BAHRIA CLASSIFICATION SOCIETY

Chapter 28 – Ventilation

JULY 2022

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red color.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction is on or after JULY 2022

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Ventilation

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Annex A - Recommendations

AMENDMENTS

Revision	RCS No.	EIF Date*
Section 01	01/2022	07/2022
Section 01	01/2022	07/2022

* Entry into Force (EIF) Date is provided for general guidance only, EIF dates given in Rule Change Summary (RCS) are considered valid. In addition to the above stated changes, editorial corrections may have been made.

SECTION 1

VENTILATION

A. General

1. Application

1.1 These rules apply to ships to be classed for unrestricted service. For ships classed for restricted service or ships which are intended to trade within specified limits as well as for small cargo vessels of less than convention size (< 500 GT), small fishing vessels, pontoons without propulsion, barges and dredgers without propulsion and pleasure craft (yachts, etc.) exemptions from the requirements of these rules may be permitted.

1.2 Designs which deviate from these rules may be approved provided that such designs have been examined by **BCS** for suitability and have been recognized as equivalent.

1.3 National rules or regulations remain unaffected.

1.4 Annex A contains recommendations which are not a matter of Classification.

2. Other Applicable Rules

In addition to the requirements of these rules:

- Tankers for the carriage of flammable liquids are subject to the provisions of BCS Machinery Rules, Chapter 4, Section 15
- Tankers for the carriage of liquefied gases in bulk are subject to the provisions of the BCS Rules for Liquefied Gas Carriers, Chapter 10
- Tankers for the carriage of hazardous chemicals in bulk are subject to the provisions of **BCS**Rules for Chemical Tankers, Chapter 8
- Seagoing and inland waterway steel vessels with or without their own means of propulsion which are intended for service in the event of accidental oil spills are subject to the provisions of **BCS** Rules for Oil Recovery Vessels, Chapter 12
- Ships intended for the carriage of dangerous goods in packaged form and for the carriage of solid bulk cargoes are subject to the provisions of **BCS** Machinery Rules, Section 18, P and Q and Electrical Installations, Section 17, D
- Ventilation systems for ships with gas as fuel are subject to **BCS** Guidelines for the Use of Gas as Fuel for Ships.

3. International Standards

For design and construction of ventilation systems the following international standards are recommended as guidance. The last edition of each standard should be applied.

- ISO 7547, Shipbuilding – Air-conditioning and ventilation of accommodation spaces on board Zships – Design conditions and basis of calculations
- ISO 8861, Shipbuilding – Engine room ventilation in diesel-engined ships – Design requirements and basis of calculations
- ISO 8862, Air-conditioning and ventilation of machinery control rooms on board ships – Design conditions and basis of calculations
- ISO 8864, Shipbuilding – Air conditioning and ventilation of wheelhouse on board ships – Design conditions and basis of calculations
- ISO 9785, Ships and marine technology – Ventilation of cargo spaces where vehicles with Internal combustion are driven
- ISO 9943, Shipbuilding – Ventilation and air-treatment of galleys and pantries with cooking appliances

B. Documents to be Submitted for Approval

The following documents are to be submitted in triplicate to BCS for approval. BCS reserve its right to ask for supplementary copies, if deemed necessary.

- Ventilation and air condition scheme – accommodation and service spaces
- Ventilation system machinery spaces and technical spaces
- Ventilation system cargo holds
- Details of fire closures and weather tight closures
- Details of duct penetrations
- Approval information (flexible ducts, fire dampers, duct penetrations)
- Principal electrical supply, control and monitoring
- Emergency stops of fans

C. Definitions

For the purposes of these regulations the following definitions shall apply:

1. Accommodation Spaces

Spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, games and hobbies rooms, barber shops, pantries containing no cooking appliances and similar spaces.

2. Air Ducts

Thin-walled piping or ducting (circular or rectangular) used exclusively to conduct air.

3. Air Pipes

Parts of tank pressure-equalizing systems not dealt with in these regulations, see BCS Hull Rules, Section 21, E

4. Air Trunks

Parts of the hull which may either themselves be used to conduct air or which contain air ducts as well as other lines (pipes, cables).

5. Approved Type

The term "Approved " relates to a material or construction, for which **BCS** has issued an Approval Certificate. A type approval can be issued on the basis of a successful standard fire test, which has been carried out by a neutral and recognized fire testing institute.

6. Cargo Spaces

All spaces used for cargo, cargo oil tanks, tanks for other liquid cargo and trunks to such spaces.

7. Closed Ro-Ro cargo Spaces

All Ro-Ro cargo spaces which are neither open Ro-Ro cargo spaces nor weather decks.

8. Control Stations

Those spaces in which the ship's radio or main navigating equipment or the emergency source of power is located or where the fire recording or fire control equipment is centralized.

9. Fire Closures

Closing appliances of ventilation inlets and outlets as required by SOLAS II-2/5.2.1.1 for fire protection purposes.

10. Free Cross-sectional Area

Means, even in the case of a pre-insulated duct, the area calculated on the basis of the inner diameter of the duct.

11. LLC 1966

International Load Line Convention 1966, as amended.

12. Machinery Spaces

All machinery spaces of category A and all other spaces containing propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, and similar spaces, and trunks to such spaces.

13. Machinery Spaces of Category A

Those spaces and trunks to such spaces which contain:

- Internal combustion machinery used for main propulsion
- Internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW
- Any oil-fired boiler or oil fuel unit, or any oil-fired equipment other than boilers, such as inert gas generators, incinerators, etc.

14. Mechanical Ventilation Systems

Systems through which air is passed by ventilators driven hydraulically, pneumatically or by electric motors.

Mechanical ventilation may also be called power ventilation or forced ventilation.

15. Natural Ventilation Systems

Systems in which the air movement is caused solely by temperature differences, natural wind or head wind.

16. Non-combustible Material

Is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750 °C, this being determined in accordance with Fire Test Procedure Code.

17. Non-sparking Fans

A fan is considered as non-sparking if in either normal or abnormal conditions it is unlikely to produce sparks.

18. Open Ro-Ro spaces

Those Ro-Ro spaces which are either open at both ends or have an opening at one end, and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10 % of the total area of the space side.

19. Public Spaces

Those portions of the accommodation which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

20. Ro-Ro Cargo Spaces

Spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

21. Service Spaces

Those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, store-rooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

22. Special Category Spaces

Enclosed spaces above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access.

23. Vehicle Spaces

Cargo spaces intended for carriage of motor vehicles with fuel in their tanks for their own propulsion.

24. Ventilator Coamings

Those thick-walled portions of air ducts which extend above a weather deck and are welded to it (cf. Regulation 19, LLC 1966).

25. Weather Deck

Is a deck which is completely exposed to the weather from above and from at least two sides.

D. General Requirements

1. General Arrangements

1.1 The ventilation systems for machinery spaces of category A, vehicle spaces, Ro-Ro spaces, galleys, special category spaces and cargo spaces shall, in general, be separated from each other and from the ventilation systems serving other spaces.

Exceptions are the galley ventilation systems on cargo ships of less than 4000 gross tonnage and in passenger ships carrying not more than 36 passengers, which need not be completely separated, but may be served by separate ducts from a ventilation unit serving other spaces. In this case, an automatic fire damper shall be fitted in the galley ventilation ducts near the ventilation unit.

1.2 Balance openings or ducts between two enclosed spaces are prohibited except for openings in or under "B" class doors. Such openings shall be provided only in the lower half of the door. Where such an opening is in or under a door, the total net area of any such opening or openings shall not exceed 0.05 m^2. Alternatively, a non-combustible air balance duct routed between the cabin and the corridor, and located below the sanitary unit, is permitted where the cross-sectional area of the duct does not exceed 0.05 m^2. Ventilation openings, except those under the door, shall be fitted with a grill made of noncombustible material.

1.3 Where necessary, main intakes and outlets are to be fitted with gratings to prevent fouling and the entry of rats and other large vermin.

1.4 Where a fixed gas fire-extinguishing system is fitted, ventilation openings of these spaces shall be capable of being closed from outside the protected space. If the closures are not fitted directly at the external bulkhead of the protected space the duct between bulkhead, and closing device shall be constructed of steel having a thickness of at least 3 mm and flange joints are to be sealed by non-combustible material.

1.5 Where individual rooms have separate arrangements for flooding with CO_2, the ventilating system must also be separate. Provision is to be made to remove CO_2, after flooding of these spaces.

1.6 Electrical machinery and installations (switch cabinets, etc.) are to be protected such that water particles penetrating into the air ducts will not cause disturbances. Risks of this kind are to be minimized by appropriate arrangement (water traps) of ducts and air in/outlets.

1.7 The number of ventilation openings in watertight subdivisions shall be reduced to the minimum compatible with the design and proper working of the ship. Where ventilation ducts are routed through watertight decks and bulkheads, arrangements shall be made to ensure the watertight integrity. If valves are provided at watertight boundaries to maintain watertight integrity, than the valves are to be capable of being operated from a control panel located in the navigation bridge, where the position of the shut-off valves is to be indicated.

2. Ventilator Coamings

2.1 General requirements

2.1.1 The height of the ventilator coamings on the exposed freeboard deck, quarter deck and on exposed superstructure decks in the range 0.25 L from F.P. is to be at least 900 mm, see Fig. 1.1.

2.1.2 On exposed superstructure decks abaft 0.25 L from F.P. the coaming height is not to be less than 760 mm.

2.1.3 Ventilators of cargo holds are not to have any connection with other spaces.

2.1.4 The thickness of the coaming plates is to be according to Chapter 1, Hull Rules, Section 16, E.3.

2.1.5 Generally, the coamings and posts shall pass through the deck and shall be welded to the deck plating from above and below. Where coamings or posts are welded onto the deck plating, filet welds subject of Hull Rules, Section 19, B.3.3 shall be adopted for welding inside and outside.

2.1.6 Coamings and posts particularly exposed to wash of sea are to be efficiently connected with the ship's structure.

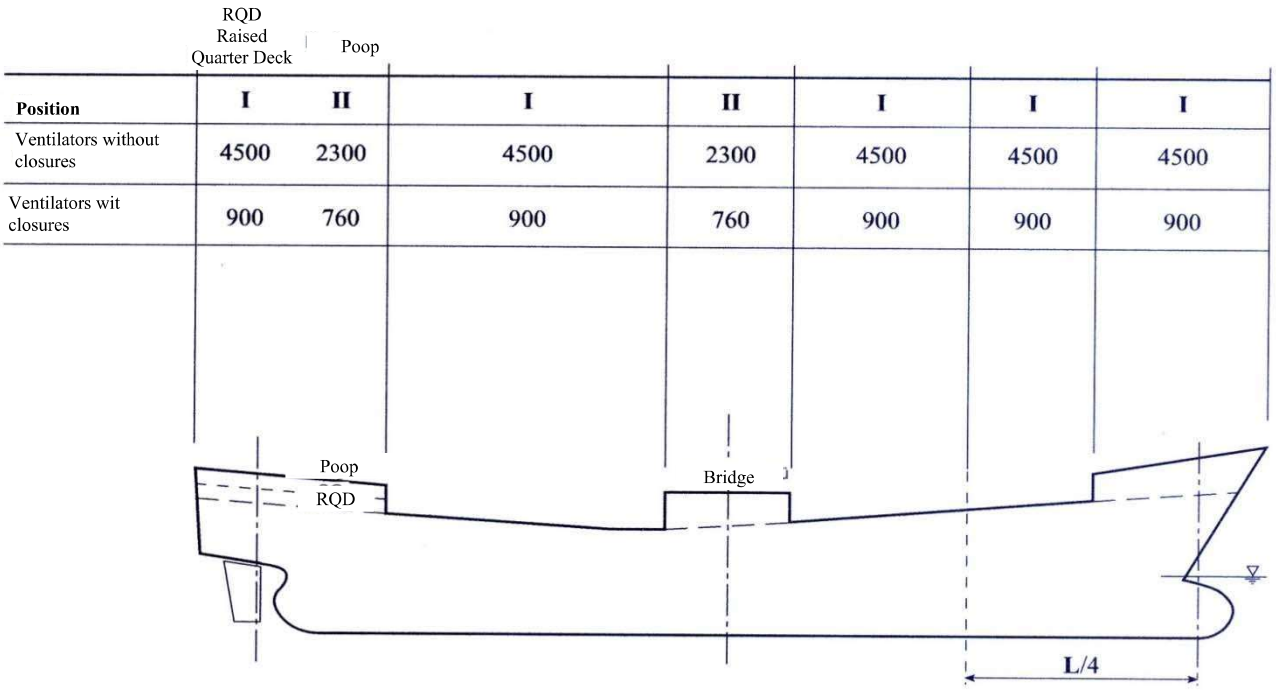

Figure 1.1 Minimum coaming height [mm] for ventilators according to LLC 66 as amended

2.1.7 Coamings of a height exceeding 900 mm are to be specially strengthened.

2.1.8 Where the thickness of the deck plating is less than 10 mm, an insert plate of 10 mm thickness is to be fitted. Their side lengths are to be equal to twice the length or breadth of the coaming.

2.1.9 Where beams are pierced by ventilator coamings, carlings of adequate scantlings are to be fitted between the beams in order to maintain the strength of the deck.

2.2 Special strength requirements for fore deck fittings

2.2.1 General

The following strength requirements are to be observed to resist green sea forces acting on ventilator pipes and their closing devices located within the forward quarter length.

2.2.3 Applied loading for ventilator pipes and their closing devices

2.2.3.1 The pressures p [kN/m^2] acting on ventilator pipes and their closing devices may be calculated from:

$$P = 0{,}5 \cdot \rho \cdot V^2 \cdot C_d \cdot C_s \cdot C_p$$

P = Density of sea water (1,025 t/m^3)

V = Velocity of water over the fore deck (13,5 m/sn)

C_d = Shape coefficient (0,5 for pipes and 1,3 for air pipe or ventilator head)

C_s = Slamming coefficient (3,2)

C_p = Protection coefficient

= 0.7 for pipes and ventilator heads located immediately behind a breakwater or forecastle

= 1.0 elsewhere and immediately behind a bulwark

2.2.3.2 Forces acting in the horizontal direction on the pipe and its closing device may be calculated from 2.2.3.1 using the largest projected area of each component.

2.2.4 Strength requirements for ventilator pipes and their closing devices

2.2.4.1 Bending moments and stresses in ventilator pipes are to be calculated at critical positions: at penetration pieces, at weld or flange connections, at toes of supporting brackets.

Bending stresses in the net section are not to exceed 0.8 σ_y, where σ_y, is the specified minimum yield stress or 0.2 % proof stres of the steel at room temperature. Irrespective of corrosion protection, a corrosion addition to the net section of 2.0 mm is then to be applied.

2.2.4.2 For standard ventilators of 900 mm height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 1.1. Where brackets are required, three or more radial brackets are to be fitted.

Brackets are to be of gross thickness 8 mm or more, of minimum length 100 mm, and height according to Table 1.1 but need not extend over the joint flange for the head. Bracket toes at the deck are to be suitably supported.

2.2.4.3 For ventilators of height greater than 900 mm, brackets or alternative means of support are to be specially considered.

2.2.4.4 All component parts and connections of the air pipe or ventilator are to be capable of withstanding the loads defined in 2.2.3.

3. Weathertight Closing Appliances

3.1 Inlet and exhaust openings of ventilation systems are to be provided with easily accessible closing appliances, which can be closed weathertight against wash of the sea. In ships of less than 100 m in length, the closing appliances are to be permanently attached. In ships exceeding 100 m in length, they may be conveniently stowed near the openings to which they belong.

3.2 For ventilator posts which exceed 4.5 m in height above the freeboard deck or raised quarterdeck and above exposed superstructure decks forward of 0.25 L from F.P. and for ventilator posts exceeding 2.3 m in height above exposed superstructure decks abaft 0.25 L from F.P. closing appliances are required in special cases only.

3.3 For the case of fire draught-tight fire dampers are to be fitted.

3.4 Weathertight closing appliances for all ventilators are to be of steel or other equivalent materials. Wood plugs and canvas covers are not acceptable in these positions.

3.5 Closing appliances are to be examined and tested for weathertightness by water jet (from a 12.5 mm dia. nozzle and a minimum hydrostatic pressure of 2.0 bar from a distance of 1.5 m).

3.6 For special strength requirements for fore deck fittings, see 2.2.

3.7 Rotating type mushroom ventilator heads are unsuitable for application in the areas defined in 2.2.2.

4. Fire closures / Dampers

4.1 Fire closures at main inlets and outlets

4.1.1 The main inlets and outlets of all ventilation systems shall be capable of being closed from outside the spaces being ventilated. The means of closing shall be easily accessible as well as prominently and permanently marked and shall indicate whether the shut-off is open or closed.

4.1.2 Fire closures at ventilation inlets and outlets located at outside boundaries need not be of approved type.

4.1.3 Fire closures, which are not of approved type, are to comply with the following requirements:

- The thickness of steel fire closures is shown in the following Table 1.2.
- If measures to increase the strength are taken, the thickness may be reduced with agreement of **BCS.** The construction of approved closures shall comply with the tested ones.
- The means of control is to be capable of being locked in open and closed position.
- When shut, the fire closures shall have close contact with a steel strip throughout their circumference. All closures shall be easily accessible and capable of being operated easily and safely.
- Hinges and bearings of the fire closures are to be largely maintenance-free and easily accessible for inspections and repairs.
- The controls and the "open" and "closed" position of the fire closures are to be clearly and permanently marked.
- Power-driven controls and remote operated controls for fire closures must be provided with a second, independent power-operating system or manual control operable from a safe position outside the space to be protected or the closures are to be of fail safe type.

Table 1.1 900 mm ventilator pipe thickness and bracket standards

Nominal pipe diameter [mm]	Minimum fitted gross thickness [mm]	Maksimum projected area of head [cm^2]	Height of brackets [mm]
80 A	6,3	-	460
100 A	7,0	-	380
150 A	8,5	-	300
200 A	8,5	550	-
250 A	8,5	880	-
300 A	8,5	1200	-
350 A	8,5	2000	-
400 A	8,5	2700	-
450 A	8,5	3300	-
500 A	8,5	4000	-

Note:
For other ventilator heights, the relevant requirements of 2.2.4 are to be applied.

4.1.4 Fire closures of multi-blade design may be accepted provided they meet at least the following design criteria:

- The fire closure shall consist of not more than 5 single plates, whereas the clear height of each plate should be at least 20 % of the total clear height of the damper but not less than 200 mm.
- Each damper plate should have an overlap of at least 5 % of its height.
- A circumferential resting bar should be provided.
- Each damper plate should have a thickness depending on its cross section as specified in Table 1.2.
- The construction should be of robust design to avoid vibrations.

Prior to installation , drawings showing construction details of the multi blade fire closure have to be submitted for approval. The construction is to be tested to the satisfaction of a **BCS** Surveyor.

Special attention shall be paid to a regular service of the multi-blade fire closures.

4.1.5 The arrangement of two fire closures of multi blade design according to 4.1.4 in a common frame is acceptable, if the following requirements are fulfilled:

- The total free cross sectional area of the entire ventilation opening is at least 3 m2
- The cross sectional area of each single blade is at least 0.5 m^2
- The two fire closures are to be separated from each other. For this purpose an intermediate frame is to be provided
- The closing mechanism of the two fire closures shall be independent from each other

4.1.6 Weather tight closures of a recognized standard are accepted as fire closures. In that case weathertight closures are to be permanently attached irrespective of the length of the ship.

4.1.7 **BCS** approved weather tight closures of multi-blade design, which are use rubber as sealing material, may be accepted as fire closures if the following requirements are fulfilled:

- The closure is located in a position, where in accordance with Load Line Convention weather tightness is required
- The closure consist of not more than 5 single blades
- The total clear height of each blade shall be at least 200 mm
- Each blade shall have a thickness depending on its cross section as specified in Table 1.2

Weather tight closures of multi-blade design, which use rubber as sealing material, shall not be fitted as fire closures for engine rooms and for positions where weather tightness is not required.

4.2 Fire dampers within the duct system

4.2.1 Approval

Fire dampers, including relevant means of operation, are to be of approved type **(1).**

4.2.2 Accessibility and indication

Fire dampers shall be easily accessible. Each damper shall be clearly marked by an identification number or letters. Where they are placed behind ceilings or linings, inspection doors shall be provided. These inspection doors shall be clearly marked with the relevant identification marks. The identification mark shall be placed also on any remote control. The status (open/ closed) of each fire damper shall be clearly indicated at the damper and each remote control.

4.2.3 Type of means of manual closing of fire dampers

Manual closing may be achieved by mechanical means of release or by remote operation of the fire damper by means of a fail-safe electrical switch or pneumatic release (spring-loaded, etc.) on both sides of the division.

5. Ventilation Ducts

5.1 Ventilation ducts shall be of steels or equivalent material. Short flexible ducts, however, not generally exceeding 2 m in length and with a free cross-sectional area not exceeding 0.02 m^2 need not be steels or equivalent, subject to the following conditions:

5.1.1 These ducts shall be of any material having low flame spread characteristics which is type approved **(2).**

5.1.2 On ships constructed on or after 1 July 2010, the ducts shall be made of heat resisting noncombustible material, which may be faced internally and externally with membranes having low flamespread characteristics and, in each case, a calorific value **(3)** not exceeding 45 MJ / m^2 of their surface area for the thickness used.

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(1) *Reference is made to the Fire Test Procedure Code, Annex 1, Part 3, adopted by IMO by Resolution MSC. 307 (88).*

(2) *Reference is made to the Fire Test Procedure Code, Annex 1, Part 5, adopted by IMO by Resolution MSC. 307 (88).*

(3) *Refer to the recommendations published by the ISO, in particular publication ISO1716 Determination of calorific potential*

Table 1.2 Thickness of fre closures

Diameter of ducti [mm]	Cross-section of duct [m^2]	Minimum thickness of fire closures [mm]
Up to 200	Up to 0,03	4
over 200 up to 400	over 0,03 up to 0,13	5
over 400 up to 600	over 0,13 up to 0,28	6
over 600 up to 800	over 0,28 up to 0,50	7
over 800	over 0,50	8

5.1.4 They shall not be situated less than 600 mm, measured along the duct, from an opening in an "A" or "B" class division including continuous "B" class ceilings.

5.2 Flexible bellows of combustible material may be used for connecting fans to the ducting in air conditioning or fan rooms.

5.3 Ducts provided for the ventilation of machinery spaces of category A, galleys, vehicle spaces, ro-ro cargo spaces or special category spaces shall not pass through accommodation spaces, service spaces or control stations unless the ducts are either:

5.3.1 constructed of steel having a thickness of at least 3 mm and 5 mm for ducts the widths or diameters of which are up to and including 300 mm and 760 mm and over respectively and, in the case of such ducts, the widths or diameters of which are between 300 mm and 760 mm having a thickness to be obtained by interpolation,

5.3.2 suitably supported and stiffened,

5.3.3 fitted with automatic fire dampers close to the boundaries penetrated and

5.3.4 insulated to "A-60" standard from the machinery spaces, galleys, vehicle spaces, ro-ro cargo spaces or special category spaces to a point at least 5 m beyond each fire damper; or

5.3.5 constructed of steel suitable supported and stiffened (see 5.3.1) and insulated to "A-60" standard throughout the accommodation spaces, service spaces or control stations.

5.4 Ducts provided for the ventilation to accommodation spaces, service spaces or control stations shall not pass through machinery spaces of category A, galleys, vehicle spaces, ro-ro cargo spaces or special category spaces unless either:

5.4.1 the ducts where they pass through a machinery space of category A, galley, vehicle space, ro-ro cargo space or special category space are constructed of steel, suitable supported and stiffened (see 5.3.1),

5.4.2 automatic fire dampers are fitted close to the boundaries penetrated and

5.4.3 the integrity of the machinery space, galley, vehicle space, ro-ro cargo space or special category space boundaries is maintained at the penetrations or

5.4.4 the ducts where they pass through a machinery space of category A, galley, vehicle space, ro-ro cargo space or special category space are constructed of steel, suitable supported and stiffened (see 5.3.1) and

5.4.5 Such ducts are insulated to "A-60" standard within the machinery spaces of category A, galleys, vehicle spaces, ro-ro cargo spaces or special category spaces.

5.5 Ducts are to be routed in such a way that neither machinery nor switchgear can be endangered by condensation or spray water. Where necessary, water traps, baffles and similar devices are to be fitted. Effective water traps are to be provided with appositely directed baffle plates. The lowermost baffle of the water trap is to be provided with a drainage pipe.

5.6 Natural ventilating systems shall not employ a branched ducting system.

5.7 Duct penetrations

5.7.1 Duct penetrations through "A" class divisions shall be of an approved type **(4).** Where steel sleeves are directly joined to ventilation ducts by means of riveted or screwed flanges or by welding, the approval is not required.

5.7.2 Where a thin plated duct with a free cross-sectional area equal to, or less than, 0.02 m^2 passes through "A" class bulkheads or decks, the opening shall be lined with a steel sheet sleeve having a thickness of at least 3 mm and a length of at least 200 mm, divided preferably into 100 mm on each side of the bulkhead or, in the case of the deck, wholly laid on the lower side of the decks pierced.

5.7.3 Where ventilation ducts with a free cross-sectional area exceeding 0.02 m^2 pass through "A" class bulkheads or decks, the opening shall be lined with a steel sheet sleeve. However, where such ducts are of steel construction and pass through a deck or bulkhead, the ducts and sleeves shall comply with the following:

5.7.4 The sleeves shall have a thickness of at least 3 mm and a length of at least 900 mm. When passing through bulkheads, this length shall be divided preferably into 450 mm on each side of the bulkhead.

These ducts, or sleeves lining such ducts, shall be provided with fire insulation. The insulation shall have at least the same fire integrity as the bulkhead or deck through which the duct passes.

5.7.5 Ducts with a free cross-sectional area exceeding 0.075 m^2 shall be fitted with fire dampers in addition to the requirements of 5.7.4. The fire damper shall operate automatically, but shall also be capable of being closed manually from both sides of the bulkhead or deck. The damper shall be provided with an indicator which shows whether the damper is open or closed.

5.7.6 Ventilation ducts with a free cross-sectional area exceeding 0.02 m^2 passing through "B" class bulkheads shall be lined with steel sheet sleeves of 900 mm in length divided preferably into 450 mm on each side of the bulkheads unless the duct is of steel for this length.

5.8 Insulation of duct penetrations

The fire protection insulation of air ducts and sleeves is to be in accordance with the space group pairings indicated in tables, see Hull Rules, Section 22, Table 22.1 to 22.8.

The tables relating to the bulkhead are likewise applicable to ducts routed through decks.

A space pairing refers to the spaces separated by a bulkhead or deck, irrespective of any other spaces served by the duct in question.

6. Non-sparking Fans

6.1 Protection screens of not more than 13 mm square mesh are to be fitted in the inlet and outlet ventilation openings on the open deck.

6.2 Overheating of the mechanical components of fans and the creation of sparks is to be avoided by appropriate design and by the choice of suitable materials. The safety clearance between the fan housing and the impeller shall not be less than 1/10 of the inner impeller bearing diameter, limited to a minimum of 2 mm and is to be such as to preclude any contact between the housing and the rotor. The maximum clearance need not be more than 13 mm. The above requirement also applies to portable fans.

6.3 Following materials or combinations of materials for impeller/housing may be used:

- non-ferrous materials having good heat conductivity (bronze, brass, copper, not aluminium) with each other or with steel (incl. galvanized, stainless)

- steel (incl. galvanized, stainless) with each other if a ring of adequate size made of above nonmetallic/non-ferrous material is fitted in way of the impeller, or if a safety clearance of 13 mm is provided

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(4) See *Fire Test Procedure Code, Annex 1, Part 3 accepted with IMO Resolution MSC. 307 (88)*

- aluminium or magnesium alloys with each other or with steel (incl. galvanized, stainless) only, if a non-ferrous ring having a good heat conductivity, i.e. copper, brass, of adequate size is fitted in way of the impeller.

7. Additional Fire Safety Arrangements

7.1 Stopping devices of ventilation

Forced ventilation of accommodation spaces, service spaces, cargo spaces, control stations and machinery spaces shall be capable of being stopped from an easily accessible position outside the spaces being served. This position shall not be readily cut off in the event of a fire in the spaces served.

7.2 Means of control for machinery space ventilation arrangements

7.2.1 Means of control shall be provided for opening and closure of skylights, closure of openings in funnels which normally allow for exhaust air ventilation and closure of ventilator dampers.

7.2.2 Means of control shall be provided for stopping fans. Controls provided for the power ventilation serving machinery spaces shall be grouped so as to be operable from two positions, one of which shall be outside such spaces. The means provided for stopping the power ventilation of the machinery spaces shall be entirely separate from the means provided for stopping ventilation of other spaces.

7.2.3 Means of control shall be provided for stopping forced and induced draught boiler fans.

7.2.4 The controls required in 7.2.1 to 7.2.3 shall be located outside the space concerned so they will not be cut off in the event of fire in the space they serve.

7.2.5 Concerning control of smoke spread for machinery spaces, see 7.3.3.

7.2.6 Automatic stopping of ventilation fans when releasing the CO_2-System is not permitted. Separate manual stopping of ventilation fans is to be carried out before releasing the CO_2- System.

7.3 Control of smoke spread

7.3.1 Purpose

The purpose of this requirement is to control the spread of smoke in order to minimize the hazards from smoke. For this purpose, means for controlling smoke in atriums, control stations, machinery spaces and concealed spaces shall be provided.

7.3.2 Prevention of spread of smoke over several decks

Ventilation ducts serving more than one deck level shall be provided with readily accessible means of closure at each deck level.

7.3.3 Release of smoke from machinery spaces

7.3.3.1 The provisions of 7.3.3.2 to 7.3.3.4 shall apply to machinery spaces of category A, and where considered desirable to other machinery spaces.

7.3.3.2 Suitable arrangements shall be made to permit the release of smoke in the event of fire, from the space to be protected. The normal ventilation systems may be acceptable for this purpose.

7.3.3.3 Means of control shall be provided for permitting the release of smoke and such controls shall be located outside the space concerned so that they will not be cut off in the event of fire in the space they serve.

7.3.3.4 The controls shall be easily accessible as well as prominently and permanently marked and shall indicate whether the shutoff is open or closed.

E. Requirements for Particular Spaces

1. Accommodation Spaces

As far as applicable, national requirements should be observed concerning primary data of air condition system and air change rates.

2. Galleys

2.1 Where they pass through accommodation spaces or spaces containing combustible materials, the exhaust ducts from galley ranges shall be constructed of insulated "A" class divisions. Each exhaust duct shall be fitted with:

- a grease trap readily removable for cleaning
- a fire damper located in the lower end of the duct and in addition, a fire damper in the upper end of the duct
- arrangements, operable from within the galley near exit, for shutting off the exhaust fan
- fixed means for extinguishing a fire within the duct are to be provided on all cargo ships and passenger vessels carrying not more than 36 passengers, where the ducts pass through accommodation spaces or spaces containing combustible materials, see Chapter 4, Machinery Rules, Section 12, M

2.2 For passenger vessels carrying more than 36 passengers see I.3.3.2.

3. Control Stations

3.1 Such measures as are practicable shall be taken in respect of control stations outside machinery spaces in order to ensure that ventilation, visibility and freedom from smoke are maintained, so that in the event of fire the machinery and equipment contained therein may be supervised and continue to function effectively.

In case a control station is served by a common ventilation system, which serves also other spaces, effective local closing arrangements shall be provided.

Effective local closing arrangements mean that the provided ventilation systems shall be fitted with fire dampers or smoke dampers which could be closed easily within the control station in order to maintain the absence of smoke in the event of fire.

3.2 Alternative and separate means of air supply shall be provided; air inlets of the two sources of supply shall be so disposed that the risk of both inlets drawing in smoke simultaneously is minimized.

Such requirements need not be applied to control stations situated on, and opening on to, an open deck and where local closing arrangements would be equally effective.

Alternative and separate means of air supply may be provided also by combination of a mechanical supply duct and a natural exhaust duct or vice versa provided that the fan is reversible.

4. Paint Stores and Flammable Liquid Lockers

4.1 Paint stores and flammable liquid lockers are to be provided with ventilation arrangements which are separate from other ventilation systems.

4.2 The ventilation system shall be capable of effecting at least 10 changes of air per hour. The ducts are to be arranged such that both vapours lighter than air and vapours heavier than air can be removed.

4.3 Ventilation outlets or their duct openings shall lead to the open deck area.

4.4 The drives of mechanical ventilators shall be installed outside the rooms and air flow. Otherwise certified safe type drive motors with an explosion protection of at least IIB T3 are to be used.

4.5 The ventilator design shall comply with item D.6.

4.6 Concerning paint stores and flammable liquid lockers see Electric Rules, Section 1, K.3.5.

5. Machinery Space Ventilation

5.1 The ventilation systems for machinery spaces of category A shall be separated from the ventilation systems serving other spaces and shall be in general of the supply type. Other modes of operation may be applied upon special approval.

5.2 Machinery spaces of category A shall be adequately ventilated so as to ensure that when machinery or boilers therein are operating at full power

in all weather conditions including heavy weather, an adequate supply of air is maintained to the spaces for the safety and comfort of personnel and the operation of the machinery. Any other machinery space shall be adequately ventilated appropriate for the purpose of that machinery space.

5.3 In general, ventilators necessary to continuously supply the machinery space shall have coamings of sufficient height to comply with LLC 1966 as amended 1988, Regulation 19(3), without having to fit weathertight closing appliances (see also D.3.2). However, where due to ship size and arrangement this is not practicable, lesser heights for machinery space coamings, fitted with weathertight closing appliances in accordance with LLC 1966 as amended 1988, Regulation 19(4), may be permitted by the Administration in combination with other suitable arrangements to ensure an uninterrupted, adequate supply of ventilation to these spaces (see, Part A, Chapter 1, Section 16, E.2.4). The machinery spaces are those defined in SOLAS Regulation II- 1/Reg. 3.16

5.4 The positions of air inlets and air outlets are to be such as to prevent short-circuiting of air.

5.5 In general the shipboard machinery, equipment and appliances in machinery spaces are to be designed for continuous operation at maximum engine room air temperature as required in the Chapter 4 - Machinery Rules, Section 1, C

5.6 For the determination of the ventilation capacity the heat radiation of the equipment in the space and the required combustion air are to be considered.

5.7 The capacity and arrangement of ventilation systems/ ducts is to ensure that accumulation of oil vapour is avoided under normal conditions.

Note

The capacity requirements mentioned in 5.5, 5.6 and 5.7 are in general deemed to be met by using the calculations as per ISO Standard 8861 in the latest version.

5.8 The number of ventilation inlets, ventilators and exhaust openings in funnels shall be kept to a minimum, consistent with the needs of ventilation and the proper and safe working of the ship.

5.9 Suitable arrangements shall be made to permit the release of smoke in the event of fire (see D.7.3.3).

5.10 Further requirements for control of fans and fire closures are stipulated in D.7.2 and D.7.3.3.
For application and design of fire closures see D.4.1.

5.11 Air ducts close to electrical switchboards must be so installed and fitted with drains, where necessary, that condensed water cannot enter the electrical installation.

5.12 In case that a gas fire-extinguishing system is provided for the machinery space it is recommended, that one of the engine room supply fans should be of reversible type and supplied from the emergency source of power supply to enable extraction of fire extinguishing gases, should the need arise.

5.13 Power driven fire closures for engine rooms containing combustion engines shall not close automatically in case of loss of energy (fail safe type) unless an uninterrupted, adequate air supply to the engine room can be maintained. This requirement is deemed to be met if e.g. a sufficient number of fire closures at air inlets and/or air outlets are of manual operated type. For a pneumatically operated system for fail safe type fire closures, the air supply may be from one air receiver located outside the machinery space with separated piping from air receiver to the fire closures. For arrangement of air receiver the Chapter 4 - Machinery Rules, Section 16, D.6.5 are to be used analogously.

6. Electrical Machines

6.1 If external forced ventilation for electrical machines is fitted with air ducts leading to the upper deck, the motors driving these ventilators shall be provided with an emergency disconnecting switch outside the engine room.

6.2 A failure of external forced ventilation shall cause an alarm.

6.3 Ventilation ducts shall comply with regulation D.5.7.

7. CO_2 Rooms

7.1 Cylinder rooms are to be provided with adequate ventilation.

7.2 Spaces where access from the open deck is not provided or which are located below the open deck are to be fitted with mechanical exhaust ventilation of not less than 6 air changes per hour.

7.3 The exhaust duct is to be led to the bottom of the space.

7.4 Other spaces are not to be connected to this ventilation system.

8. Refrigerating Machinery Rooms

8.1 Refrigerating machinery spaces shall be provided with a suitably arranged forced ventilation system. In case of group 1 refrigerants, at least the exhaust air is to be conveyed into the open air independently of other space ventilation ducting. The inlet ducting shall not be connected to the ventilation system serving the accommodation spaces.

8.2 In case of group 2 refrigerants, e.g. ammonia, the ventilation of refrigerating machinery spaces shall be independent from ventilation systems of other ship spaces. The ventilation system is to be of exhaust type.

8.3 Within the ship, the exhaust air ducts of fans serving refrigerating machinery spaces are to be gastight. The exhaust air shall be conveyed in such a way as to prevent gas ingress into other ship spaces.

8.4 Provision shall be made for starting and stopping the fans of refrigerating machinery spaces from outside the spaces in question. The switches are to be clearly marked.

8.5 The rating of forced ventilation systems is subjected the following rules:

- For refrigerating machinery spaces with group 1 refrigerants, forced ventilation shall ensure at least 30 air changes per hour.

- For refrigerating machinery spaces in with group 2 refrigerants, e.g. ammonia, the minimum capacity of the fan shall be determined by the formula:

$$\dot{V} = 60 \cdot \sqrt[3]{m^2}$$

In the above formula:

V = Capacity of fan [m^3/h]

m = Charge of refrigerant in system [kg]

However, the number of air changes per hour shall not be less than 40.

Where refrigeration systems using ammonia are installed in rooms equipped with an effective sprinkler system, the minimum required capacity of the fans indicated above may be reduced by 20 %.

9. Spaces Containing Batteries

9.1 General requirements

All battery-installations, except for gastight batteries, in rooms, cabinets and containers shall be constructed and ventilated in such a way as to prevent the accumulation of ignitable gas mixtures. Gastight NiCd-, NiMH- or Li- batteries need not be ventilated.

9.2 Batteries installed in switchboards with charging power up to 0.2 kW

Lead batteries with a charging power up to 0.2 kW may be installed in switchboards without separation to switchgear and without any additional ventilation, if:

- the batteries are valve regulated (VRLA), provided with solid electrolyte

- the battery cases are not closed completely (IP 2X is suitable)

- the charger is regulated automatically by an IU-controller with a maximum continuous

- Charging voltage of 2.3 V/cell and rated power of the charger is limited to 0.2 kW

9.3 Ventilated spaces with battery charging power up to 2 kW

Batteries may be installed in ventilated cabinets and containers arranged in ventilated spaces (excepted rooms mentioned in the Chapter 5 – Electric Rules, Section 2, C.1.1)

The unenclosed installation (IP 12) in well ventilated positions in machinery spaces is permitted.

Otherwise batteries shall be installed in ventilated battery cabinets or containers.

The charging power P [W] for automatic IU-charging shall be calculated as follows:

$$P = U \cdot I$$

U = Rated battery voltage [V]

I = Charging current [A]

$= \frac{8 \cdot k}{100}$ For Pb-batteries

$= \frac{16 \cdot k}{100}$ For Ni-Cd batteries

k = Battery capacity [Ah]

The gassing voltage shall not be exceeded. If several battery sets would be used, the sum of charging power has to be calculated.

The room free air volume V [m^3] and the air quantity Q [m^3/h] shall be calculated depending on battery size as follows:

$$V = 2{,}5 \cdot Q$$

$$Q = f \cdot \frac{I}{4} \cdot n$$

n = Number of battery-cells in series connection

f = 0,03 for lead batteries with solid electrolyte

= 0,11 for batteries with fluid electrolyte

If several battery sets would be installed in one room, the sum of air quantity shall be calculated.

Where the room volume or the ventilation is not sufficient, enclosed battery cabinets or containers with natural ventilation into suitable rooms or areas shall be used.

The air ducts for natural ventilation shall have a cross-section A [cm^2] as follows, assuming an air speed of 0.5 m/s:

$$A = 5{,}6 \cdot Q$$

The required minimum cross-sections of ventilation ducts are shown in Table 1.3.

Small air ducts and dimensions of air inlet and outlet openings shall be calculated based on an air speed lower than 0.5 m/s.

9.4 Ventilated rooms with battery charging power more than 2 kW

Batteries exceeding charging power of 2 kW shall be installed in closed cabinets, containers or battery rooms forced ventilated to open deck area. Lead batteries up to 3 kW may be ventilated by natural means.

Battery Rooms shall be arranged according to Chapter 5 – Electric Rules, Section 2, C.3.

9.5 Ventilation requirements

Ventilation inlet and outlet openings shall be so arranged to ensure that fresh air flows over the surface of the storage battery.

The air inlet openings shall be arranged below and air outlet openings shall be arranged above.

If batteries are installed in several floors, the free distance between them shall be at least 50 mm.

Devices which obstruct the free passage of air, e.g. fire dampers and safety screens, shall not be mounted in the ventilation inlet and outlet ducts of battery-rooms. If necessary, weathertight closures are to be fitted.

Air ducts for natural ventilation shall lead to the open deck directly. Openings shall be at least 0.9 m above the cupboard/ boxes. The inclination of air ducts shall not exceed 45° from vertical.

Battery room ventilators are to be fitted with a means of closing whenever:

- The battery room does not open directly onto an exposed deck, or
- The ventilation opening for the battery room is required to be fitted with a closing device according to the Load Line Convention (i.e. the height of the open ing does not extend to more than 4.5 m (14.8 feet) above the deck for position 1 or to more than 2.3 m (7.5 feet) above the deck in position 2), or
- The battery room is fitted with a fixed gas fire extinguishing system.

Where a battery room ventilator is fitted with a closing device, then a warning notice stating, for example “This closing device is to be kept open and only closed in the event of fire or other emergency – EXPLOSIVE GAS”, is to be provided at the closing device to mitigate the possibility of inadvertent closing.

9.6 Forced ventilation

If natural ventilation is not sufficient or required cross-sections of ducts according to Table 1.3 are to big, forced ventilation shall be provided.

The air quantity Q shall be calculated according to 9.3.

The air speed shall not exceed 4 m/s.

Where storage batteries are charged automatically, with automatic start of the fan at the beginning of the charging, arrangements must be made for the ventilation to continue for at least 1 h after completion of charging.

Wherever possible, forced ventilation exhaust fans shall be used. The fan motors must be either certified safe type with a degree of protection IIC T1 and resistant to electrolyte or, preferably, located outside of the endangered area.

Fans are to be of non-sparking construction according to D.6

The ventilation systems shall be independent of the ventilation systems serving other rooms.

Air ducts for forced ventilation shall be resistant to electrolyte and shall lead to the open deck.

10. Separator Spaces

10.1 Where fuel oil purifiers for heated fuel oil are installed in a separate enclosed space an independent mechanical ventilation system (supply and exhaust air) is to be provided. This ventilation system shall be so arranged that gas/air mixtures or vapours cannot enter into other parts of the engine room. A ventilation system ensuring equivalent separation from the engine room ventilation system, e.g. by means of locally controlled fire closures, may be accepted. For the height of ventilation openings E.5.3 is to be observed.

10.2 Where fuel oil purifiers for heated fuel oil are installed in a space open to the engine room a mechanical exhaust ventilation system is to be provided ensuring that gas/air mixtures or vapours cannot enter into other parts of the engine room.

10.3 For the separator spaces under 10.1 and 10.2 a specific capacity rate of 30 air changes per hour is deemed to be sufficient. Higher air rates may be required due to heat generation within the space.

11. Emergency Generator Rooms

11.1 The ventilation system serving the emergency generator room has to ensure a sufficient supply of combustion and cooling air for the equipment installed.

11.2 In general, ventilators necessary to immediately supply the emergency generator room must have coamings which comply with regulation 19(3) of LLC 1966, without weathertight closing appliances, see also D.3.2. However, where due to vessels size and arrangement this is not practicable, lesser heights for

emergency generator room ventilator coamings may be accepted. In this case weathertight closing appliances in accordance with regulation 19(4) of LLC 1966 in combination with other suitable arrangements have to be provided to ensure an uninterrupted, adequate supply of ventilation to these spaces **(5).**

Table 1.3 Cross-section of ventilation ducts

Calculation based on battery charging power (automatic IU- charging)			
Battery charging power [w]	**Cross-section [m²]**		
	Lead battery solid electrolyte VRLA	**Lead battery fluid electrolyte**	**Nickel-Cadmium Battery**
< 500	40	60	80
500 < 1000	60	80	120
1000 < 1500	80	120	180
1500 < 2000	80	160	240
2000 < 3000	80	240	Forced ventilation
> 3000	Forced ventilation		

11.3 Bulkheads between emergency generator room and open decks may have air intake openings without means of closure, unless a fixed gas fire fighting system is fitted. However, for passenger vessels carrying more than 36 passengers the ventilation openings are to be fitted with fire closures, which are to be capable of being closed from outside the emergency generator room.

11.4 If the emergency generator starts automatically it is to be ensured that the fire closures are open. In case the fire closures do not open automatically, a warning plate is to be provided stating that they are to be kept open all the time.

11.5 The following requirements apply to closable ventilation louvers and ventilator closing appliances serving emergency generator rooms, where fitted.

11.5.1 Ventilation louvers and closing appliances may either be hand-operated or power operated (hydraulic / pneumatic / electric) and are to be operable under a fire condition.

11.5.2 Hand-operated ventilation louvers and closing appliances are to be kept open during normal operation of the vessel. Corresponding instruction plates are to be provided at the location where hand-operation is provided.

11.5.3 Power-operated ventilation louvers and closing appliances shall be of a fail-to-open type. Closed power-operated ventilation louvers and closing appliances are acceptable during normal operation of the vessel. Power-operated ventilation louvers and closing appliances shall open automatically whenever the emergency generator is starting / in operation.

11.5.4 It shall be possible to close ventilation openings by a manual operation from a clearly marked safe position outside the space where the closing operation can be easily confirmed. The louver status (open / closed) shall be indicated at this position. Such closing shall not be possible from any other remote position.

12. Emergency Fire Pump Room

The ventilation system of the space in which the emergency fire pump respectively the fire pump outside engine room is installed shall be so designed that smoke cannot enter the room in the event of a fire in the engine room. Forced ventilation, if necessary for pump

(5) *Reference is made to Amendments to the Protocol of 1988 Relating to the ICCL 1966 adopted by IMO by Resolution MSC.143* (77)

operation, is to be connected to the emergency power supply. If continuously air supply is needed for operation of emergency fire pump than the height of ventilation openings has to be in accordance with E.5.3.

13. Pipe Tunnels

13.1 Pipe tunnels are to be at least naturally ventilated.

13.2 If the pipe tunnels are to be entered via doors or hatches for operating (e.g. for normal operation of valves or reading of measuring instruments) a mechanical ventilation shall be provided.

13.3 If the pipe tunnels are entered from the engine room the engine room ventilation system may be accepted as sufficient means of mechanical ventilation.

13.4 Pipe tunnels containing ducts or pipes with flanges, valves or pumps and open ends to hazardous areas requiring explosion proof equipment, belonging to the extended hazardous areas (zone 2), see F.2 These areas are considered safe if they are ventilated with at least 6 changes of air per hour. Should the ventilation fail, this shall be announced optically and audibly and the equipment not permitted for the extended hazardous area shall be switched off.

14. Thruster Rooms

Thruster rooms are to be provided with suitable ventilation so as to allow simultaneously crew attendance and thruster machinery operation at rated power for the intended period of time.

15. Oxygen-acetylene Storage Rooms

15.1 Gas cylinder storage rooms are to be fitted with ventilation systems capable of providing at least 6 air changes per hour based on the gross volume of the room. The ventilation system is to be independent of ventilation systems of other spaces. The fans are to be of certified safe type IIC T2 and of the non-sparking construction, see D.6.

15.2 It is to be observed that a room temperature of 40 °C will not be exceeded.

15.3 If gas cylinders are stored in cabinets, openings for natural ventilation are to be provided in the upper and the lower part.

16. Storage Places of Gas Bottles for Domestic Purposes

The requirements as per item 15 apply.

17. Helicopter Refuelling and Hangar Facilities

Enclosed hangar facilities or enclosed spaces containing refuelling installations shall be provided with mechanical ventilation, as required for closed ro-ro spaces of cargo ships in accordance with H.

F. Ventilation Requirements for the Carriage of Dangerous Goods

1. Zone 1 (Hazardous Area)

1.1 Areas in which a dangerous gas/air mixture, dangerous vapours or a dangerous quantity and concentration of dust are liable to occur from time to time are defined to be areas subject to explosion hazard and are defined to be Zone 1.

1.2 Zone 1-areas are:

- Closed cargo spaces intended for carriage of solid goods in bulk which may develop dangerous dust
- Closed cargo spaces and closed or open ro-ro cargo spaces, intended for carriage of explosive substances in packaged form, flammable liquids with a flash point ≤ 23 °C in packaged form, flammable gases and highly dangerous bulk cargoes which under certain conditions develop a potentially explosive gaseous atmosphere,
- Enclosed or semi-enclosed rooms with non-closable direct openings to zone 1 areas
- Ventilation ducts for zone 1-areas
- Areas on open deck or semi-enclosed spaces on open deck within 1.5 m around ventilation openings of ventilation ducts for zone 1-areas.

1.3 Requirement concerning with the protection against explosion in this zone are given in Tables 1.4 and 1.5.

1.4 Concerning further details and installation of electrical equipment and cables see Chapter 5 – Electric Rules, Section 17.

2. Zone 2 (Extended hazardous area)

2.1 Areas in which a dangerous gas/air mixture, dangerous vapours or a dangerous quantity and concentration of dust are liable to occur only rarely, and then only for a brief period, are defined to be Zone 2.

2.2 Zone 2-areas are:

- Areas which can be separated by gastight doors from zone 1-areas mentioned in F.1.2, items 1 to 4
- Enclosed spaces like bilge pump rooms or pipe tunnels containing ducts or pipes with flanges, valves or pumps and open ends to hazardous areas if they are ventilated less than 6 changes per hour
- Areas of 1.5 m surrounding zone 1-areas mentioned in F.1.2, last item.

2.3 Concerning further details and installation of electrical equipment and cables see Chapter 5 – Electrical Installation Rules, Section 17.

3. Cargo Holds

3.1 General

3.1.1 Cargo hold ventilating systems are to be separated from the ventilation systems serving other spaces.

3.1.2 If cargo holds are subdivided for reasons of stability, freeboard or fire protection (e.g. separate flooding with CO_2) this has to be taken into account for the design of the ventilation systems.

3.1.3 Air ducts and components of ventilation systems are to be so installed that they are protected from damage.

3.1.4 For the types of protection generally to be applied for ventilating systems and the associated electrical equipment, see Chapter 5 – Electrical Installation Rules, Section 1, Table 1.9.

4. Dangerous Goods in Packaged Form

4.1 The requirements on the capacity of the ventilation system, the certified safe type of electrical explosion protection, the electrical protection and mechanical design are summarised in the Machinery Rules – Chapter 4, Section 18, Table 18.10a to 18.10e and are related to the requirements indicated in SOLAS, Chapter II-2, Regulation 19.

4.2 If mechanical ventilation is required, independent exhaust ventilation is to be provided for the removal of gases and vapours from the upper and lower part of the cargo space. This requirement is considered to be met if the ducting is arranged such that approximately 1/3 of the air volume is removed from the upper part and 2/3 from the lower part. The position of air inlets and air outlets shall be such as to prevent short circuiting of the air. Interconnection of the hold atmosphere with other spaces is not permitted.

4.3 If fans of electrical explosion protection type are required, the fan openings on deck are to be fitted with fixed protective screens with mesh size not exceeding 13 mm.

4.4 The fans of electrical explosion protection type must be of non-sparking design, see D.6.2 and D.6.3.

4.5 For the area around ventilation openings requiring explosion protection, see 1. and 2.

4.6 If adjacent spaces are not separated from cargo spaces by gastight bulkheads or decks, then they should be considered as part of the enclosed cargo space and the ventilation requirements should apply to the adjacent space as for the enclosed cargo space itself.

4.7 For open top container holds the mechanical ventilation is interpreted to be required only for the lower part of the cargo hold for which purpose ducting is required.

5. Solid Dangerous Goods in Bulk and Materials Hazardous Only in Bulk

5.1 The requirements on the capacity of the ventilation system, the certified safe type of electrical explosion protection, the electrical protection and mechanical design are summarised in the Machinery Rules – Chapter 4, Section 18, Table 18.11 and are related to the requirements indicated in SOLAS, Chapter II-2, Regulation 19 and the International Maritime Solid Bulk Cargoes Code (IMSBC Code).

5.2 If mechanical or natural ventilation is required the ducting is to be arranged such that the space above the cargo can be ventilated and that exchange of air from outside to inside the entire cargo space is provided. The position of air inlets and air outlets shall be such as to prevent short circuiting of the air. Interconnection of the hold atmosphere with other spaces is not permitted.

5.3 If mechanical ventilation required portable fans may be used instead of fixed ones. If so, suitable arrangements for securing the fans safely are to be provided. Electrical connections are to be fixed and expertly laid for the duration of the installation. Details are to be submitted to BCS for approval.

5.4 If continuous ventilation is required a ventilation system which incorporates at least two powered fans with a capacity of at least three air changes per hour each based on the empty cargo hold is to be provided. The ventilation openings shall comply with the requirements of the Load Line Convention, for openings not fitted with means of closure. According to ICLL, Regulation 19(3) the openings shall be arranged at least 4.50 m above deck in position 1 and at least 2.30 m above deck in position 2.

Note:

This does not prohibit ventilators from being fitted with a means of closure as required for fire protection purposes under SOLAS, Chapter II-2, Regulation 5.2.1.1.

5.5 If fans of electrical explosion protection type are required, the fan openings on deck are to be fitted with fixed protective screens with mesh size not exceeding 13 mm.

5.6 The fans of electrical explosion protection type must be of non-sparking design, see D.6.2 and D.6.3

5.7 For the area around ventilation openings requiring explosion protection see F.1 and F.2.

5.8 For cargoes emitting toxic gases or vapours the ventilation outlets shall be arranged away from living quarters on or under deck.

5.9 If adjacent spaces are not separated from cargo spaces by gastight bulkheads or decks, then they should be considered as part of the enclosed cargo space and the ventilation requirements should apply to the adjacent space as for the enclosed cargo space itself.

G. Refrigerated Containers

1. Refer to Annex A, G.

2. Vessels for which the class notation **RCP** is applied for, the requirements of the BCS Guidelines for the Carriage of Refrigerated Containers on Board Ships are to be complied with.

H. Cargo Spaces for the Carriage of Vehicles with Fuel in their Tanks and Cargo Spaces of Ro-Ro Ships

1. Capacity of Ventilation System

1.1 The cargo spaces for the carriage of vehicles with fuel in their tanks of cargo ships and cargo spaces of ro-ro ships are to be provided with forced ventilation capable of at least 6–10 air changes per hour, depending on arrangement of electrical equipment. See Electrical Installation Rules, Section 16.

1.2 During periods of loading and unloading an increased air change rate of 20 air changes per hour is to be provided **(6).**

2. Performance and Design of Ventilation Systems

2.1 In cargo ships, ventilation fans shall normally be run continuously and give at least the number of air changes required in item 1.1 whenever vehicles are on board, except where an air quality control system in accordance with paragraph 2.4 is provided. Where this is impracticable, they are to be operated for a limited period daily as weather permits and in any case for a reasonable period prior to discharge, after which period the ro-ro or vehicle space shall be proved gas-free.

One or more portable combustible gas detecting instruments are to be carried on board for this purpose.

2.2 The system shall be entirely separate from other ventilating systems. Ventilation ducts serving ro-ro or vehicle spaces shall be capable of being effectively sealed for each cargo space. The system shall be capable of being controlled from a position outside such spaces.

2.3 The ventilation system shall be such as to prevent air stratification and the formation of air pockets.

2.4 Where an air quality control system is provided based on the guidelines **(7)**, the ventilation system may be operated at a decreased number of air changes and/or a decreased amount of ventilation. This relaxation does not apply to spaces to which at least ten air changes per hour is required by Chapter 5 Electrical Installation Section 16 B.2.1 and spaces subject to item Chapter 1 Hull Section 21 C.15.1 and Chapter 4 Machinery Section 18 B.12.

2.5 An independent power ventilation system is to be provided for the removal of gases and vapours from the upper and lower part of the cargo space. This requirement is considered to be met if the ducting is arranged such that approximately 1/3 of the air volume is removed from the upper part and 2/3 from the lower part. Supply ventilation may be natural and be introduced into the cargo spaces at the top of these spaces.

2.6 The design of mechanical exhaust ventilators has to comply with D.6

2.7 A fan failure (monitoring of motor fan switching devices is sufficient) shall be alarmed on the bridge.

2.8 Inlets for exhaust ducts are to be located within 450 mm above the vehicle deck. Outlets are to be located in a safe position, having regard to sources of ignition near the outlets.

2.9 For areas in the vicinity of air openings**,** see F.1 ad F.2.

3. Closing Appliances and Ducts

3.1 Arrangements shall be provided to permit a rapid shutdown and effective closure of the ventilation system from outside of the space in case of fire, taking into account the weather and sea conditions.

Access routes to the controls for closure of the ventilation system permit “a rapid shutdown” and “adequately take into account the weather and sea conditions” if the routes:

- Are clearly marked and at least 600 mm clear width;
- Are provided with a single handrail or wire rope lifeline not less than 10 mm in diameter, supported by stanchions not more than 10 m apart in way of any route which involves traversing a deck exposed to weather; and
- Are fitted with appropriate means of access (such as ladders or steps) to the closing devices of ventilators located in high positions (i.e. 1.8 m and above).

(6) *Alternatively the required air changes can be calculated according to Revised design guidelines and operational recommendations for ventilation systems in ro-ro cargo spaces (MSC.1/Circ.1515)*

(7) *Refer to the Revised design guidelines and operational recommendations for ventilation systems in ro-ro cargo spaces (MSC.1/Circ.1515).*

Alternatively, remote closing and position indicator arrangements from the bridge or a fire control station for those ventilator closures are acceptable.

3.2 Ventilation ducts, including dampers, shall be made of steel. Ventilation ducts shall not pass through machinery spaces of category A unless fire insulated to A-60 standard.

4. Permanent Openings

Permanent openings in the side plating, the ends or deckhead of the space shall be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

5. Electrical Equipment and Cable Installation

Concerning installation of electrical equipment and cables see Chapter 5 – Electrical Installation Rules, Section 16.

I. Additional Rules for Passenger Ship

1. General

1.1 Application

These rules are applied in addition to the rules of D ÷ E.

1.2 Means of control

All controls indicated in D.7.2 as well as means of control for permitting release of smoke from machinery spaces are to be located at one control position or grouped in as few positions as possible. Such positions are to have a safe access from the open deck.

1.3 Ventilation ducts

Where in a passenger ship it is necessary that a ventilation duct passes through a main vertical zone division, a fail-safe automatic closing fire damper shall be fitted adjacent to the division. The damper shall also be capable of being manually closed from each side of the division. The operating position shall be readily accessible and be marked in red light-reflecting colour. The duct between the division and the damper shall be of steel or other equivalent material and, if necessary, insulated to the same standard as the penetrated division. The damper shall be fitted on at least one side of the division with a visible indicator showing whether the damper is in the open position.

1.4 Smoke extraction systems in atriums of passenger ships

Public spaces within a single main vertical zone spanning three or more open decks (Atriums) and contain combustibles such as furniture and enclosed spaces such as shops, offices and restaurants shall be equipped with a smoke extraction system. The smoke extraction system shall be activated by the required smoke detection system and be capable of manual control. The fans shall be sized such that the entire volume within the space can be exhausted in 10 min or less **(8).**

2. Additional Rules for Passenger Vessels Carrying not More than 36 Passengers

2.1 Cargo spaces for the carriage of vehicles with fuel in their tanks and cargo spaces of ro-ro ships

2.1.1 Capacity of ventilation system

2.1.1.1 The closed ro-ro and vehicle spaces of passenger ships carrying not more than 36 passengers are to be provided with forced ventilation capable of at least 6 air changes per hour, if the electrical equipment is of certified safe type in the entire space, or at least 10 air changes per hour, if the electrical equipment is of certified safe type up to a height of 450 mm above the deck (see Chapter 5 – Electric Rules, Section 16).

2.1.1.2 Special category spaces are to be equipped with forced ventilation capable of effecting at least 10 air changes per hour. Special category spaces are closed vehicle decks on passenger ships to which the passengers have access.

2.1.1.3 During loading and unloading periods 20 air changes per hour is to be provided **(9).**

(8) *See MSC / Circ. 1034.*

(9) *Alternatively, the air changes can be calculated according to Revised design guidelines and operational recommendations for ventilation systems in ro-ro cargo spaces (MSC.1/Circ.1515)*

2.1.2 Performance and design of ventilation systems

2.1.2.1 In passenger ships, the power ventilation system shall be separate from other ventilation systems. The power ventilation system shall be operatedto give at least the number of air changes required in item 2.1.1.1 at all times when vehicles are in such spaces, except where an air quality control system in accordance with item 2.1.2.2 is provided. Ventilation ducts serving such cargo spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

2.1.2.2 Where an air quality control system is provided based on the guidelines **(7)**, the ventilation system may be operated at a decreased number of air changes and/or a decreased amount of ventilation. This relaxation does not apply to spaces to which at least ten air changes per hour is required by Chapter 5 Electrical Installation Section 16 B.1.1 and spaces subject to item Chapter 1 Hull Section 21 B.21.1 and Chapter 4 Machinery Section 18 B.12.

2.1.2.3 On passenger ships, a fan failure (monitoring of motor fan switching devices is sufficient) or failure related to the number of air changes specified for vehicle decks and holds shall be alarmed on the bridge.

2.1.3 Closing appliances and ducts

Ventilation ducts, including dampers shall be made of steel. In passenger ships, ventilation ducts that pass through other horizontal zones or machinery spaces shall be "A-60" class steel ducts constructed in accordance with D.5.3.

2.2 Ro-ro cargo spaces in passenger ships not intended for the carriage of vehicles with fuel in their tanks

2.2.1 For closed ro-ro cargo spaces which are not intended for the carriage of vehicles with fuel in their tanks nor are special category spaces the requirements as per H and I.2.1, with the exception of H.2.5, H.2.7 and H.5 apply.

2.2.2 For open ro-ro cargo spaces which are not intended for the carriage of vehicles with fuel in their tanks nor are special category spaces the requirements applicable to a conventional cargo space shall be observed with the exception that a sample extraction smoke detection system is not permitted.

3. Rules for Passenger Vessels Carrying more than 36 Passengers

3.1 In general, the ventilation fans shall be so disposed that the ducts reaching the various spaces remain within the main vertical zone.

3.1.1 Where ventilation systems penetrate decks, precautions shall be taken, in addition to those relating to the fire integrity of the deck, see D.5.7 to reduce the likelihood of smoke and hot gases passing from one between deck space to another through the system. In addition to insulation requirements contained in D.5 vertical ducts shall, if necessary, be insulated as required by the appropriate tables.

3.2 Means of control

3.2.1 All power ventilation, except machinery and cargo spaces ventilation and any alternative systems which may be required under D.7.3.2, shall be fitted with controls so grouped that all fans may be stopped from either of two positions which shall be situated as far apart as practicable. Controls provided for the power ventilation serving machinery spaces shall also be grouped so as to be operable from two positions, one of which shall be outside such spaces. Fans serving power ventilation systems to cargo spaces shall be capable of being stopped from a safe position outside such spaces.

3.2.2 Controls for shutting down the ventilation fans shall be centralized in a continuously manned central control station. The ventilation fans shall be capable of reactivation by the crew at this location, whereby the control panels shall be capable of indicating closed or off status of fans.

3.3 Ventilation ducts

3.3.1 Except in cargo spaces, ventilation ducts shall be constructed of the following materials:

3.3.1.1 Ducts not less than 0,075 m^2 in sectional area and all vertical ducts serving more than a single tween deck space shall be constructed of steel or other equivalent material.

3.3.1.2 Ducts less than 0,075 m^2 in sectional area other than vertical ducts referred to in 3.3.1.1 shall be constructed of steel or other equivalent material. Where such ducts penetrate "A" or "B" Class divisions due regard shall be given to ensuring the fire integrity of the division.

3.3.2 Exhaust ducts from galley ranges in which grease or fat is likely to accumulate shall meet the requirements as mentioned in D.5.3.5 and shall be fitted with:

- A grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted
- A fire damper located in the lower end of the duct which is automatically and remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct
- A fixed means for extinguishing a fire within the duct, see also Chapter 4 – Machinery Rules, Section 12
- Remote control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in 3.3.2, item 2 and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley. Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system
- Suitably located hatches for inspection and cleaning

3.3.3 Exhaust ducts from ranges for cooking equipment installed on open decks shall conform to paragraph 3.3.2, as applicable, when passing through accommodation spaces or spaces containing combustible materials.

3.3.4 Exhaust ducts from main laundries shall be fitted with:

- Filters readily removable for cleaning purposes
- A fire damper located in the lower end of the duct which is automatically and remotely operated
- Remote control arrangements for shutting off the exhaust fans and supply fans from within the space and for operating the fire damper mentioned in paragraph I.3.3.4, item 2
- Suitably located hatches for inspection and cleaning

3.3.5 Exhaust ducts shall be provided with suitably located hatches for inspection and cleaning. The hatches shall be located near the fire damper.

3.4 Stairway

Stairway enclosures shall be ventilated by an independent fan and duct system which shall not serve any other spaces in the ventilation system.

3.5 Cargo spaces for the carriage of vehicles with fuel in their tanks and cargo spaces of ro-ro ships

3.5.1 Capacity of ventilation system

3.5.1.1 The closed ro-ro, vehicle and special category spaces of passenger ships carrying more than 36 passengers are to be provided with forced ventilation capable of effecting at least 10 air changes per hour.

3.5.1.2 During loading and unloading periods an increased air change rate of 20 air changes per hour is to be provided. Alternatively, the air changes can be calculated according to MSC.1/Circ.1515 – Revised design guidelines and operational recommendations for ventilation systems in ro-ro cargo spaces.

3.5.2 Performance and design of ventilation systems

3.5.2.1 In passenger ships, the power ventilation system of the space shall be separate from other ventilation systems and shall be in operation at all times when vehicles are in such spaces. Ventilation ducts serving such cargo spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

3.5.2.2 On passenger ships, a fan failure (monitoring of motor fan switching devices is sufficient) or failure related to the number of air changes specified for vehicle decks and holds shall be alarmed on the bridge.

3.5.3 Closing appliances and ducts

Ventilation ducts, including dampers shall be made of steel. In passenger ships, ventilation ducts that pass through other horizontal zones or machinery spaces shall be "A-60" class steel ducts constructed in accordance with D.5.3.

3.6 Ro-ro cargo spaces in passenger ships not intended for the carriage of vehicles with fuel in their tanks

3.6.1 For closed ro-ro cargo spaces which are not intended for the carriage of vehicles with fuel in their tanks nor are special category spaces the requirements as per H and I.3.5, with the exception of H.2.5 and H.2.7.

3.6.2 For open ro-ro cargo spaces which are not intended for the carriage of vehicles with fuel in their tanks nor are special category spaces the requirements applicable to a conventional cargo space shall be observed with the exception that a sample extraction smoke detection system is not permitted.

J. Special Class Notation AHTS

1. General

The class notation **AHTS** (Advanced Hatch Tightness System) stands for a system which provides additional tightness of cargo hold hatch covers by means of sealing air while pressurising the cargo hold. Preferably the system should be used in connection with a cargo hold air drying system.

2. Documents to be submitted

- General arrangement
- Ventilation arrangement of cargo holds İncluding AHTS
- Details of weather tight closures of hatch covers
- Details of fire flaps and demister (mist eliminators)
- Details of fan layout
- Details of fan control and pressure alarm system

3. Requirements

3.1 The cargo hold hatch cover sealing system must be of weather tight design.

3.2 If one fan is shut-down, the number of fans is to be selected such that the required air capacity may still be supplied to the cargo hold (e.g. 2 . 100 % or 3 . 50 %).

3.3 The cargo holds are to be pressurised by a system separate of other cargo hold ventilation systems.

3.4 The system must be capable of generating an overpressure in the cargo holds of not less than 0,04 bar.

3.5 Each cargo hold is to be provided with an excess flow valve/flap designed for continuous operation. The opening shall be arranged at a height of not less than 4,50 metre above freeboard deck. The excess flow devices are to incorporate fire closures and pressure control facilities operable from outside. The maximum release pressure of the excess flow valves/flaps is not to exceed the set pressure by more than 10 %.

3.6 The maximum excess flow valve/flap and fan air capacities are to be based on the expected maximum amount of leakage air which may flow through the weathertight hatch cover sealings and other cargo hold sealings taking into account sealing maintenance and the overflow device set pressure.

3.7 The fans are to be controlled from the navigation bridge. The operating pressure of each cargo hold equipped with AHTS and the operating current of the fans are to be indicated on the navigation bridge.

3.8 A visual and audible individual high pressure and low pressure alarm for each cargo hold equipped with AHTS is to be provided on the navigation bridge.

3.9 The lower edge of the suction air openings of the over pressure fans must end at a height of not less than 4,50 metre above the freeboard deck. The suction air openings are to be provided with fire closures and effective demisters.

3.10 Doors and hatches to and from the cargo spaces under pressure are to be provided with warning labels stating that the overpressure fans are to be shutdown before opening.

3.11 Doors and hatches to the cargo spaces when under pressure must be provided with locking arrangements which shall be under the control of the responsible ship's officer.

3.12 Emergency stop of the overpressure fans at the doors/hatches of cargo spaces under pressure is to be provided which gives audible alarm on the navigation bridge.

3.13 A written statement of the manufacturer of the hatch covers is be available before granting the class notation AHTS confirming that the higher loads during operation under pressure as per 3.4, considering as well the pressure tolerance mentioned under 3.5, had been considered.

4. Testing

Following the plan approval a successful functional test in the presence of a BCS-Surveyor has to be carried out .

K. Additional Rules for Tankers

For the design and construction of ventilation system for tankers the following rules are to be observed in addition :Tankers Chapter 4 – Machinery Rules, Section 20- Tankers

Oil Recovery Vessels Vessels	Chapter 12 – Oil Recovery
Liquefied Gas	Chapter 10 – Liquefied Gas Tankers
Tankers	Section 12 – Mechanical Ventilation in the Cargo Area
Chemical Tankers	Chapter 8 – Chemical Tankers, Section 12 - Mechanical Ventilation in the Cargo Area

L. Air Changes per Hour

In the following Tables 1.4 to 1.5 the requirements in terms of air changes per hour are listed for various types of ship.

Table 1.4 General requirements for all ships

Ventilated space	Air changes/hour Supply air	Air changes/hour Exhaust air	Req. no.	Remarks
Paint stores and flammable liquid lockers		10	E.4	
Engine room			E.5	as per combustion air and heat radiation requirement, see also ISO 8861 as guidance
CO_2 room		6	E.7	Below open deck
Refrigerating machinery room		30 / 40	E.8	Formula
Spaces containing batteries			E.9	Formula
Separator space		30	E.10	increase due to heat radiation possible
Emergency generator room			E.11	as per combustion air and heat radiation requirement
Dangerous goods in packaged form		6 (for certain cargoes)	F.4	2 air changes/hour for container cargo spaces
Solid dangerous goods in bulk		6 (for special bulk cargoes)	F.5	
Reefer cargo holds			G	Class notation **RCP**
Cargo ships: Closed vehicle spaces, closed ro-ro spaces		10 or 6 (acc. to the provided grade of explosion protection	H	increased ventilation capacity (at least 20 air changes/hour) during vehicle roll on/roll off required. Optional proof acc. to IMO MSC.1/Circ.1515 possible
Livestock spaces	20-30		Annex A,H	
Location emergency fire pump			E.12	Clear of smoke
Pipe tunnel			E.13	extended dangerous area (zone 2) to be observed
Thruster room			E.14	intended time span to observe
Oxygen/Acetylen storage room		6	E.15	
Storage place of gas bottles for domestic purposes		6	E.16	

Table 1.5 Special requirements for passenger ships

Ventilated space	Air changes/hour Supply air	Air changes/hour Exhaust air	Req. no.	Remarks
Passenger ships (≤ 36 passengers): Closed vehicle spaces, closed ro-ro spaces		10 or 6 air changes/hour acc. to the provided grade of explosion protection	I.2.1	Increased ventilation capacity (at least 20 air changes/hour) during vehicle roll on/roll off required. Optional proof acc. to IMO MSC.1/Circ.1515 possible.
Passenger ships (≥ 36 passengers): Closed vehicle spaces, closed ro ro spaces		10	I.3.5	Increased ventilation capacity (at least 20 air changes/hour) during vehicle roll on/roll off required. Optional proof acc. to IMO MSC.1/Circ.1515 possible.
Passenger ships: Special category space:		10	I.2.1 + I.3.5	Increased ventilation capacity (at least 20 air changes/hour) during vehicle roll on/roll off required. Optional proof acc. to IMO MSC.1/Circ.1515 possible.

ANNEX A

RECOMMENDATIONS

A. General Arrangement

Short-circuiting between intakes and exhaust openings should be prevented.

B. Testing

Where so agreed, measurements of air flow, air temperature, air humidity or air velocity may be performed after installation of the systems.

The accuracy of the measurements should be ensured by suitable measuring instruments.

It is recommended that for the measurements the following allowances are accepted:

air flow of the unit [m3/h] – 10 % to + 15 %
air flow of spaces [m3/h] – 10 % to + 10 %
air humidity [R.H.] – 10 % to + 15 %
air velocity accom. spaces [m/s] – 0.05 m/s to + 0.05 m/s
air temperature accom. spaces [°C] - 1.5 °C to + 1.5 °C

C. Ventilating Equipment

Ventilating equipment should be designed to keep noise pollution to a tolerable level.

D. Machinery Space Ventilation

1. *A slight overpressure (< 50 Pa) in the machinery space during normal operation should be ensured.*

2. *For conventional ventilation systems on seagoing ships with unrestricted service it is recommended to use the ISO Standard 8861 in the latest version.*

3. *The stream of supply air should not be directed immediately towards hot machine parts, turbine components, measuring instruments or switchboards.*

4. *The air should be conducted in such a way as to avoid local accumulations of heat wherever possible.*

5. *Power operated fire closures should be capable of being operated individually for test purposes at site.*

6. *The areas of the crew's normal watch-keeping within the engine room should be ventilated to keep a maximum ambient air temperature of + 45 °C. Workshops should be provided with direct "cold spot" ventilation with fresh air. Engine control rooms should be normally air-conditioned to keep a maximum air temperature of + 28 °C under the expected heat load and by moderate fresh air exchange rates. In case of failure of the air condition unit "direct ventilation" with fresh air to remove the expected heat should be possible or second independent air condition unit with sufficient capacity should be provided.*

E. Cargo Holds

1. *Where the nature of the cargo so requires, every cargo hold should be adequately ventilated.*

2. *The position of air inlets and air outlets should be such as to prevent short circuiting of air.*

F. Emergency Generator Room

1. *The emergency generator room should be provided with fire closures even if no gas fire extinguishing system is installed.*

2. *If the emergency generator automatically starts the fire closures should open automatically, if normally closed fire closures are provided.*

G. Refrigerated Containers

1. *For unrestricted service range of the vessel the following values for supply air may be used as guidance:*

- *Refrigerated containers using air-cooled condensers:*
  - *3 100 m3/h per TEU*
  - *4 500 m3/h per FEU*

- *Refrigerated containers using water-cooled condensers*

  ◦ *460 m3/h per TEU*

  ◦ *700 m3/h per FEU*

In case of restricted services, the capacities for supply air may be reduced depending on the nature of cargoes and the shipping routes.

2. *Air ducting and air distribution systems should be so designed as to ensure heat dissipation from container holds under worst case conditions.*

H. Livestock Carrier

1. *An enclosed space for the carriage of livestock should be provided with a mechanical supply ventilation system of sufficient capacity to change the air of that space in its entire volume as follows:*

- *if the minimum clear height of the space is 2.30 m or more, not less than 20 air changes per hour*

- *if the minimum clear height of the space is 1.80 m, not less than 30 air changes per hour*

- *if the minimum clear height of the space is between 2.30 m and 1.80 m, at a rate proportional to those specified above.*

2. *A space for the carriage of livestock that is not enclosed should be provided with a mechanical ventilation system according 1, if*

- *the space, being a structure having an arrangement of pens on more than one deck level, has a breadth greater than 20 m; or*

- *because of a partial enclosure of the space, the natural ventilation is restricted.*

3. *A mechanical ventilation system should distribute air so as to ensure that the whole of each livestock space is efficiently ventilated. Exhaust air outlets should be sited clear of the accommodation.*

4. *Ventilators serving livestock spaces should remain open in all weather conditions while livestock are on board.*

5. *A secondary source of electrical power for the ventilation system should be provided. It should be capable of supplying power to ventilation system for a period of three days in case of a fire or other casualty in the space containing the main source of electrical power.*

6. *National requirements, if any, should be observed.*

I. Principal Construction of Duct Penetration through "A" Class Bulkheads or Decks

The following Fig. A.1 to A.3 show principal construction details of duct penetrations.

J. Air Changes per Hour

1. Values of Air Changes per Hour

The following Table A.1 contains air change rates for the design of ventilation system, which refers to the empty space.

2. Accommodation Spaces

2.1 *Accommodation spaces should be assured of sufficient air renewal under all conditions of weather and climate proper to the intended range of service.*

2.2 *Ventilation systems should be capable of effecting the changes of air specified in Table A.1.*

2.3 *Ships navigating in the tropics or similar regions should be equipped with mechanical ventilation or an air-conditioning system.*

2.4 Air Conditioning and Hot Air Heating Systems

The following conditions apply:

Summer (not applicable to hot air heating systems)
Outside air + 35 °C – 70 % relative humidity
Inside Air + 27 °C – 50 % relative humidity

Winter

Outside air – 20 °C
Inside Air + 22 °C

Other assumption may be permitted for winter operation in certain defined ranges of service.

2.5 *Cabins with own sanitary facilities should be supplied with approximately 10% more incoming air than extracted from the sanitary space.*

2.6 *When cooling, the temperature of the supply air should not be more than 10 °C below the mean room temperature, and, when heating should not be more than 23 ° C above the mean room temperature.*

2.7 *The temperature variation within a space should not more than 2 °C.*

2.8 *The velocity and direction of the air flow should be chosen so as to prevent troublesome draughts. Air outlets should not be located at the head end of bunks.*

2.9 *Air movements in accommodation areas should not exceed 0.2 to 0.3 m/s.*

2.10 *The air velocity through exhaust gratings should not exceed 5 m/s.*

2.11 *The exhaust air from pantries and public sanitary spaces should in general be directly and independently conducted to the outside atmosphere.*

Table A.1 Air change rates

Ventilated space	***Air changes/hour Supply air***	***Air changes/hour Exhaust air***	***Remarks***
Living/sleeping quarters	*6 (8)*	*-*	*Value in brackets valid for 20 % recirculated air.*
Messes, saloons, offices	*12 (15)*	*12 (15)*	
Hospitals	*12*	*12*	
Galleys	*12+28 (15+25)*	*40*	
Pantries	*15 (20)*	*15 (20)*	
Dry provision rooms	*5 (10)*	*5 (10)*	
Sanitary rooms		*10-15*	
Laundries	*10-20*	*15-30*	
Drying rooms	*25*	*30*	

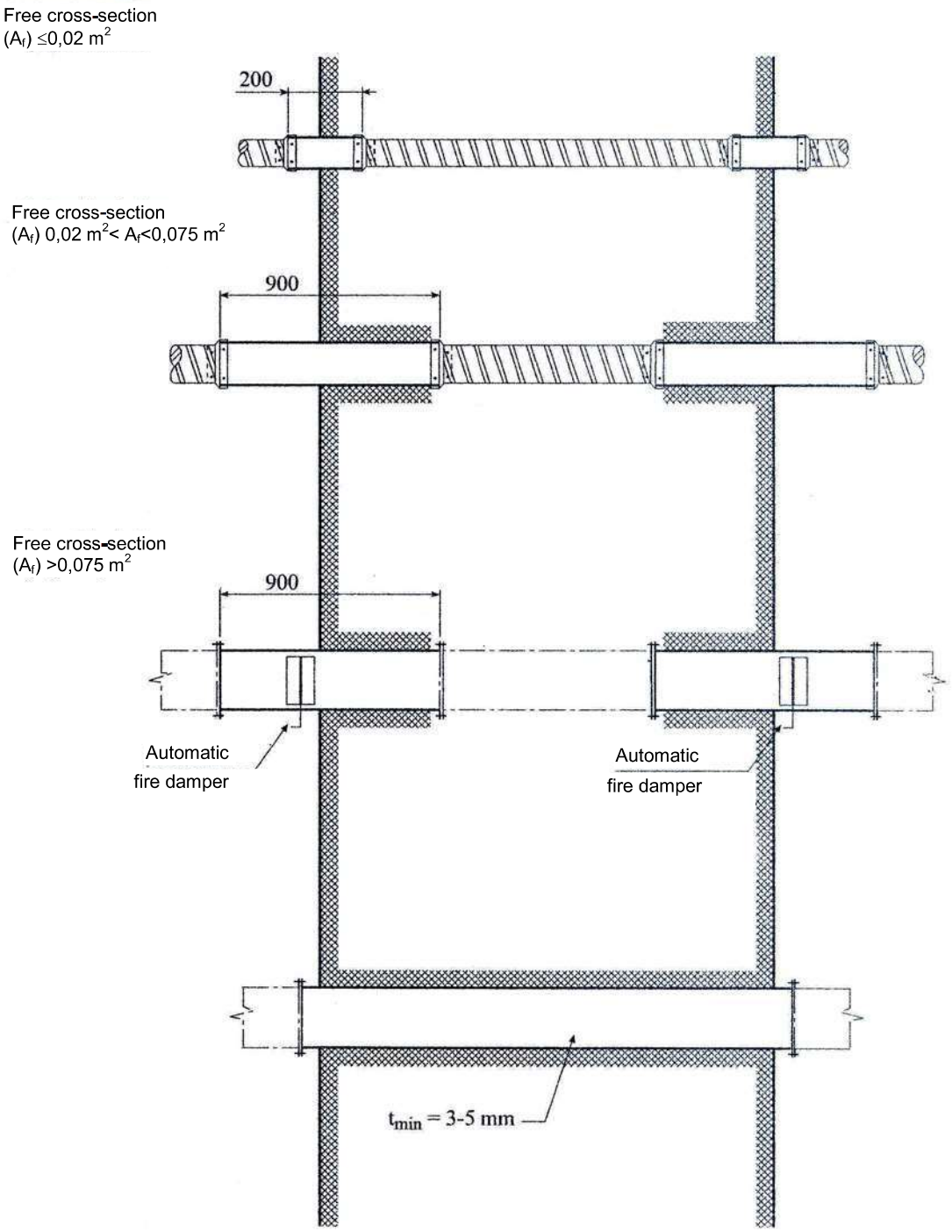

Figure A.1 Detail of duct penetrations through "A" class bulkheads

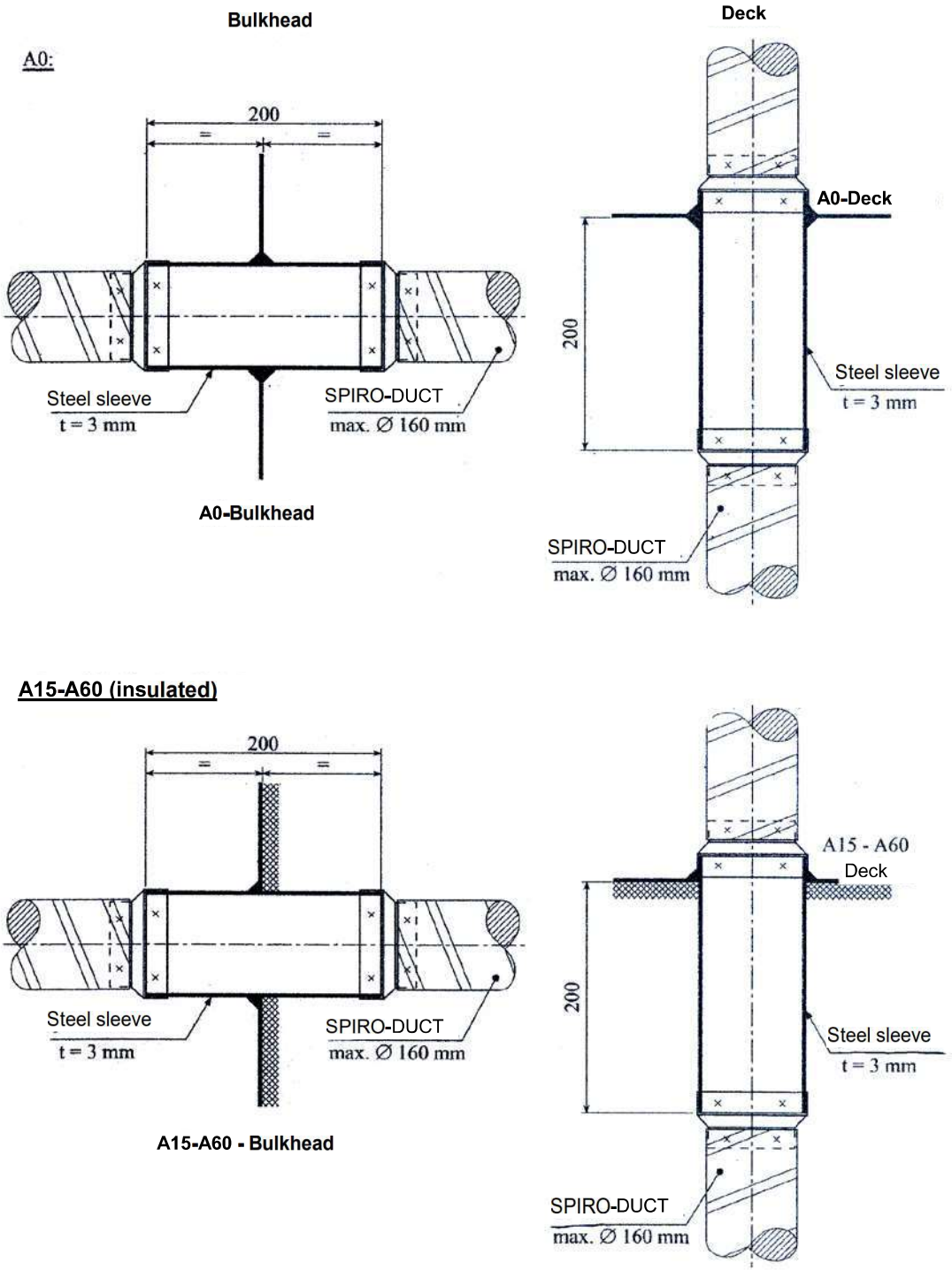

Figure A.2 Detail of duct penetrations through "A" class bulkheads or decks with a free cross-section (A_f) ≤0,02 m^2

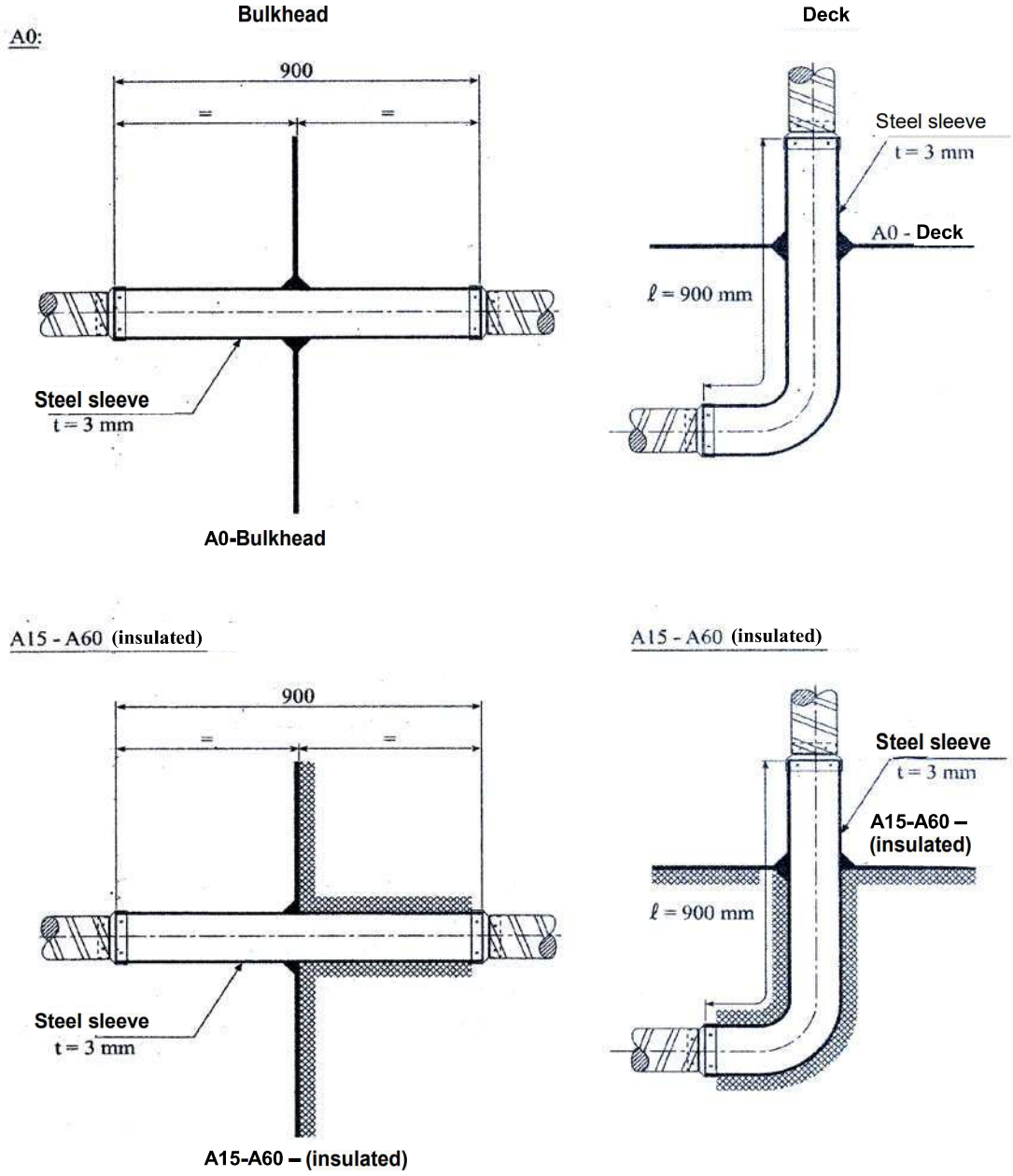

Figure A.3 Detail of duct penetrations through "A" class bulkheads or decks free cross-section (A_f): 0,02 m^2 < A_f < 0,075m^2