment or using the normal access ladders and escapes serving the compartment.

(viii) safe means shall be provided for the crew to check the quantity of medium in the containers and the pressure therein.

(ix) the quantity of extinguishing medium for cargo spaces intended solely for the carriage of vehicles which are not carrying any cargo shall be calculated in accordance with Table 1. This quantity shall be based on the gross volume of the protected space.

TABLE 1

Halon	Minimum	Maximum
1301 (BTM)	5 per cent	7 per cent
1211 (BCF)	5 per cent	5.5 per cent

The volume of Halon 1301 (BTM) shall be calculated at 0.16 cubic metres per kilogramme and the volume of Halon 1211 (BCF) shall be calculated at 0.14 cubic metres per kil.ogramme.

(x) The quantity of extinguishing medium for machinery spaces shall be calculated in accordance with Table 2. This quantity shall be based on the gross volume of the space in respect of the minimum concentration and the net volume of the space in respect of the maximum concentration, including the casing.

TABLE 2

Hal.on	Minimum	Maximum
1301 (BTM)	4.25 per cent	7 per cent
1211 (BCF)	4.25 per cent	5.5 per cent

The volume of Hal.on 1301 (BTM) shall be calculated at 0.16 cubic metres per kilogramme and the volume of Halon 1211 (BCF) shall be calculated at 0.14 cubic metres per kilogramme.

(c) Where the medium is Halon 1301 (BTM), the storage containers may be permitted within a protected machinery space other than a pump room provided that the arrangements comply with the following requirements -

(i) the containers shall be individually distributed throughout the protected space having regard to the appropriate requirements of paragraph 1(d).

(ii) a manually initiated power release, located outside the protected space, shall be provided. Duplicate sources of power shall be provided for this release and shall be located outside the protected space and be immediately available except that for machinery spaces, one of the sources of power may be located inside the protected space.

(iii) the sources of pneumatic and hydraulic pressure and of electrical power shall be monitored for loss of pressure or power as appropriate and electrical circuits essential for the release of the medium from the containers shall be monitored for all fault conditions. Visual and audible alarms shall be provided to indicate this. Pneumatic or hydraulic power circuits connecting the containers shall be duplicated.

(iv) within the protected space, electrical circuits essential. for the release of the medium shall be mineral insulated cable or other equivalent material. Hydraulic and pneumatic piping systems essential for the release of the medium shall be of steel or other equivalent heat-resisting material.

(v) each container shall be fitted with an automatic over-pressure device which will safely vent the contents of the container into the protected space in the event of overpressure caused by the container being exposed to a fire and in operation on failure of the power.

(vi) the arrangements of the containers and the electric circuits and piping essential for the release of the medium shall be such that in the event of damage at anyone location in a circuit through fire or explosion, i.e. a single fault concept at least two-thirds of the quantity of medium required for that space in accordance with subparagraphs 4(b)(ix) or 4(b)(x) can still be discharged at will, having regard to the requirement for uniform distribution of medium throughout the space. In small compartments, only one or two containers may be permitted if the storage and release arrangements are satisfactory.

(vii) not more than two discharge nozzles shall be fitted to any pressure container and the maximum quantity of agent in each container shall be satisfactory in regard to the requirement for uniform distribution of medium throughout the space.

(viii) the containers shall be monitored for decrease in pressure due to leakage and discharge. Visual and audible alarms in the protected area and on the navigation bridge or at the control station shall be provided to indicate this condition, except that for cargo spaces alarms need only be provided on the navigation bridge or the control station.

(d) Local automatically operated units containing Halon 1301 (BTM) or Halon 1211 (BCF) fitted in enclosed areas of high fire risk within machinery spaces in addition to and independent of any required fixed fire-extinguishing system may be accepted provided the units comply with the following requirements

(i) the space in which such additional local protection is provided should be on one working level and on the same level as the access. More than one working level may be permitted subject to an access being provided on each level.

(ii) the escape arrangements shall be such that escape from anywhere in such protected spaces can be effected in not more than ten seconds.

(iii) the operation of any unit shall be indicated by visual and audible alarms outside each access into the space and at the navigating bridge or at the control station.

(iv) a notice stating that the space contains one or more automatically operated units and the name of the medium used shall be displayed outside each access to the space.

(v) the time to discharge the liquid phase of the medium in any local automatically operated unit shall not exceed ten seconds.

(vi) the arrangements of such units shall be such that release of the medium from any unit does not result in the loss of electrical. power or reduction in the manoeuvrability of the ship.

(vii) the total quantity of medium provided in such units within a protected space shall be such that the maximum vapour concentration at 20°C as specified in subparagraph 4(b)(x) is not exceeded when all such units operate; provided that the concentration may be exceeded where such units are operated together with a fixed system fitted in compliance with subparagraph 4(b).

(viii) every such unit shall comply with paragraphs 1(1), 4(b)(vi), 4(b)(vii) and 4(b)(viii).

(e) Local automatically operated units fitted in machinery spaces over equipment having high fire risk in addition to and independent of any required fixed fire-extinguishing system may be accepted provided that they comply with the following requirements -

(i) the total quantity of medium provided in such units within the machinery space shall be such that the maximum vapour concentration of 1.25 per cent of the gross volume of that space is not exceeded when all such units operate simultaneously.

(ii) every such unit shall comply with paragraphs 1(l), 4(b)(vii), (except that uniform distribution of the medium may not be required), 4(b)(viii), 4(d)(iii), 4(d)(iv), 4(d)(v), 4(d)(vi) and 4(d)(viii).

Other gas systems

5. (a) Where gas other than carbon dioxide or halogenated hydrocarbon is produced on the ship and is used as an extinguishing medium, it shall be a gaseous product of fuel combustion in which the oxygen content, the carbon monoxide content, the corrosive elements and any solid combustible elements have been reduced to a permissible minimum. Any system using such gas shall afford equivalent protection to that provided by a fixed carbon dioxide system.

(b) When a system producing inert gas is used to provide extinguishing gas in a fixed fire-extinguishing system for cargo spaces, except cargo oil. tanks, in compliance with the Regulations it shall be capable of producing hourly a volume of free gas at least equal to 25 per cent of the gross volume of the largest compartment protected in this way for a period of 72 hours.

(c) **For ships built before 25 May 1980** the injection of gas or steam into machinery or cargo spaces for fire-extinguishing purposes (other than an installation fitted for the rapid injecting of fire smothering gas in a ship of Class VIII, mainly or wholly constructed of wood and under 150 tons), the pipes for conveying the gas or steam shall be so placed that they will be easily accessible and not readily cut off from use by an outbreak of fire. Such control valves or cocks shall be permanently marked to indicate clearly the compartments to which the pipes are led. Suitable provision shall be made to prevent inadvertent admission of the gas or steam to any compartment.

(d) Where cargo spaces fitted with a gas or steam smothering system for fire protection are used as passenger spaces the smothering gas or steam pipe connection shall be blanked during service as a passenger space.

(e) (i) The piping shall be so arranged as to provide effective distribution of fire smothering gas or steam. Where steam is used in any hold exceeding 18.3 metres in length there shall be at least two pipes one of which shall be fitted in the forward part and one in the after part of the hold. Except in tankers and ships used for the conveyance of coal, pipes for conveying steam shall be fitted with outlets as low as practicable to the centre line of the space.

(ii) In tankers the piping shall be so arranged that the steam or fire smothering gas will be distributed over the surface of the cargo.

regulations 11(l)(b); 11(10); 24(1); 24(2); 24(3); 24(4) 57(5)(c); 64(1)(a)(ii); 64(2); 64(4); 82(1); 82(2); 82(3); 99

SCHEDULE 5

FIXED FIRE DETECTION AND FIRE ALARM SYSTEMS

General requirements

1. (a) Fixed fire detection and fire alarm systems with manually operated call points shall be capable of immediate operation at all times.

(b) Power supplies and electric circuits necessary for operation of the system shall be monitored for loss of power or fault conditions as appropriate. Occurrence of a fault condition shall initiate a visual and audible fault signal at the control panel which shall be distinct from a fire signal.

(c) There shall be not less than two sources of power supply for the electrical equipment used in the operation of the fire detection and fire alarm system, one of which shall be an emergency source. The supply shall be provided by separate feeders reserved solely for that purpose. Such feeders shall run to an automatic change-over switch situated in or adjacent to the control panel for the fire detection system.

(d) Detectors and manually operated call points shall be grouped into sections. The activation of any detector or manually operated call point shall initiate a visual and audible fire signal at the control panel and indicating units. If the signals have not received attention within two minutes an audible alarm shall be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of Category A. This alarm sounder system need not be an integral part of the detection system.

(e) The control. panel. shall be located on the navigating bridge or in the main fire control station.

(f) **For ships built on or after 1 July 1986** the indicating units shall, as a minimum, denote the section in which a detector or manually operated call point has operated. At least one unit shall be so located that it is easily accessible to responsible members of the crew at all times, when at sea or in port except when the ship is out of service. One indicating unit shall be located on the navigating bridge if the control panel is located in the main fire control station.

(g) Clear information shall be displayed on or adjacent to each indicating unit about the spaces covered and the locations of the sections.

(h) (i) **In the case of equipment installed before 1 July 1986**, no section covering more than one deck within accommodation spaces, service spaces and control. stations shall be permitted except a section which covers an enclosed stairway. In order to avoid delay in identifying the source of fire, each section shall contain not more than 100 detectors and shall cover not more than 50 enclosed spaces in any sector.

(ii) **In the case of equipment installed on or after 1 July 1986**, where the fire detection system does not include means for remotely identifying each detector individually, no section covering more than one deck within accommodation spaces, service spaces and control stations shall, normally, be permitted except a section which covers an enclosed stairway. In order to avoid delay in identifying the source of fire, each section shall contain not more than 100 detectors and shall cover not more than 50 enclosed spaces in any sector. If the detection system is fitted with remotely and individually identifiable fire detectors the sections may cover several decks and serve any number of enclosed spaces in any sector.

(i) (i) **In the case of equipment installed before 1 July 1986**, in passenger ships a section of detectors shall not serve spaces on both sides of the ship nor on more than one deck and neither shall it be situated in more than one main vertical zone except that if the protection of the ship against fire will not thereby be reduced, such a section of detectors may be permitted to serve both sides of the ship and more than one deck.

(ii) **In the case of equipment installed on or after 1 July 1986**, in passenger ships, if there is no fire detection system capable of remotely and individually identifying each detector, a section of detectors shall not serve spaces on both sides of the ship nor on more than one

deck and neither shall it be situated in more than one main vertical zone except that, if the protection of the ship against fire will not thereby be reduced, such a section of detectors may be permitted to serve both sides of the ship and more than one deck. In passenger ships fitted with individually identifiable fire detectors, a section may serve spaces on both sides of the ship and on several decks but may not be separated in more than one vertical zone.

(j) A section of fire detectors covering a control station, service space, accommodation space or cargo space shall not include a machinery space of Category A.

(k) Detectors shall be operated by heat, smoke or other products of combustion, flame or any combination of these factors. Detectors operated by other factors indicative of incipient fires may be accepted provided that they are no less sensitive than such detectors. Flame detectors shall be used only as additional to smoke or heat detectors.

(l) Suitable instructions and spare components for testing and maintenance shall be provided.

(m) The function of the detection system shall be periodically tested by means of equipment producing hot air at the appropriate temperature, or smoke or aerosol particles having the appropriate range of density or particle size, or other phenomena associated with incipient fires to which the detector is designed to respond. All detectors shall be of a type such that they can be tested for correct operation and restored to normal surveillance without the renewal. of any component.

(n) The fire detection system shall not be used for any other purpose except that closing of fire doors and similar functions may be permitted at the control panel.

(o) Fire detection systems with a zone address identification capability fitted **on or after 1 October 1994** shall be so arranged that -

(i) a loop cannot be damaged at more than one point by a fire;

(ii) means are provided to ensure that any fault (such as power break, short circuit, earth) occurring in the loop will not render the whole loop ineffective;

(iii) all arrangements are made to enable the initial configuration of the system to be restored in the event of failure (electrical, electronic, informatic); and

(iv) the first initiated fire alarm will not prevent any other detector from initiating further alarms.

Installation requirements

2. (a) Manually operated call points shall be installed throughout the accommodation spaces, service spaces and control stations. One manually operated call point shall be located at each exit. Manually operated call points shall be readily accessible in the corridors of each deck such that no part of the corridor is more than 20 metres from a manually operated call point.

(b) Smoke detectors shall be installed in all stairways, corridors and escape routes within accommodation spaces.

(c) Where a fixed fire detection and fire alarm system is required for the protection of spaces other than those specified in subparagraph (b) at least one detector complying with subparagraph 1(k) shall be installed in each such space.

(d) Detectors shall be located for optimum performance. Positions near beams and ventilation ducts or other positions where patterns of air flow could adversely affect performance and positions where impact or physical. damage is likely shall be avoided. In general, detectors which are located in overhead positions shall be a minimum distance of 0.5 metre away from bulkheads.

(e) The maximum spacing of detectors shall be in accordance with Table 1 below

TABLE 1

Type of detector	Maximum floor area per detector	Maximum distance apart between centres	Maximum distance away from bulkheads
Heat	37m2	9m	4.5m
Smoke	74m2	11m	5.5m

Other spacings may be used provided they are based upon test data which demonstrate the characteristics of the detectors.

(f) Electrical wiring which forms part of the system shall be so arranged as to avoid galleys, machinery spaces of Category A, and other enclosed spaces of high fire risk except where it is necessary to provide for fire detection or fire alarm in such spaces or to connect to the appropriate power supply.

Design requirements

3. (a) The system and equipment shall be suitably designed to withstand supply voltage variation and transients, ambient temperature changes, vibration, humidity, shock, impact and corrosion normally encountered in ships.

(b) Smoke detectors required by subparagraph 2(b) shall be certified to operate before the smoke density exceeds 12,5 per cent obscuration per metre, but not to operate until the smoke density exceeds 2 per cent obscuration per metre. Smoke detectors to be installed in other spaces shall operate within sensitivity limits having regard to the avoidance of detector insensitivity or over-sensitivity.

(c) Heat detectors shall be certified to operate before the temperature exceeds 78°C but not to operate until the temperature exceeds 54°C, when the temperature is raised to those limits at a rate less than 1°C per minute. At higher rates of temperature rise, the heat detector shall operate within satisfactory temperature limits having regard to the avoidance of detector insensitivity or over-sensitivity.

(d) The permissible temperature of operation of heat detectors may be increased to 30°C above the maximum deckhead temperature in drying rooms and similar spaces of a normal high ambient temperature.

Special requirements for periodically unattended machinery spaces

4. For periodically unattended machinery spaces the fixed fire detection and fire alarm system shall comply with the following additional. Requirements -

(a) this fire detection system shall be so designed and the detectors so positioned as to detect rapidly the onset of fire in any part of those spaces and under any normal conditions of operation of the machinery and variations of ventilation as required by the possible range of ambient temperatures. Except in spaces of restricted height and where their use is specially appropriate detection systems using only thermal. detectors shall not be permitted. The detection system shall initiate audible and visual alarms distinct in both respects from the alarms of any other system not indicating fire, in sufficient places to ensure that the alarms are heard and observed on the navigating bridge and by a responsible engineer officer. When the navigating bridge is unmanned the alarm shall sound in a place where a responsible member of the crew is on duty;

(b) after installation the system shall be tested under varying conditions of engine operation and ventilation.

Special requirements for cargo spaces

5. In cargo spaces the system shall comply with the following additional requirements

(a) detectors shall be grouped into separate sections such that a section shall cover not more than one cargo space. Each section shall contain not more than 100 detectors;

(b) the type, number and spacing of detectors shall take into account the conditions of ventilation and other factors prevailing in the space in which the detectors are installed;

(c) in special category spaces and ro-ro cargo spaces, the system shall be capable of rapidly detecting the onset of fire. After being installed, the system shall be tested under normal. ventilation conditions and shall give a satisfactory overall response time.

regulations 11(2); 66(a)

SCHEDULE 6

SAMPLE EXTRACTION SMOKE DETECTION SYSTEMS

General requirements

1. (a) In this Schedule "system" means sample extraction smoke detection system.

(b) Any required system shall be capable of continuous operation at all times except that systems operating on a sequential scanning principle may be accepted, provided that the interval between scanning the same position twice gives a satisfactory overall response time.

(c) Power supplies necessary for the operation of the system shall be monitored for loss of power. Occurrence of loss of power shall initiate a visual and audible signal at the control panel and the navigating bridge which shall be distinct from a signal indicating smoke detection.

(d) An alternative power supply for the electrical equipment used in the operation of the system shall be provided.

(e) The control panel shall be located on the navigating bridge or in the main fire control station.

(f) The detection of smoke or other products of combustion shall initiate a visual and audible signal at the control panel and the navigating bridge.

(g) Clear information shall be displayed on or adjacent to the control panel designating the spaces covered.

(h) The sampling pipe arrangements shall be such that the location of the fire can be readily identified.

(i) Suitable instructions and spare components shall be provided for the testing and maintenance of the system.

(j) The function of the system shall be periodically tested. The system shall be of a type that can be tested for correct operation and restored to normal surveillance without the renewal of any component.

(k) The system shall be designed, constructed and installed so as to prevent the leakage of any toxic or flammable substances or fire-extinguishing medium into any accommodation space, service space, control station or machinery space.

Installation requirements

2. (a) At least one smoke accumulator shall be located in every enclosed space for which smoke detection is required. However, where space is designed to carry oil or refrigerated cargo alternatively with cargoes for which a smoke sampling system is required, means may be provided to isolate the smoke accumulators in such compartments for the system.

(b) Smoke accumulators shall be located for optimum performance and shall be spaced so that no part of the overhead deck area is more than 12 metres measured horizontally from an accumulator. Where systems are used in spaces which may be mechanically ventilated, the position of the smoke accumulators shall be considered having regard to the effects of ventilation.

(c) Smoke accumulators shall be positioned where impact or physical. damage is unlikely to occur.

(d) Not more than four accumulators shall be connected to each sampling point.

(e) Smoke accumulators from more than one enclosed space shall not be connected to the same sampling point.

(f) Sampling pipes shall be self-draining and suitably protected from impact or damage from cargo working.

Design requirements

3. (a) The system and equipment shall be suitably designed to withstand supply voltage variations and transients, ambient temperature changes, vibration, humidity, shock, impact and corrosion normally encountered in ships and to avoid the possibility of ignition of flammable gas/air mixtures.

(b) The sensing unit shall be certified to operate before the smoke density within the sensing chamber exceeds 6.65 per cent obscuration per metre.

(c) Duplicate sample extraction fans shall be provided. The fans shall be of sufficient capacity to operate with the normal conditions of ventilation in the protected area and shall give a satisfactory overall response time.

(d) The control panel shall permit observation of smoke in the individual sampling pipe.

(e) Means shall be provided to monitor the airflow through the sampling pipes and to ensure that as far as practicable equal. quantities are extracted from each interconnected accumulator.

(f) Sampling pipes shall be a minimum of 12 millimetres internal diameter except when used in conjunction with fixed gas fire-extinguishing systems when the minimum size of pipe should be sufficient to permit the fire-extinguishing gas to be discharged within the appropriate time.

(g) Sampling pipes shall be provided with an arrangement for periodically purging with compressed air.

regulations 30(8); 30(9); 30(12); 30(14); 30(16)

SCHEDULE 7

FIXED DECK FOAM SYSTEMS

1. The arrangements for providing foam shall be capable of delivering foam to the entire cargo tanks deck area as well as into any cargo tank, the deck of which has been ruptured.

2. The deck foam system shall be capable of simple and rapid operation. The main control station for the system shall be suitably located outside the cargo area adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

3. The rate of supply of foam solution (that is, the mixture of foam concentrate and water before expansion) shall be not less than the following whichever is the greatest -

(a) 0.6 litre per minute per square metre of cargo tanks deck area, where cargo tanks deck area means the maximum breadth of the ship times the total longitudinal extent of the cargo tank spaces;

(b) 6 litres per minute per square metre of the horizontal sectional area of the single tank having the largest such area; or

(c) 3 litres per minute per square metre of the area protected by the largest monitor, such area being entirely forward of the monitor, but not less than 1,250 litres per minute.

4. Sufficient foam concentrate shall be supplied to ensure at least 20 minutes of foam generation in ships fitted with an inert gas system or 30 minutes of foam generation in ships not fitted with an inert gas system when using the solution rates stipulated in paragraph 3. The foam expansion ratio (that is, the ratio of the volume of foam produced to the volume of the mixture of foam concentrate and water before expansion) shall not generally exceed 12 to 1.

5. Foam from the fixed foam system shall be supplied by means of monitors and foam applicators. At least 50 per cent of the foam solution rate required in subparagraphs 3(a) and (b) shall be delivered from each monitor. On tankers of less than 4,000 tonnes deadweight, applicators may be substituted for an installation of monitors. In such a case the capacity of each applicator shall be at least 25 per cent of the foam solution rate required in subparagraph 3(a) or (b).

6. (a) The number and position of monitors shall be such as to comply with paragraph 1. The capacity of any monitor shall be at least 3 litres per minute of foam solution per square metre of deck area protected by that monitor, such area being entirely forward of the monitor. Such capacity shall be not less than 1,250 litres per minute.

(b) The distance from the monitor to the farthest extremity of the protected area forward of that monitor shall not be more than 75 per cent of the monitor throw in still air conditions.

7. A monitor and hose connection for a foam applicator shall be situated both port and starboard at the front of the poop or accommodation spaces facing the cargo tanks deck. **On tankers constructed on or after 1 September 1984** of a deadweight of less than 4,000 tonnes not fitted with monitors a hose connection for a foam applicator shall be situated both port and starboard at the front of the poop or accommodation spaces facing the cargo tanks deck.

8. The capacity of any applicator shall be not less than 400 litres per minute and the applicator throw in still air conditions shall be not less than 15 metres. The number of foam applicators provided in accordance with the requirements of paragraph 5, shall be not less than four. The number and disposition of foam main outlets shall be such that foam from at least two applicators can be directed on to any part of the cargo tank deck area.

9. Valves shall be provided in the foam main, and in the fire main when this is an integral part of the deck foam system, immediately forward of any monitor position to isolate damaged sections of those mains.

10. Operation of a deck foam system at its required output shall permit the simultaneous use of the minimum required number of jets of water at the required pressure from the fire main.

regulations 7(1)(C)i 20(1)(c)
Small ships regulations 8(1)(c)

SCHEDULE 8

FIXED HIGH-EXPANSION FOAM FIRE-EXTINGUISHING SYSTEMS IN MACHINERY SPACES

1. Any fixed high-expansion foam system in machinery spaces shall be capable of rapidly discharging through fixed discharge outlets a quantity of foam sufficient to fill the greatest space to be protected at a rate of at least 1 metre in depth per minute. The quantity of foam-forming liquid available shall be sufficient to produce a volume equal to five times the volume of the largest space to be protected. The expansion ratio of the foam shall not exceed 1,000 to 1.

2. Supply ducts for delivering foam, air intakes to the foam generator and the number of foam-producing units shall provide effective foam production and distribution.

3. The arrangement of the foam generator delivery ducting shall be such that a fire in the protected space will not affect the foam generating equipment.

4. The foam generator, its sources of power supply, foam-forming liquid and means of controlling the system shall be readily accessible and simple to operate and shall be grouped in as few locations as possible at positions not likely to be cut off by a fire in the protected space.

SCHEDULE 9

INERT GAS SYSTEMS: STANDARD REQUIREMENTS

1. Every inert gas system shall be designed, constructed and tested to the satisfaction of the Secretary of State.

2. The system shall be capable of -

(a) inerting empty cargo tanks including slop tanks by reducing the oxygen content of the atmosphere in each tank to a level at which combustion cannot be supported;

(b) maintaining the atmosphere in any part of any cargo tank or slop tank at an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times both in port and at sea except when it is necessary for such a tank to be gas free;

(c) eliminating the need for air to enter a tank during normal. operations except when it is necessary for such a tank to be gas free;

(d) purging empty cargo tanks including slop tanks of hydrocarbon gas, so that subsequent gas freeing operations will at no time create a flammable atmosphere within the tank.

3. (a) The system shall be capable of delivering inert gas to the cargo tanks and slop tanks at a rate of at least 125 per cent of the maximum rate of discharge capacity of the ship, expressed as a volume.

(b) The system shall be capable of delivering inert gas with an oxygen content of not more than 5 per cent by volume in the inert gas supply main to the cargo tanks and slop tanks at any required rate of flow.

4. The inert gas supply may be treated flue gas from the main or auxiliary boilers, from one or more separate gas generators or other sources or from any combination thereof. Other systems using inert gases other than flue gas, may be accepted if they can be shown to provide an equivalent standard of safety. Systems using stored carbon dioxide shall not be permitted unless the risk of ignition from generation of static electricity by the system itself is minimised.

5. Flue gas isolating valves shall be fitted in the inert gas supply mains between the boiler uptakes and the flue gas scrubber. These valves shall be provided with indicators to show whether they are open or shut, and precautions shall be taken to maintain them gas-tight and keep the seating clear of soot. Arrangements shall be made so that boiler soot blowers cannot be operated when the corresponding flue gas valve is open.

6. (a) A flue gas scrubber shall be fitted which will effectively cool the volume of gas specified in paragraph 3 and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential. services on the ship. Provision shall also be made for an alternative supply of cooling water.

(b) Filters or equivalent devices shall be fitted to minimise the amount of water carried over to the inert gas blowers.

(c) The scrubber shall be located aft of all cargo tanks, slop tanks, cargo pump rooms and cofferdams separating these spaces from machinery spaces of Category A.

7. (a) At least two blowers shall be fitted which together shall be capable of delivering to the cargo tanks and slop tanks at least the volume of gas required by paragraph 3. In a system provided with a gas generator, one blower may be permitted if that system is capable of delivering the total volume of gas required by paragraph 3 to the protected cargo tanks, provided that sufficient spares for the blower and its prime mover are carried on board to enable any failure of the blower and its prime mover to be rectified by the ship's crew.

(b) Two fuel oil pumps shall be fitted to the inert gas generator. One fuel oil pump may be permitted if sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the ship's crew.

(c) The inert gas system shall be so designed that the maximum pressure which it can exert on any cargo tank will not exceed the test pressure of any cargo tank. Suitable shut-off arrangements shall be provided on the suction and discharge connections of each blower. Arrangements shall be provided to enable the functioning of the inert gas plant to be stabilised before commencing cargo discharge. If the blowers are to be used for gas freeing, their air inlets shall be provided with blanking arrangements.

(d) The blowers shall be located aft of all cargo tanks, cargo pump rooms and cofferdams separating these spaces from machinery spaces of Category A.

8. (a) The design and location of the scrubber and blowers with relevant piping and fittings shall be such as to prevent flue gas leakages into enclosed spaces.

(b) To permit safe maintenance, an additional water seal or other effective means of preventing flue gas leakage shall be fitted between the flue gas isolating valves and scrubber or incorporated in the gas entry to the scrubber.

9. (a) A gas regulating valve shall be fitted in the inert gas supply main. This valve shall be automatically controlled to close as required in subparagraph 19(c) and (d). It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless means are provided to automatically control the speed of the inert gas blowers required in paragraph 7.

(b) The valve referred to in subparagraph (a) shall be located at the forward bulkhead of the most forward gas-safe space through which the inert gas supply main passes.

10. (a) At least two non-return devices, one of which shall be a water seal, shall be fitted in the inert gas supply main in order to prevent the return of hydrocarbon vapour to the machinery spaces uptakes or to any gas-safe spaces under all normal conditions of trim, list and motion of the ship. They shall be located between the automatic valve required by paragraph 9 and the aftermost connection to any cargo tank or cargo pipeline.

(b) The devices referred to in this paragraph shall be located in the cargo area on deck.

(c) The water seal. referred to in subparagraph (a) shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times.

(d) The arrangement of the seal and its associated provisions shall be such that it will prevent back-flow of hydrocarbon vapours and will ensure the proper functioning of the seal. under operating conditions.

(e) Provision shall be made to ensure that the water seal. is protected against freezing, in such a way that the integrity of the seal is not impaired by overheating.

(f) A water loop or other arrangement shall also be fitted to all associated water supply and drain piping and all venting or pressure sensing piping leading to gas safe spaces. Means shall be provided to prevent such loops from being emptied by vacuum.

(g) The deck water seal and all loop arrangements shall be capable of preventing return of hydrocarbon vapours at a pressure equal to the test pressure of the cargo tanks.

(h) The second non-return device mentioned in subparagraph (a) shall be a non-return valve or equivalent, capable of preventing the return of vapours or liquids or both and fitted forward of the deck water seal required by subparagraph (a). It shall be provided with either positive means of closure or an additional valve having such means of closure located forward of the non-return valve to isolate the deck water seal from the inert gas main to the cargo tanks and slop tanks.

(i) As an additional safeguard against the possible leakage of hydrocarbon liquids or vapours back from the deck main, means shall be provided to permit the section of the line between the valve having positive means of closure referred to in subparagraph (h), and the valve referred to in paragraph 9 to be vented in a safe manner when the first of these valves is closed.

11. (a) The inert gas main may be divided into two or more branches forward of the non-return devices required by paragraph 10.

(b) (i) The inert gas supply main shall be fitted with branch piping leading to each cargo tank and slop tank. Branch piping for inert gas shall be fitted with either stop valves or equivalent means of control for isolating each tank. Where stop valves are fitted, they shall be provided with locking arrangements, which shall be under the control of a responsible ship's officer.

(ii) In combination carriers the arrangements to isolate the slop tanks containing oil or oil residues from other tanks shall consist of blank flanges which will remain in position at all times when cargoes other than oil are being carried except as provided for in the relevant section of the guidelines on Inert Gas Systems published by the International Maritime Organisation.

(c) Means shall be provided to protect cargo tanks and slop tanks against the effect of over-pressure or vacuum caused by thermal variations when such tanks are isolated from the inert gas main.

(d) Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

(e) Suitable arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas.

12. The arrangements for the venting of all vapours displaced from the cargo tanks during loading or ballasting shall comply with regulation 12 of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984 and shall consist of either one or more mast risers, or a number of high velocity vents. The inert gas supply main may be used for such venting.

13. The arrangements for inerting, purging or gas freeing of empty tanks as required in paragraph 2 shall be such that the accumulation of hydrocarbon vapours in pockets formed by the internal structural members in a tank is minimised and that

(a) on individual cargo tanks or slop tanks the gas outlet pipe, if fitted, shall be positioned as far as practicable from the inert gas/air inlet and in accordance with regulation 12 of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984. The inlet of such outlet pipes may be located at either deck level or at not more than 1 metre above the bottom of the tank;

(b) the cross sectional area of such a gas outlet pipe referred to in subparagraph (a) shall be such that an exit velocity of at least 20 metres per second can be maintained when any three tanks are being simultaneously supplied with inert gas. Their outlets shall extend not less than 2 metres above deck level;

(c) each gas outlet referred to in subparagraph (b) shall be fitted with suitable blanking arrangements;

(d) (i) if a connection is fitted between the inert gas supply main and the cargo piping system, arrangements shall be made to ensure an effective isolation having regard to the high pressure difference which may exist between the systems. This shall consist of two shut-off valves with an arrangement to vent the space between the valves in a safe manner or an arrangement consisting of a spool-piece with associated blanks; and

(ii) the valve separating the inert gas supply main from the cargo main and which is on the cargo main side shall be a non-return valve with a positive means of closure.

14. (a) One or more pressure-vacuum breaking devices shall be provided to prevent the cargo tanks from being subject to

(i) a positive pressure in excess of the test pressure of the cargo tank if the cargo were to be loaded at the maximum rated capacity and all other outlets were left shut; and

(ii) a negative pressure in excess of 700 millimetres water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blower were to fail. Such devices shall be installed on the inert gas main unless they are installed in the venting system required by regulation 12 of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984 or on individual cargo tanks.

(b) The location and design of the devices referred to in subparagraph (a) shall be in accordance with regulation 12 of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984.

15. Means shall be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the gas blowers, whenever those gas blowers are operating.

16. (a) Instrumentation shall be fitted for continuously indicating and permanently recording when the inert gas is being supplied -

(i) the pressure of the inert gas supply main forward of the non-return devices required by subparagraph 10(a); and

(ii) the oxygen content of the inert gas in the inert gas supply main on the discharge side of the gas blowers.

(b) The devices referred to ip subparagraph (a) shall be placed in the cargo control room where provided. Where no cargo control. room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

(c) In addition, meters shall be fitted

(i) in the navigating bridge, to indicate at all times the pressure referred to in subparagraph (a) (i) and the pressure in the slop tanks of combination carriers, whenever those tanks are isolated from the inert gas supply main; and

(ii) in the machinery control room or in the machinery space, to indicate the oxygen content referred to in subparagraph (a)(ii).

17. Portable instruments for measuring oxygen and flammable vapour concentration shall be provided. In addition, suitable arrangements shall be made on each cargo tank and slop tank such that the condition of the tank atmosphere can be determined using these portable instruments.

18. Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in paragraphs 16 and 17.

19. (a) For an inert gas system of the flue gas type, or of the inert gas generator type in a ship **constructed on or after 1st February 1992**, audible and visual. alarms shall be provided to indicate -

(i) low water pressure or low water flow rate to the flue gas scrubber referred to in subparagraph (6)(a);

(ii) high water level in the flue gas scrubber referred to in sub paragraph (6)(a);

(iii) high gas temperature referred to in paragraph 15;

(iv) failure of any of the inert gas blowers referred to in subparagraph 7(a);

(v) oxygen content in excess of 8 per cent by volume referred to in subparagraph 16(a)(ii);

(vi) failure of the power supply to the automatic control. system for the gas regulating valve and to the indicating devices referred to in paragraph 9 and subparagraph 16 (a) respectively;

(vii) low water level in the water seal. referred to in subparagraph 10(a);

(viii) gas pressure less than 100 millimetres water gauge as referred to in subparagraph 16(a)(i), the alarm arrangement for this gas pressure shall be such as to ensure that the pressure in slop tanks in combination carriers can be monitored at all times; and

(ix) high gas pressure referred to in subparagraph 16(a)(i).

For an inert gas system of the inert gas generator type in a ship **constructed before 1st February 1992**, audible and visual alarms shall be provided to indicate as stated in subparagraphs (a) (i), (iii) and (v) to (ix).

(b) For an inert gas system of the inert gas generator type (whatever the date of construction of the ship) additional. alarms (which, in the case of a ship constructed on or after 1st February 1992, must be audible and visual.) shall be pl1ovided to indicate

(i) insufficient fuel oil supply;

(ii) failure of the power supply to the generator;

(iii) failure of the power supply to the automatic control. system for the generator.

(c) Automatic shut down of the inert gas blowers and gas regulating valve shall be arranged on predetermined limits being reached in respect of subparagraph (a) (i), (a)(ii) and (a)(iii).

(d) Automatic shut down of the gas regulating valve shall be arranged so as take account of failure of the inert gas blowers referred to in paragraph 7.

(e) In relation to subparagraph (a)(v), automatic or manual shutdown of the isolation valve referred to in subparagraph (10)(h).

(f) The alarms required in subparagraphs (a)(v), (a) (vi) and (a) (viii) shall be fitted in the machinery space and cargo control room, where provided, but in any event in such a position that they are

immediately received by responsible members of the crew.

(g) In relation to subparagraph (a) (vii) there shall be an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal. shall be maintained when the gas flow ceases. The audible and visual alarm on the low level of water in the water seal. shall operate when the inert gas is not being supplied.

(h) An audible alarm system, independent of that required by subparagraph (a) (viii), or automatic shut down of cargo pumps shall be provided to operate on predetermined lined limits of low pressure in the inert gas main being reached.

20. A detailed instruction manual shall be provided on board by the owner and it shall cover the operational safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manual shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system as detailed in the Guidelines for Inert Gas Systems.

regulations 30(2)(a)i 30(2)(b)

SCHEDULE 10

INERT GAS SYSTEMS: ALTERNATIVE REQUIREMENTS FOR CHEMICAL TANKERS

1. (a) Every inert gas system shall be designed, constructed and tested to the satisfaction of the Secretary of State.

(b) In this Schedule a reference to a cargo tank includes a reference to a slop tank containing cargo residues.

2. The system shall be capable of -

(a) inerting empty cargo tanks by reducing the oxygen content of the atmosphere in each tank to a level. at which combustion cannot be supported;

(b) maintaining the atmosphere, in all parts of each cargo tank designated to carry flammable products requiring protection by an inert gas system, with an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times in port and at sea except when it is necessary for such a tank to be gas-free;

(c) eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas-free;

(d) purging empty cargo tanks of flammable vapour, so that subsequent gas-freeing operations will at no time create a flammable atmosphere within the tanks.

3. (a) The system shall be capable of delivering inert gas to the cargo tanks at a rate of at least 125 per cent of the maximum rate of discharge capacity of the ship expressed as a volume. The Secretary of State may accept an inert gas system having a lower delivery capacity provided that the maximum rate of discharge of cargoes from cargo tanks being protected by the system is restricted to 80 per cent of the inert gas capacity.

(b) The system shall be capable of delivering inert gas with an oxygen content of not more than 5 per cent by volume in the inert gas supply main to the cargo tanks at any required rate of flow.

4. (a) Suitable fuel in sufficient quantity shall be provided for the inert gas generators.

(b) The inert gas generators shall be located outside the cargo tank area as defined in the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk or the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk. Spaces containing inert gas generators shall have no direct access to accommodation, service or control station spaces, but may be located in machinery spaces. If they are not located in machinery spaces, they shall be located in a compartment reserved solely for their use. Such a compartment shall be separated by a gastight steel bulkhead or deck from accommodation, service and control station spaces. Adequate positive-pressure-type mechanical ventilation shall be provided for such a compartment. Access to such compartments located aft shall be only from an open deck outside the cargo tank area. Access shall be located on the end bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse at a distance of at least 25 per cent of the length of the ship but not less than 5 metres from the end of the superstructure or deckhouse facing the cargo area. In the case of such a compartment being located in the forecastle, access shall be through the deckhead forward of the cargo area.

(c) Inert gas piping systems shall not pass through accommodation, service and control station spaces.

5. (a) Means shall be provided which will effectively cool the volume of gas specified by paragraph 3 and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential services on the ship. Provision shall also be made for an alternative supply of cooling water.

(b) Filters or equivalent devices shall be fitted to minimise the amount of water carried over to the inert gas main.

6. (a) Two air blowers shall be fitted to each inert gas generator, which together shall be capable of delivering to the cargo tanks required to be protected by the system at least the volume of gas required by paragraph 3. One blower maybe permitted if it is capable of delivering to the protected cargo tanks the total volume of gas required by paragraph 3, provided that sufficient spares for the air blower and its prime mover are carried on board to enable any failure of the air blower and its prime mover to be rectified.

(b) The inert gas system shall be so designed that the maximum pressure which it can exert on any cargo tank will not exceed the test pressure of that tank.

(c) Where more than one inert gas generator is provided, suitable shut-off arrangements shall be provided on the discharge outlet of each generator plant.

(d) Arrangements shall be made to vent the inert gas to the atmosphere in case the inert gas produced is sub-standard, for example during starting-up or in case of equipment failure.

(e) Where inert gas generators are served by positive displacement blowers, a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

7. Two fuel oil pumps shall be fitted to each inert gas generator. One fuel oil pump may be permitted if sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the ship's crew.

8. A gas-regulating valve shall be fitted in the inert gas supply main. This valve shall be automatically controlled to close as required by subparagraphs 17(b) and (c). It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless other means are provided to control automatically the inert gas flow rate.

9. (a) At least two non-return devices, one of which shall be a water seal, shall be fitted in the inert gas supply main in order to prevent the return of flammable vapour to the inert gas generator and to any gas-safe space under all normal conditions of trim, list and motion of the ship. They shall be located between the automatic valve required by paragraph 8 and the first connection to any cargo tank or cargo pipeline. An alternative arrangement or device may be permitted if it can be shown that it provides a measure of safety equivalent to that of a water seal..

(b) The devices referred to in subparagraph (a) shall be located in the cargo tank area on deck.

(c) The water seal referred to in subparagraph (a) shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times.

(d) The arrangement of the water seal and its associated provisions shall be such that it will prevent back flow of flammable vapours and will ensure the proper functioning of the water seal under operating conditions.

(e) Provision shall be made to ensure that any water seal is protected against freezing, in such a way that the integrity of the water seal. is not impaired by overheating.

(f) A water loop or other approved arrangement shall also be fitted to all associated water supply and drain piping and to all venting or pressure-sensing piping leading to gas-safe places. Means shall be provided to prevent such loops from being emptied by vacuum.

(g) Any water seal or equivalent device and all loop arrangements shall be capable of preventing the return of flammable vapours to an inert gas generator at a pressure equal to the test pressure of the cargo tanks.

(h) The second device shall be a non-return valve or equivalent capable of preventing the return of vapours or liquids or both and fitted between the water seal or the equivalent device required by subparagraph (a) and the first connection from the inert gas main to a cargo tank. It shall be provided with positive means of closure. As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the non-return valve and the first connection to the cargo tanks to isolate the water seal. or equivalent device.

(i) As an additional safeguard against the possible leakage of flammable liquids or vapours back from the deck main, means shall be provided to permit the section of the line between the valve having positive means of closure referred to in subparagraph (h) and the valve referred to in paragraph 8 to be vented in a safe manner when the first of these valves is closed.

10. (a) The inert gas main may be divided into two or more branches between the non-return devices required by paragraph 9 and the cargo tanks.

(b) Inert gas supply mains shall be fitted with branch piping leading to each cargo tank designated for the carriage of flammable products required to be inerted. Each cargo tank containing or loading products not required to be inerted shall be separated from the inert gas main by -

(i) removing spool. pieces, valves or other pipe sections, and blanking the pipe ends; or

(ii) an arrangement of two spectacle flanges in series with provision for detecting leakage into the pipe between the two spectacle flanges.

(c) Means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations when the tanks are isolated from the inert gas mains.

(d) Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

(e) Suitable arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas.

11. Unless the arrangements for venting of all vapours displaced from the cargo tanks during loading and ballasting comply with the requirements of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk or the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk for controlled venting, such arrangements shall comply with regulation 12 of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984 and shall consist either of one or more mast risers or of a number of high velocity vents. **In chemical tankers constructed before 1st July 1986** the inert gas supply mains shall not be used for such venting.

12. The arrangements for inerting, purging or gas-freeing of empty tanks as required by paragraph 2 shall be such that the accumulation of hydrocarbon vapours in pockets formed by the internal. structural members in a tank is minimised, and when in accordance with paragraph 3 a system is designed to supply only one tank or two tanks simultaneously, the outlet pipes shall be sized such that an exit velocity in the outlet pipes of 20 metres per second can be maintained and, **except on chemical tankers constructed before 1st July 1986 -**

(a) the gas outlet pipe on individual cargo tanks, if fitted, shall be positioned as far as practicable from the inert gas / air inlet and in accordance with regulation 12(5)(c) of the Merchant Shipping (Cargo Ship Construction and Survey) Regulations 1984, or paragraph 8.2.2.3 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk. The inlet of such outlet pipes may be located either at deck level. or not more than 1 metre above the bottom of the tank;

(b) the cross-sectional area of such gas outlet pipe referred to in subparagraph (a) shall be such that an exit velocity of at least 20 metres per second can be maintained when any three tanks are being simultaneously supplied with inert gas. Their outlets shall extend not less than 2 metres above deck level; and

(c) each gas outlet referred to in subparagraph (b) shall be fitted with suitable blanking arrangements.

13. Means shall be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the system, whenever it is operating.

14. (a) Instrumentation shall be fitted for continuously indicating and permanently recording, when the inert gas is being supplied -

(i) the pressure of the inert gas supply mains between the non-return devices required by subparagraph 9(a) and the cargo tanks; and

(ii) the oxygen content of the inert gas in the inert gas supply main.

(b) The devices referred to in subparagraph (a) shall be placed in the cargo control room where provided. Where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

(c) In addition, meters shall be fitted -

(i) in the navigating bridge to indicate at all times the pressure referred to in subparagraph (a)(i); and

(ii) in the machinery control room or in the machinery space to indicate the oxygen content referred to in subparagraph (a)(ii).

15. Portable instruments for measuring oxygen and flammable vapour concentration shall be provided. In addition, suitable arrangements shall be made on each cargo tank such that the condition of the tank atmosphere can be determined using these portable instruments.

16. Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in paragraphs 14 and 15.

17. (a) Audible and visual alarms shall be provided to indicate

(i) low water pressure or low water flow rate to the cooling and scrubbing arrangements referred to in subparagraph 5(a);

(ii) low fuel. supply;

(iii) high gas temperature referred to in paragraph 13;

(iv) failure of the power supply to the inert gas generators;

(v) oxygen content in excess of 8 per cent by volume referred to in subparagraph 14(a)(ii);

(vi) failure of the power supply to the indicating devices referred to in subparagraph 14(a) and to the automatic control system for the gas-regulating valve referred to in paragraph 8 and the inert gas generator;

(vii) low water level in the water seal. referred to in paragraph 9;

(viii) gas pressure less than 100 millimetres water gauge referred to in subparagraph 14(a);

(ix) high gas pressure referred to in subparagraph 14(a)(i).

(b) Automatic shutdown of the gas-regulating valve and of the fuel. oil supply to the inert gas generator shall be arranged on predetermined limits being reached in respect of subparagraphs (a)(i) and (iii).

(c) Automatic shutdown of the gas-regulating valve shall be arranged in respect of subparagraph (a)(iv).

(d) In respect of subparagraph (a) (v), automatic or manual. shutdown of the deck isolation valve referred to in subparagraph 9(h).

(e) The alarms required by subparagraphs (a) (v), (vi) and (viii) shall be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew. All other alarms required by this paragraph shall be audible to responsible members of the crew either as individual alarms or as a group alarm.

(f) In respect of subparagraph (a) (vii) there shall be an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal shall be maintained when the gas flow ceases, The audible and visual alarm on the low level of water in the water seal. shall operate when the inert gas is not being supplied.

(g) An audible alarm system, independent of that required by subparagraph (a) (viii), or automatic shutdown of cargo pumps shall be provided to operate on pre-determined limits of low pressure in the inert gas mains being reached.

18. Detailed information manuals shall be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manuals shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

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