

**RUSSIAN MARITIME REGISTER OF SHIPPING**

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**RULES**  
**FOR THE CLASSIFICATION**  
**AND CONSTRUCTION**  
**OF SEA-GOING SHIPS**

**PART XII**  
**REFRIGERATING PLANTS**



Saint-Petersburg  
Edition 2016

Rules for the Classification and Construction of Sea-Going Ships of Russian Maritime Register of Shipping have been approved in accordance with the established approval procedure and come into force on 1 January 2016.

The present nineteenth edition of the Rules is based on the eighteenth edition (2015) taking into account the additions and amendments developed immediately before publication.

The unified requirements, interpretations and recommendations of the International Association of Classification Societies (IACS) and the relevant resolutions of the International Maritime Organization (IMO) have been taken into consideration.

The Rules are published in the following parts:

Part I "Classification";

Part II "Hull";

Part III "Equipment, Arrangements and Outfit";

Part IV "Stability";

Part V "Subdivision";

Part VI "Fire Protection";

Part VII "Machinery Installations";

Part VIII "Systems and Piping";

Part IX "Machinery";

Part X "Boilers, Heat Exchangers and Pressure Vessels";

Part XI "Electrical Equipment";

Part XII "Refrigerating Plants";

Part XIII "Materials";

Part XIV "Welding";

Part XV "Automation";

Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats";

Part XVII "Distinguishing Marks and Descriptive Notations in the Class Notation Specifying Structural and Operational Particulars of Ships";

Part XVIII "Common Structural Rules for Bulk Carriers and Oil Tankers". The text of the part is identical to that of the IACS Common Structural Rules.

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*As compared to the previous edition (2015), the nineteenth edition contains the following amendments.*

The term "ice category" has been replaced by the term "ice class" throughout the text of the Rules.

## **RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS**

### **PART XII. REFRIGERATING PLANTS**

1. Chapter 3.1: para 3.1.1 has been amended considering IACS UR M57.
2. Editorial amendments have been made.

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# PART XII. REFRIGERATING PLANTS

## 1 GENERAL

### 1.1 APPLICATION

**1.1.1** The requirements of the present Part of the Rules apply to stationary marine refrigerating plants and their equipment in compliance with 4.1, Part I "Classification".

**1.1.2** Classed refrigerating plants shall comply with all the requirements of the present Part.

**1.1.3** Unclassed refrigerating plants shall comply with the requirements of the present Part, set forth in 1.3.2.1, 1.3.2.2, 1.3.2.5 (only for heat exchangers and vessels subject to a pressure of a refrigerant), 1.3.2.6 (only for refrigerant systems), 1.3.2.7 (only for the protection system), 1.3.4.2 (only for systems working under a pressure of a refrigerant), 1.3.4.3, 1.3.4.5, 1.3.4.7 (only for protection systems), 1.3.4.8, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 3.1.1, 3.1.3 to 3.1.8, 3.2.1 to 3.2.5, 3.3.4, 3.3.8, 3.3.10, 3.4, 3.5, 4.1.2, 4.1.5, 5.1.1, 5.1.2, 5.1.4, 5.1.5, 5.2.1, 6.1.1, 6.1.2, 6.2.1 (only for refrigerant piping), 6.2.2, 6.2.3, 6.2.5 to 6.2.8, 7.1.2, 7.2.2, 7.2.3, 7.2.4.2, 7.2.4.3, 7.2.7, 8.2.3, 8.2.4, 12.1.2 (only for equipment working under a pressure of a refrigerant), 2.5, 3.3.12, 12.1.3, 12.1.6, 12.2.2, 12.2.4, 12.2.6.

### 1.2 DEFINITIONS AND EXPLANATIONS

**1.2.1** Definitions and explanations relating to general terminology of the Rules are given in Part I "Classification".

For the purpose of the present Part the following definitions and explanations have been adopted.

**Refrigerating machinery space** is a space containing mechanical and other types of equipment intended for cold production.

**Refrigerated spaces** are cargo spaces provided with equipment capable of maintaining the reduced temperatures and intended for the carriage of refrigerated and frozen cargoes.

**Refrigerant** is a working medium of the refrigerating cycle.

**Secondary refrigerant** is a substance for heat removal from refrigerated objects and heat transfer to a refrigerant.

*Note.* A brine is an example of a secondary refrigerant.

### 1.3 SCOPE OF SURVEYS AND TECHNICAL DOCUMENTATION

**1.3.1** General provisions and procedure of classification, surveys as well as the amount of technical documents for the refrigerating plant, which

shall be submitted to the Register for review and approval are specified in the General Regulations for the Classification and Other Activity, as well as in Section 4, Part I "Classification" and in Section 12 of the present Part.

The technical documents for compressors and pumps to the extent, which shall be submitted to the Register for review, are specified in 1.2.3.2, Part IX "Machinery" and for heat exchangers and pressure vessels, as determined in 1.3.4.1, Part X "Boilers, Heat Exchangers and Pressure Vessels".

**1.3.2** The following machinery and apparatus shall be surveyed by the Register in the process of manufacture:

- .1 refrigerant compressors;
- .2 refrigerant pumps;
- .3 secondary refrigerant pumps;
- .4 cooling water pumps;
- .5 heat exchangers and other apparatus and pressure vessels of refrigerant, secondary refrigerant or cooling water;

.6 pipes and valves intended for work at a pressure of 1,0 MPa and over;

.7 devices of control, indication and protection systems as well as instruments for measuring and recording of temperature in the refrigerated spaces.

**1.3.3** The parts of machinery and apparatus mentioned in 1.3.2 are subject to survey by the Register during manufacture to ensure that the provisions of Part XIII "Materials" and Part XIV "Welding" as well as particular requirements of technical documents approved by the Register are complied with. The parts of machinery under 1.3.2.1 to 1.3.2.4 are listed in Table 1.2.4, Part IX "Machinery" and the parts of apparatus indicated in 1.3.2.5 are given in Table 1.3.3, Part X "Boilers, Heat Exchangers and Pressure Vessels".

**1.3.4** In the process of ship's construction the following shall be subjected to survey by the Register:

- .1 manufacture and testing of the relevant items of the refrigerating plant at the workshop;
- .2 mounting of machinery, heat exchangers and pressure vessels;
- .3 mounting of refrigerant systems;
- .4 mounting of secondary refrigerant, cooled air and cooling water systems;
- .5 mounting of the main and emergency ventilation systems;
- .6 fitting of insulation of the cooling spaces and freezing chambers, apparatus, pressure vessels and refrigerating pipes;
- .7 installation of control, indication, alarm and protection systems of the refrigerating plant;
- .8 testing of the refrigerating plant.

## 2 GENERAL TECHNICAL REQUIREMENTS

### 2.1 GENERAL

**2.1.1** The machinery and other units of the refrigerating plant shall remain operative under the environmental conditions specified in 2.3, Part VII "Machinery Installations".

**2.1.2** The machinery and equipment of the refrigerating plant shall be installed and secured on board the ship in accordance with the requirements of 4.4.1, 4.4.4, 4.4.6 to 4.4.8, Part VII "Machinery Installations".

### 2.2 REFRIGERANTS AND DESIGN PRESSURE

**2.2.1** Refrigerants in accordance with Table 2.2.1 are subdivided into two groups as follows:

- I — non-flammable and low-toxic refrigerants;
- II — flammable, explosive and toxic refrigerants.

Use of refrigerants other than specified in Table 2.2.1 is subject to special consideration by the Register with regard to their toxicity, inflammability and explosiveness.

Table 2.2.1

Refrigerant group	Symbol	Name	Chemical formula	Design pressure $p$ , MPa
I	R22	Freon 22	CHClF <sub>2</sub>	2,0
	R134a	Freon 134a	CF <sub>3</sub> CH <sub>2</sub> F	1,2
	R744	Carbon dioxide	CO <sub>2</sub>	refer to 2.2.3
II	R717	Ammonia	NH <sub>3</sub>	2,0

**2.2.2** In strength calculations of the items operating under the refrigerant pressure, the design pressure shall be taken not less than the excessive pressure of the saturated vapors of the refrigerant at a temperature +50 °C (refer to Table 2.2.1).

**2.2.3** For the refrigerant equipment working under the pressure of refrigerants with low critical temperatures (below +50 °C) the design pressure is subject to special consideration by the Register in each particular case.

**2.2.4** The refrigerating plant components working under pressure shall be calculated for compliance with hydraulic test pressure (refer to 12.1.2). The stresses involved shall not exceed 0,9 times the yield stress of material.

**2.2.5** It is allowed to use hydrocarbons (isobutane R600a or others) as refrigerants in household refrigerators and freezers on board the ships in case the total amount of the refrigerant in household refrigerators and freezers installed in one space does not exceed 150 g. In other cases the possibility of

installation of such household refrigerators and freezers on board the ships is subject to special consideration by the Register.

### 2.3 COMPOSITION AND CAPACITY OF THE REFRIGERATING EQUIPMENT

**2.3.1** The refrigerating plant shall provide effective maintenance of the temperatures in refrigerated spaces as may be required for the cargo carried, depending upon its type and conditions of navigation area as well as cold treatment of cargo.

**2.3.2** The refrigerating plant shall provide maintenance of required temperatures in the refrigerated cargo spaces with the main equipment at work supplying cold to all consumers under the following environmental conditions:

- sea water temperature not below + 32 °C;
- ambient air temperature not below + 40 °C.

The design environmental conditions of the refrigerating plants of fishing vessels and special purpose ships, which, in addition to the refrigerating plants of the cargo spaces, are equipped with other refrigerating facilities, are subject to special consideration by the Register in each case.

**2.3.3** Capacity of main equipment of the refrigerating plant shall be sufficient to maintain the required temperatures in refrigerated spaces when working 24 h a day and to supply cold to other consumers.

The main equipment shall comprise not less than two similar condensers and, where intermediate secondary refrigerant or cascade and stage cycles are used, two similar evaporators, intercascade heat exchangers and intermediate pressure vessels.

**2.3.4** Capacity of the refrigerating plant designed also for cooling of non-precooled cargo with all the machinery at work including the standby unit shall be sufficient to reduce the cargo temperature to the required temperature as quickly as it is necessary for preservation of that cargo.

**2.3.5** Standby equipment of compressor refrigerating plant shall comprise one compressor with a drive motor, one condenser, control systems and all valves necessary for independent operation of all components of this equipment.

Capacity of the standby equipment shall be such as to supply cold to all consumers with one of the main compressors or condensers inoperative.

**2.3.6** For fishing vessels and special purpose ships which, in addition to the refrigerating plants of the cargo spaces, are equipped with other refrigerating facilities (e.g. freezing, cooling and ice making),

provision of the standby equipment is subject to special consideration by the Register in each case.

**2.3.7** Freezing and cooling facilities shall provide freezing (cooling) of cargo during the time period as required by the conditions of its preservation, handling and proper carriage.

**2.3.8** Pipelines between apparatus and machinery shall be joined in such a way as to provide operation of the refrigerating units at various combinations of apparatus, machinery and facilities necessary for their independent operation.

The apparatus shall be fitted with the connections for suction and delivery pipes providing the transfer of the refrigerant and its discharge from the apparatus.

**2.3.9** When pumping for liquid refrigerant circulation is used, at least two circulating pumps shall be fitted, one of which shall be a standby pump.

If the refrigerant system is so designed that it is capable of properly working without pumps, the standby pump need not be installed, provided the refrigerant system capacity meets the requirements of 2.3.1 and the freezing units capacity is not reduced in excess of 20 per cent.

**2.3.10** The secondary refrigerant system serving a single group of cold consumers shall comprise at least two circulating pumps, one of which being standby.

In case of two or more groups of cold consumers with separate secondary refrigerant systems (differing in temperatures), each group shall have at least one circulating pump; a common standby pump may be admitted provided it has adequate capacity and pressure head.

**2.3.11** Cooling water supply to the refrigerating plant shall be provided from at least two circulating pumps, one of which shall be used for standby purpose. Any of sea water pumps with adequate capacity and pressure head may be accepted as standby means.

**2.3.12** Cooling water shall be supplied from at least two sea connections. Where it is intended to use sea connections of general service, proper structural arrangements shall be provided for adequate supply of cooling water from each sea connection under normal service conditions of the ship.

## 2.4 MATERIALS

**2.4.1** Quality and main characteristics of materials used for the manufacture of parts, assemblies and securing items of the refrigerating equipment subject to the dynamic loads, excessive pressure, variable and

low temperatures shall comply with the requirements of Part XIII "Materials".

The choice of materials depends on the working temperature and physical and chemical properties of the refrigerant:

**.1** materials used for the manufacture of parts of equipment exposed to the refrigerants, lubricating oils and their combinations, cooling and cooled media shall be inert and resistant to their action;

**.2** materials used for the manufacture of parts of equipment working at low temperatures shall not be subject to structural irreversible modifications and shall maintain adequate strength at the temperatures concerned;

**.3** materials used for the manufacture of parts and assemblies of the refrigerating equipment working at temperatures not below  $-50^{\circ}\text{C}$  shall comply with the requirements of 1.2, Part II "Hull" and 3.5, Part XIII "Materials";

**.4** materials used for the manufacture of parts of equipment working at temperatures below  $-50^{\circ}\text{C}$  are subject to special consideration by the Register in each case.

**2.4.2** Parts of machinery and apparatus exposed to the action of corrosive agents shall be made of materials with adequate corrosion resistance or be protected by corrosion-resisting coatings.

Assemblies and parts of machinery and apparatus made of materials differing in electrolytic potential shall be protected against contact corrosion.

**2.4.3** Steel piping of refrigerant, secondary refrigerant and connecting pieces of these pipes made of steel other than stainless steel shall be galvanized on the outside or treated in some other way ensuring equivalent antirust protection. Surfaces in contact with refrigerant or secondary refrigerant shall not be galvanized.

In manufacturing pipes the requirements of 2.4.1 and 2.4.2 shall be taken into consideration.

## 2.5 ELECTRICAL EQUIPMENT

**2.5.1** Electrical equipment of refrigerating plants and automatic devices as well as the lighting of refrigerating machinery and refrigerated spaces and refrigerant storerooms shall comply with the requirements of Section 20 and other applicable requirements of Part XI "Electrical Equipment".

**2.5.2** Driving motors of compressors, pumps and fans shall meet the requirements of Sections 5 and 10, Part XI "Electrical Equipment".

### 3 SPACES FOR REFRIGERATING PLANTS AND REFRIGERATED CARGO SPACES

#### 3.1 REFRIGERATING MACHINERY SPACES

**3.1.1** The refrigerating machinery spaces shall meet the requirements of 4.5.1, 4.5.3 and 4.5.4, Part VII "Machinery Installations" as well as the requirements of the present Chapter.

Refrigerating equipment working with Group II refrigerants shall be arranged in isolated gastight compartments.

For fishing vessels of and under 55 m in length and other plants with refrigerant agent not exceeding 25 kg, a refrigerating machine working with Group II refrigerant may be arranged in common machinery space under the following conditions:

the space where refrigerating machines are installed shall be served by a special hood with exhaust ventilation, so as not to permit any leakage of ammonia from dissipating into other areas in the machinery space. The number of the air changes shall be not less than specified in 3.1.6 and 3.1.7.1;

water screens shall be provided for the said area;

a fixed ammonia system with alarms inside and outside the compartment shall be fitted;

at least two sets of breathing apparatus and protective clothing shall be available.

Otherwise the possibility of installation of a refrigerating machine using a Group II refrigerant in the common machinery space of the ship is subject to special consideration by the Register with regard to the formal safety assessment of the ship ammonia refrigerating plants according to the procedure set forth in the Collection of Regulating Documents, Book 14.

Drainage of the refrigerating machinery space with Group II refrigerant shall be provided as required by 7.4.10, Part VIII "Systems and Piping".

**3.1.2** The machinery, apparatus and piping shall be so arranged in the refrigerating machinery space as to permit easy access for maintenance and shall enable the parts to be renewed, if necessary, without dismantling the machinery and apparatus from foundations. Care shall be taken that the machinery, apparatus and other equipment be placed not less than 100 mm remote from bulkheads and other vertical surfaces.

**3.1.3** The refrigerating machinery space shall have two exits located as far apart as practicable, with the doors opening outwards. Where the refrigerating machinery space is situated above or below the open deck, each escape route shall be fitted with steel ladders as widely separated from each other as possible and leading to the spaces, which give access to the open deck.

A second exit is not required:

.1 for refrigerating machinery spaces, provided the distance between the farthest place where people are likely to be and the exit is 6 m and less;

.2 unattended rooms of automated refrigerating machinery working with Group I refrigerants.

**3.1.4** The means of escape from spaces of refrigerating machinery working with Group II refrigerants shall not lead in accommodation, public and service spaces or spaces in communication therewith. One of the means of escape shall lead to the open deck.

Where the escape routes pass through corridors and casings, these shall be fitted with supply and exhaust ventilation, forced air supply being obligatory. The starting arrangements of the ventilation shall be available both inside and outside the refrigerating machinery space, placed in immediate proximity to the exit.

**3.1.5** Exits from spaces housing refrigerating machinery working with Group II refrigerants shall be provided with water-screen arrangements. The starting means of water screens shall be available from the outside of the space placed in immediate proximity to the exit.

In the machinery space there shall be one fire hydrant with a hose.

**3.1.6** The refrigerating machinery space shall have an independent ventilation system ensuring 10 air changes per hour. Where refrigerating machinery are arranged in other spaces the ventilation system of these spaces is subject to special consideration by the Register in each case.

**3.1.7** In addition to the main ventilation system required by 3.1.6, each refrigerating machinery space shall be fitted with emergency ventilation system of a capacity sufficient for:

.1 30 air changes per hour for spaces of refrigerating machinery working with Group II refrigerants;

.2 20 air changes per hour for spaces of refrigerating machinery working with Group I refrigerant.

Depending on density of the refrigerant, exhaust ventilation shall be provided from the uppermost or lowest parts of the space.

When calculating the emergency ventilation system, the capacity of the main ventilators may be included, provided these are operable with the emergency ones, shall the switchboard of the refrigerating units be deenergized.

**3.1.8** At least two breathing apparatus suitable for the refrigerant used, access to which will not be cut in case of refrigerant leakage, shall be provided at the exits of the refrigerating machinery space.



At least two sets of gastight protective clothings shall be available at the exits of the spaces of refrigerating machinery working with Group II refrigerants.

### 3.2 REFRIGERANT STOREROOMS

**3.2.1** Refrigerant storerooms shall be separated from other spaces.

The spaces intended for storage of the refrigerant shall be gastight.

In case of storing small amounts of Group I refrigerant the departure is allowed from the above-mentioned requirements on agreement with the Register.

The refrigerant storage cylinders shall comply with the requirements of 6.4.5, Part X "Boilers, Heat Exchangers and Pressure Vessels".

**3.2.2** The refrigerant storage cylinders shall be secured in place in such a way that they will not shift in adverse weather conditions.

Non-metallic pads shall be placed between the steel plating and the storage cylinders as well as between storage cylinders proper.

**3.2.3** The refrigerant storerooms shall be provided with an independent ventilation system.

**3.2.4** Storage cylinders containing compressed gases other than the refrigerant gas are not permitted to be stowed in spaces of refrigerant storage, nor shall combustible materials be used for the outfit of these spaces.

**3.2.5** Storage of refrigerant in fixed receivers is permitted on condition that the receivers and spaces they are arranged in comply with the requirements stated in 3.1.5, 3.1.7, 5.1.1, 5.1.2, 5.1.4, 6.2.5 and 6.2.6. Provision shall be made for sucking off Group II refrigerant from the service piping of each receiver after complete filling of the system or periodical replenishing.

Service piping of receivers designed for refrigerant storage is not to pass through accommodation and service spaces.

### 3.3 REFRIGERATED CARGO SPACES

**3.3.1** Cooling apparatus, grids, mechanisms, devices as well as piping and air ducts arranged in the refrigerated cargo spaces shall be efficiently secured and protected from being damaged by cargo.

**3.3.2** Where the air cooling system is used, the air coolers may be located either in separate spaces or in the same spaces as the cargo cooled. Being arranged in the refrigerated cargo spaces, the air coolers shall be provided with condensate tray. For the refrigerated spaces with the ambient air temperature being

negative, the condensate trays shall be provided with the heating system.

**3.3.3** Where the air cooling system is adopted, the air coolers shall be made accessible with the cargo space being entirely loaded with refrigerated cargo. Alternatively, access to the air coolers shall be provided from adjacent non-cooled spaces. The access opening of the air cooler space shall be as large as to permit the fan impeller and electric motor to be carried through, if necessary.

**3.3.4** In places where air ducts pass through watertight bulkheads, sluice valves shall be fitted. The sluice valves shall be designed as strong as the bulkhead. The sluice valves shall be operable from positions above the bulkhead deck.

In passenger ships and special purpose ships, the cargo cooling air ducts may pass through more than one watertight bulkhead if the means of closure at such openings are operated by power and are capable of being closed from the main machinery control room located above the bulkhead deck.

**3.3.5** Appropriate ventilation system capable of supplying uncontaminated atmospheric air into the spaces of refrigerated cargoes requiring adequate air exchange during carriage shall be provided.

**3.3.6** Each air inlet and outlet shall have airtight closure.

**3.3.7** Ventilation ducts passing through refrigerated cargo and other spaces shall be airtight and efficiently insulated.

**3.3.8** Where cooling arrangements (batteries or air coolers) under a refrigerant pressure are used in cargo spaces, an independent ventilation system shall be provided for these spaces capable to ensure, relative to the volume of the empty space:

.1 two air changes per hour, where a Group I refrigerant is used;

.2 three air changes per hour, where a Group II refrigerant is used.

The above ventilation system may be combined with the system referred to in 3.3.5 and 10.1.8, if any. For spaces where cooling arrangements working under Group II refrigerant pressure are used, the requirement of 3.5.4 as regards two exits shall be met.

**3.3.9** The refrigerated spaces shall be fitted with telethermometric arrangements.

**3.3.10** Drainage of refrigerated spaces shall conform to the requirements stated in 7.4.10 and 7.8, Part VIII "Systems and Piping".

**3.3.11** Piping passing through refrigerated spaces shall comply with 5.4, Part VIII "Systems and Piping".

**3.3.12** Each refrigerated space with an indoor temperature of 0 °C and below shall be fitted with a readily identifiable signal push-button located in an accessible position. The "Man-in-Space" signal actu-

ated by this push-button shall be transmitted to the position where continuous watch is kept.

#### **3.4 FREEZING AND COOLING APPARATUS**

**3.4.1** The arrangement of air coolers and fans in freezing apparatus shall comply with the requirements of 3.3.1.

**3.4.2** Provision shall be made in the refrigerating machinery space for the devices for monitoring the operation of freezing and cooling apparatus.

#### **3.5 SPACES CONTAINING PROCESS EQUIPMENT**

**3.5.1** The arrangement of machinery, apparatus and refrigerant pressure vessels in spaces other than

the refrigerating machinery spaces shall be subject to special consideration by the Register in each case.

**3.5.2** Spaces containing the process equipment working under pressure of Group II refrigerant shall be provided with a fire hydrant with a hose.

**3.5.3** Spaces containing the process equipment working under pressure of a refrigerant shall have an independent ventilation system complying with the requirements of 3.1.6 and 3.1.7.

**3.5.4** In spaces containing the process equipment working under pressure of Group II refrigerants there shall be two exits, as it is specified in 3.1.3 and 3.1.4.

When using Group II refrigerants, the exits shall be fitted with arrangements capable of producing water screens. The cut-in device of the screens shall be placed from the outside of the space in immediate proximity to the exit.

## 4 MACHINERY

### 4.1 COMPRESSORS

**4.1.1** Compressors shall comply with the requirements specified in this Part of the Rules and also with those of 5.1, Part IX "Machinery".

**4.1.2** Parts of compressors exposed to the action of dynamic loads and excessive pressure shall be calculated for strength having in view the design pressures in compliance with 2.2.1.

**4.1.3** The refrigerant suction and delivery sides of the compressor shall have stop valves apart from the automatic valves.

**4.1.4** Cavities in compressors reserved for refrigerant, lubricating oil and cooling water shall have drain arrangements, where necessary.

**4.1.5** A pressure relief valve or other safety device shall be fitted in the delivery line of the intermediate and final compression stages of compressor between the delivery cavity and the stop valve, the discharge being led to the suction side of the compressor in case of excessive pressure rise. Discharging capacity of the safety devices shall not be less than the maximum

volumetric capacity of the compressor stage protected.

The opening pressure of safety valve shall not exceed 10 per cent of the working pressure, with the valve being open.

No shut-off devices are permitted in the refrigerant gas relief line.

**4.1.6** Refrigerant compressor safety devices shall comply with the requirements of 7.2.3.

### 4.2 PUMPS

**4.2.1** Pumps shall comply with the requirements set out in 5.2, Part IX "Machinery".

### 4.3 FANS

**4.3.1** Fans shall comply with the requirements set out in 5.3, Part IX "Machinery".

## 5 HEAT EXCHANGERS, PRESSURE VESSELS AND COOLING ARRANGEMENTS

### 5.1 HEAT EXCHANGERS AND PRESSURE VESSELS

**5.1.1** Heat exchangers and pressure vessels as regards materials, scantlings of components and provision with valves shall comply with the relevant requirements of Section 6 (except for 6.3.1, 6.3.3, 6.4.1, 6.4.2.3 and 6.4.2.4), Part X "Boilers, Heat Exchangers and Pressure Vessels" and also with the requirements of the present Part.

**5.1.2** "Shell and tube" heat exchangers and pressure vessels with the volume of the refrigerant space of 50 dm<sup>3</sup> and over shall be fitted with safety devices having the discharging capacity so designed that the pressure will not rise in excess of 10 per cent of the design pressure, with the valve being completely open.

The designed discharging capacity  $G$ , in kg/s, shall not be less than determined by the following formula:

$$G = qS/r \quad (5.1.2)$$

where  $q$  = specific intensity of the heat flow from the space during fire, kW/m<sup>2</sup> (assumed to be 10 kW/m<sup>2</sup> in all cases);  
 $S$  = area of the outer surface of pressure vessel (heat exchanger), m<sup>2</sup>;  
 $r$  = specific heat of the refrigerant vaporization under opening pressure of the safety valve, kJ/kg.

The safety devices shall consist of two safety valves and a change-over device so constructed that both or one of these valves will, in any case, communicate with the heat exchanger or pressure vessel involved. Each of these valves shall provide the full discharging capacity.

The Register may require that the safety valves are also fitted in other apparatus if this is deemed expedient.

No shut-off valves are permitted between the heat exchanger or pressure vessel and the safety device.

The use of safety devices with one safety valve or safety devices of other types is subject to special consideration by the Register in each case.

**5.1.3** Heat exchangers and pressure vessels shall have suitable facilities for removing water, air, lubricating oil and secondary refrigerant.

**5.1.4** Pressure vessels with Group II liquid refrigerants shall have suitable facilities for emergency dumping of the latter.

The rated time of refrigerant dumping shall not be more than 2 min with refrigerant in heat exchangers or pressure vessels under constant excessive pressure assumed equal to the design pressure according to 2.2.1.

**5.1.5** Cooling facilities of refrigerated cargo spaces, freezing and cooling apparatus arranged outside the space for refrigerating machinery working under the pressure of the refrigerant shall be equipped with shut-off valves enabling facilities and apparatus to be disconnected remotely from the refrigerant delivery and return lines. The disconnection shall be performed from positions arranged outside the spaces where these facilities and apparatus are placed.

### 5.2 AIR COOLERS, COOLING GRIDS

**5.2.1** Air coolers working under pressure of a refrigerant shall be of welded or soldered construction. Flanged connections between the coil sections and pipes are permitted only when this is proved necessary; all flanged connections shall be arranged in readily accessible places to enable inspection for tightness.

**5.2.2** Where only one air cooler is used for cooling cargo spaces, it shall be arranged in not less than two sections, each of which shall be capable of being disconnected, if necessary.

**5.2.3** The distribution of cooling grids shall provide the uniform cooling of the space concerned.

Grids shall be combined in not less than two independent sections, with means providing shut-off of each section.

**5.2.4** The cooling facilities of refrigerated cargo spaces shall be provided with effective defrosting system or means.

## 6 VALVES AND PIPING

### 6.1 VALVES

**6.1.1** The refrigerating plants shall be provided with shut-off, regulating and safety valves designed for pressure of not less than  $1,25p$ , where  $p$  is the design pressure as given in 2.2.1.

As a rule, valves shall be made of steel. The use of other types of materials is subject to special consideration by the Register in each case.

The integral shut-off valves made of grey cast iron, which are intended for the inlet and outlet cavities of the refrigerant compressors, as well as the valves made of spheroidal graphite cast iron may be permitted when using Group I and Group II refrigerants at ambient temperatures not below  $-40^{\circ}\text{C}$ .

**6.1.2** The design of safety valves shall ensure the valve blowing up at a pressure exceeding the design pressure as given in 2.2.1 by not more than 10 per cent.

### 6.2 PIPING

**6.2.1** The piping of refrigerant, secondary refrigerant and cooling water systems as well as air ducts shall comply with the relevant requirements set out in Section 2 and 5.4, Part VIII "Systems and Piping" and also with the requirements of the present Chapter.

In accordance with Table 1.3.2, Part VIII "Systems and Piping", piping conveying Group I refrigerant is Class II piping while piping conveying Group II refrigerant is Class I piping.

**6.2.2** The piping of refrigerant shall be made of seamless pipes. The joining of steel pipes carrying the refrigerant shall, as a rule, be made by welding and, where copper pipes are concerned, by welding or brazing. Where pipes are joined with machinery, heat exchangers and pressure vessels, detachable connections may be admitted.

**6.2.3** The refrigerant delivery piping of the compressors and refrigerant pumps shall be fitted with non-return valves. These valves need not be used for compressors working with Group I refrigerant and having no discharge facilities.

**6.2.4** Refrigerant driers for moisture absorption shall be fitted on the liquid piping carrying the refrigerant slightly soluble in water. They shall be fitted together with gauze filters to the regulators or structurally connected with them.

**6.2.5** The pipes from safety devices of Group II refrigerant shall be led overboard below the waterline corresponding to the minimum draught. These pipes shall be provided with non-return valves fitted in proximity to the ship's side.

Refrigerant leak detectors shall be installed after each safety device (other than those referred to in 4.1.5).

Group I refrigerant may be discharged to the atmosphere at a position safe for people.

**6.2.6** The pipes for Group II refrigerant dumping from heat exchangers and pressure vessels in emergency shall terminate into a header (refer to 5.1.4) located outside the refrigerating machinery space, but near the access thereto. Each dumping pipe shall be fitted with shut-off valves located near the header. These valves shall be protected from opening by unauthorized persons and shall be so constructed as to be convenient for sealing when closed. No other shut-off valves shall be fitted on the emergency drain pipes between pressure vessels or heat exchangers and shut-off valves near the header. The common main of the emergency dumping header shall have a non-return valve fitted in accordance with 4.3.2.10, Part VIII "Systems and Piping" and shall be laid overboard below the waterline corresponding to the minimum draught of the ship. To permit purging of the common main, steam or compressed air connections shall be provided.

The inner diameters of the refrigerant emergency dumping pipes of separate heat exchangers and pressure vessels shall not be less than the diameter of the relief valve determined as required by 5.1.2. The cross-sectional area of the dumping main shall not be less than the total cross-sectional area of three largest dumping pipes communicating with the main.

**6.2.7** For pipes laid overboard in a place below the waterline according to 6.2.5 and 6.2.6, the minimum pipe wall thickness in all cases shall not be less than that specified in column 3 of Table 2.3.8, Part VIII "Systems and Piping".

**6.2.8** Group II refrigerant piping shall not pass through accommodation and service spaces specified in 1.5.2 and 1.5.3, Part VI "Fire Protection". Group I refrigerant piping shall not pass through accommodation spaces. Their passage is permitted through service spaces and corridors adjacent to or leading into service spaces.

## 7 INDICATING AND MEASURING INSTRUMENTS. CONTROL, PROTECTION, REGULATION AND ALARM

### 7.1 INDICATING AND MEASURING INSTRUMENTS

**7.1.1** The compressors and apparatus for the refrigerating plants shall be fitted with suitable devices to permit the working parameters being monitored. Besides, the arrangement shall provide for the possibility of installing additional indicating and measuring instruments required when testing the plant.

**7.1.2** Indicating and measuring instruments shall be placed in readily accessible and visible positions. The instruments shall bear clear marks indicating admissible values of the parameters controlled.

Indicating and measuring instruments shall be checked by competent bodies.

### 7.2 CONTROL, PROTECTION, REGULATION AND ALARM

**7.2.1** Protective, regulation and alarm devices shall comply with the applicable requirements of Part XV "Automation".

The requirements for control, regulation and alarm of refrigerating plants of unattended operation are given in 4.8, Part XV "Automation".

**7.2.2** Provision shall be made for local control and regulation of operating conditions of the refrigerating plant.

**7.2.3** The refrigerant compressors shall be provided with protective devices capable of stopping the compressors in case of:

- .1 inadmissible drop of suction pressure;
- .2 inadmissible rise of discharge pressure;
- .3 inadmissible drop of lubricating oil pressure;
- .4 inadmissible rise of refrigerant discharge temperature (intended for the refrigerating plants working with Group II refrigerants as well as for the automated refrigerating plants with unattended operation);
- .5 inadmissible axial rotor displacement of centrifugal compressor;
- .6 inadmissible temperature rise in sliding bearings of centrifugal compressors.

**7.2.4** Liquid separators, intermediate vessels and liquid refrigerant receivers (where pumps are used for refrigerant circulation) as well as free-level type evaporators shall be fitted with regulation and protective devices capable of:

- .1 maintaining constant level of refrigerant liquid necessary for proper work of the evaporator, or constant temperature of vapour superheating;

- .2 stopping the delivery of liquid refrigerant into evaporators and any type of intermediate vessels, in case of compressor shut-down;

- .3 stopping the compressor, shall the level of refrigerant liquid rise inadmissibly.

**7.2.5** Plants incorporating "shell and tube" type evaporators shall be fitted with protective devices capable of:

- .1 stopping the compressor, shall the circulation of the secondary refrigerant inside the evaporator be impeded, or cutting off this evaporator from the refrigerant system;

- .2 stopping the compressor, shall the temperature of secondary refrigerant drop inadmissibly.

**7.2.6** The refrigerating plants shall be provided with signal devices, which shall give general warnings at the refrigerating plant control station after operation of protective devices specified in 7.2.3 to 7.2.5.

Provision shall be made at the local control station for decoding of the above signals.

**7.2.7** Each space with equipment under refrigerant pressure shall be fitted with gas detection panel and refrigerant leakage alarm that comes into action in the following cases:

- for Group I refrigerants (freons):
  - where the concentration of refrigerant in the working zone air is above the maximum allowable sanitary standard (3000 mg/m<sup>3</sup>);
  - for Group I refrigerants (carbon dioxide):
    - where the concentration of the refrigerant in the working zone is above the maximum allowable sanitary standard (9200 mg/m<sup>3</sup>);
    - for Group II refrigerants (ammonia):
      - where the concentration of refrigerant in the working zone air is above the maximum allowable sanitary standards (20 mg/m<sup>3</sup>);
      - where the maximum allowable concentration of refrigerant (60 mg/m<sup>3</sup>) in the space protected increases threefold. In this case, provision shall be made for automatic switching on the emergency ventilation, except for the refrigerated spaces;
      - where the concentration of 500 mg/m<sup>3</sup> is attained. In this case access to the space without individual protection outfit shall be prohibited.

Warning audible and visible alarms shall be mounted in the spaces protected and before entrance to these spaces. Warning signals shall be duplicated at the position where continuous watch is kept.

**7.2.8** The system for temperature, humidity and atmosphere control inside the refrigerated spaces

shall ensure accuracy in maintaining these parameters within the ranges consistent with the cargo transportation conditions.

**7.2.9** When using the cascade refrigerating machines with carbon dioxide in the lower cascade branch the auxiliary (harbor) cooling unit of the

lower cascade branch shall be automatically switched on in case of disconnecting the cascade refrigerating machines and to maintain the required temperature during the entire period of disconnecting the cascade refrigerating machine.

## 8 INSULATION

### 8.1 INSULATION OF THE REFRIGERATED SPACES

**8.1.1** All steelwork of ship's hull inside the refrigerated cargo spaces shall be efficiently insulated. The applied insulating materials shall be of a type approved by the Register and shall also comply with the requirements of the properly authorized Sanitary Inspection Authorities.

**8.1.2** The insulating materials adopted for refrigerated cargo spaces shall have adequate resistance to adverse biological factors and shall be of the type that does not give off any odour.

**8.1.3** The surfaces of the bulkheads and the inner bottom plating in way of fuel tanks shall be coated with oil-resistant and inodorous material. The coating shall be applied before the insulation of these surfaces is arranged.

**8.1.4** Care shall be taken to prevent the insulation from infiltration with water, or, alternatively, suitable means for drying it during service as well as protective measures against damage by rodents shall be provided.

**8.1.5** The insulation of refrigerated cargo spaces shall be covered with suitable lining or other protective coating. In places where insulation linings

may be crushed by cargo, they shall be suitably protected.

**8.1.6** The insulation in freezing apparatus shall comply with the requirements of 8.1.2, 8.1.4, 8.1.5.

### 8.2 INSULATION OF PIPING

**8.2.1** Where pipes are laid through bulkheads and decks, no direct contact with surfaces they pierce is permitted to prevent heat exchange.

**8.2.2** Provision shall be made for protecting the insulation of piping from dampness.

**8.2.3** The insulating materials used for piping shall be non-combustible in accordance with 1.6.3.1, Part VI "Fire Protection".

This requirement does not apply to insulation of piping arranged within the refrigerated cargo spaces and refrigerated storerooms.

**8.2.4** Vapour barriers and adhesives used in conjunction with insulation as well as insulation of pipe valves need not satisfy the requirements of 8.2.3, provided they are kept to the minimum quantity and their exposed surfaces have low flame spread characteristics in accordance with 1.6.3.5, Part VI "Fire Protection".



## **9 REFRIGERATING PLANTS DESIGNED FOR COOLING OF CARGO IN THERMAL CONTAINERS**

### **9.1 GENERAL PROVISIONS AND TECHNICAL REQUIREMENTS**

**9.1.1** The refrigerating plants designed to supply cooled air to the thermal containers and installed permanently on board ship are covered by the applicable requirements of the present Part.

**9.1.2** The refrigerating plants shall be capable of supplying cooled air within the required temperature range to the thermal containers with the cargo contained therein.

The degree of air circulation in the containers, devices for measuring and controlling temperature, maintaining required humidity, alarms to indicate maintenance of required parameters shall be consistent with transportation conditions of particular kinds of cargo.

The refrigerating capacity margin of the plant shall not be less than 20 per cent of the specified capacity.

**9.1.3** If the purpose of a container is such that for carriage of cargo inside the container atmosphere control is required, its ventilation arrangements, insulation and alarm system shall meet the requirements of Part III "Thermal Containers" of the Rules for the Construction of Containers.

**9.1.4** The atmosphere control system inside the thermal containers shall be capable of maintaining the required oxygen concentration in the containers.

**9.1.5** The cooled air supplied to the thermal containers shall be sufficiently dry to avoid ice formation in flexible couplings.

**9.1.6** The thermal containers carried on board ship shall comply with the requirements of Part III "Thermal Containers" of the Rules for the Construction of Containers and the Rules for Technical Supervision of Containers in Service.

Failure to meet these requirements cannot impede classification of the refrigerating plant.

## 10 ATMOSPHERE CONTROL SYSTEM

### 10.1 GENERAL PROVISIONS AND TECHNICAL REQUIREMENTS

**10.1.1** To add a distinguishing mark **CA** (refer to 4.2.2.4, Part I "Classification") to the character of classification of a refrigerating plant at least 50 per cent of the ship's total refrigerated cargo space volume shall meet the requirements for operation with controlled atmosphere.

**10.1.2** Equipment, laying of piping shall meet the requirements of 2.1.1, 2.5, 4.1.1, 5.1.1, 6.2.1, 7.2.1.

**10.1.3** Each refrigerated space served by the atmosphere control system shall be fitted with a safety device, which pressure set point and pressure relieving capacity shall be such that the pressure in the space shall not exceed 0,5 kPa (50 mm water column) and shall not be less than 0,2 kPa (20 mm water column).

**10.1.4** Gas shall be discharged from the safety device through vertical ducts, whose outlets shall be located at least 2 m above the upper deck and within 4 m of the ventilation intakes of accommodation spaces.

**10.1.5** Arrangements shall be provided to ensure that the inert gas cannot be delivered to the depressurized refrigerated spaces.

**10.1.6** The inert gas used in the system shall not be hostile to the cargo carried, insulating and structural materials of the refrigerated spaces.

**10.1.7** Alarm shall be provided to automatically giving audible and visual warning at least 60 s before the inert gas injection takes place.

The alarm shall be interlocked with the inlet valve in such a way that the inlet valve cannot be opened unless the alarm signal has been given.

**10.1.8** The refrigerated spaces with the controlled atmosphere shall be provided with an independent ventilation system with a capacity of at least 2 air changes per hour.

**10.1.9** All spaces leading to the refrigerated spaces with controlled atmosphere and adjacent to them shall have an independent permanent ventilation system giving at least 6 air changes per hour.

**10.1.10** The ventilation system serving the spaces specified in 10.1.8 and 10.1.9 shall be operated from outside the ventilated spaces.

**10.1.11** All other spaces adjacent to the refrigerated spaces, other than those specified in 10.1.9 shall be arranged for ventilation by use of at least two portable ventilators provided on board, each of them being capable to give at least 2 air changes per hour.

**10.1.12** The refrigerated spaces with controlled atmosphere shall be fitted with permanent devices providing O<sub>2</sub> volume content monitoring in the spaces before they are entered.

In addition, at least two portable O<sub>2</sub> analyzers shall be provided on board ship.

**10.1.13** The supply and exhaust ducts of the atmosphere control system shall not pass through the accommodation and service spaces.

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## **11 REFRIGERATING PLANTS DESIGNED FOR COOLING OF LIQUEFIED GAS**

### **11.1 GENERAL**

**11.1.1** The refrigerating plants shall ensure maintenance of temperatures and pressures as may be required for the carriage of liquefied gas in bulk.

**11.1.2** The refrigerating plants shall comply with the requirements of 4.2, Part VI "Systems and

Piping" of the Rules for the Classification and Construction of Gas Carriers, as well as the requirements of the present Part.

**11.1.3** The minimum temperature the refrigerating plant is capable to maintain in the cargo tank shall be indicated in the Classification Certificate for the refrigerating plant.

## 12 TESTS

### 12.1 TESTS AT THE MANUFACTURER'S

**12.1.1** Tests of the refrigerating plant components listed in the present Chapter shall be carried out in the presence of a surveyor to the Register.

**12.1.2** Hydraulic tests for strength of the components working under the refrigerant pressure shall be carried out by a test pressure of not less than 1,5p in accordance with 2.2.1.

Components working under the pressure of secondary refrigerant or water shall be tested by a hydraulic pressure of 1,5 times the working pressure, but not less than 0,4 MPa, whereas box structures shall be tested by a pressure equal to 1,5 times their working pressure.

**12.1.3** Pneumatic leak tests of the components working under the refrigerant pressure shall be carried out at a test pressure of not less than the design pressure assumed according to 2.2.1.

**12.1.4** Equipment designed for operation under pressure of a refrigerant, which is below the atmospheric pressure, shall be subjected to vacuum-tight tests at a residual pressure of not more than 0,8 kPa.

**12.1.5** Valves in assembly and automatic devices provided with shut-off facilities shall be subjected to a leak test by pneumatic pressure equal to the design pressure in accordance with 2.2.1.

**12.1.6** The machinery and equipment specified in 1.3.2 after assembling shall be tested in accordance with the requirements of 1.4, Part IX "Machinery".

### 12.2 TESTING OF REFRIGERATING PLANT ON BOARD

**12.2.1** To verify the fulfilment of the requirements of the present Chapter, the refrigerating plant, after having been completely assembled on board, shall be tested and checked in operation under a programme approved by the Register.

**12.2.2** The entire refrigerant system shall be subjected to pneumatic leak tests at a test pressure equal to the design one in accordance with 2.2.1. Pneumatic tests may be carried out using nitrogen, carbon dioxide or dried air. Upon completion of leak test of the Group II refrigerant system, operation of the refrigerant emergency drain system shall be checked.

**12.2.3** Upon completion of leak test, the Group I refrigerant system shall be tested for tightness by a vacuum test at a residual pressure of not more than 1 kPa.

**12.2.4** After the system has been filled with refrigerant all joints and valves shall be checked for leak.

**12.2.5** All pipes of secondary refrigerant and cooling water systems together with pertaining valves shall be subjected to leak tests under operational conditions.

**12.2.6** The main and emergency ventilation, drainage, water-screen, remote machinery shutdown, safety devices, protective automatic equipment, refrigerant leak gas detection systems shall be checked in operation.

**12.2.7** The refrigerating plant equipment shall be checked in operation under all operational conditions and along with that the fulfilment of the requirements of 2.3 and 7.2.8, the work of the regulating automatic equipment and cooling facilities, defrosting efficiency shall be verified.

**12.2.8** The refrigerating plant shall be tested at full design cooling load and specified refrigerant boiling and condensing temperatures. Where the tests are carried out at low outdoor temperatures, which differ from the specified ones, the simulation of additional cooling load may be required.

**12.2.9** The calculation results of an averaged heat-transfer factor for refrigerated spaces shall be confirmed by insulation quality tests.

### 12.3 TESTING OF REFRIGERATING PLANTS WITH ATMOSPHERE CONTROL

**12.3.1** Air ducts to thermal containers shall be tested for distribution of cooled air by measuring the amount of air supplied to the flexible coupling of the container when the fan is running at full capacity. Air flow (by amount of air) available at each thermal container are not to differ by more than  $\pm 5$  per cent from the design one.

**12.3.2** After cooled air ducts have been completely fitted onboard before installation of insulation, strength tests shall be carried out by air pressure of not less than 1,5 times the design pressure and also leak tests shall be carried out by a working pressure; the above tests may be combined.

## 13 SPARE PARTS

### 13.1 GENERAL

**13.1.1** Each refrigerating plant shall be provided with spare parts carried on board to an extent that is not less than required by the present Section.

**13.1.2** The spare parts shall be secured in accessible positions marked and protected against corrosion in an effective way.

### 13.2 REQUIRED MINIMUM OF SPARE PARTS

**13.2.1** Compressors, pumps and internal combustion engines driving the compressors shall be supplied with spare parts according to the provisions of Section 10, Part VII "Machinery Installations".

Electric motors of compressors, pumps and fans shall be supplied with spare parts according to the provisions of Section 21, Part XI "Electrical Equipment".

**13.2.2** Apart from the requirements of 13.2.1, the refrigerating plants shall be supplied with spare parts in accordance with Table 13.2.2.

Table 13.2.2

Nos	Spare parts	Quantity
1	Compressor piston with connecting rod complete, of each size used	1
2	Shaft seal <sup>1</sup> for compressor of each size used	1
3	Liner of compressor cylinder of each size used	1
4	Blades of rotary compressor of each size used	1 set for 1 compressor
5	Crankshaft bearings of piston compressor or rotor bearings of screw compressor	1 set for each compressor
6	Lubricating oil pump of piston, screw compressor	1
7	Filter elements of each type and size	1
8	Automatic monitoring and protective devices for refrigerating plant of each type	1
9	Fan impeller with shaft for refrigerated spaces and freezing apparatus of each size used	1
10	Control refrigerant expansion valve of each size used	1
11	Assorted cocks, valves of each size used	1
12	Gaskets and packings of each size used	1
13	Thermometers, pressure gauges and vacuum gauges of each size used	1
14	Safety valve springs of each size used	2
15	Leak detector	1
16	Hydrometer (only where the liquid secondary refrigerant is used)	1

<sup>1</sup>To be provided as spare parts are rapidly wearing parts of seals only if it is permitted by the seal design.

## **14 REFRIGERATING PLANTS WITH ABSORPTION LITHIUM BROMIDE REFRIGERATING MACHINES**

### **14.1 GENERAL**

**14.1.1** The requirements of the present Section apply to refrigerating plants with absorption lithium bromide refrigerating machines intended for operation in ship air conditioning systems.

**14.1.2** Refrigerating plants with absorption lithium bromide refrigerating machines shall comply

with the requirements of 1.3.4.2, 1.3.4.5, 1.3.4.7 (for protection systems only), 1.3.4.8, 2.1.2, 3.1.1, 3.1.6, 5.1.1, 7.1.2, 7.2.2, 12.2.6.

**14.1.3** Heating systems of the absorption lithium bromide refrigerating machine units (by water steam or hot water) shall comply with the applicable requirements of Section 18, Part VIII "Systems and Piping".



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