CHINA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

2015

PART FIVE REFRIGERATED CARGO INSTALLATIONS

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 General requirements

1.1.1.1 Ships with refrigerated cargo systems complying with the relevant requirements of Chapters 1 to 3 of this PART may be assigned the following class notations as appropriate:

CRS (× × Hold × ×℃, ××℃ Max. Sea Water)

— For ships fitted with refrigerated cargo installations, this notation is to be added after type notation, and minimum temperature(s) to be maintained by the installation at maximum sea water temperature stated and cargo area covered by the minimum temperature(s) are to be stated;

CF — For refrigerated installations for cargo fruits, this notation is to be added;

QF — For refrigerating plants having a quick-freezing capability for fishing vessels, this notation is to be added.

1.1.1.2 The certification requirements for and the products inspections related to refrigerated cargo systems are to comply with the relevant requirements of Chapter 3 of PART ONE of the Rules.

1.1.2 Refrigerants

1.1.2.1 The provisions of this PART are applicable to the following refrigerants:

R717 Ammonia (NH_3);

R22 Monochlorodifluoromethane ($CHClF_2$);

R134a Tetra fluoro ethane (CH_2F-CF_3).

1.1.2.2 Where other refrigerants are to be used, relevant information is to be submitted for approval.

1.1.2.3 In addition, consideration is to be given to the relevant provisions for the application scope of refrigerants specified by the flag State Administration.

1.1.3 Operating conditions

1.1.3.1 The refrigeration systems are to operate satisfactorily when the ship is under the following conditions:

(1) permanent list up to 15º, and permanent trim up to 5º;

(2) rolling: 22.5º, and pitching: 7.5º.

1.1.3.2 Where the refrigerating units are provided with centralized control or automatic controlling and monitoring systems, the equipment of such systems is to comply with the relevant requirements of Chapter 2 of PART SEVEN of the Rules.

1.1.4 Special cases

1.1.4.1 Any proposed addition to or relaxation of the requirements of this PART in respect to ships engaged on voyages of short duration, to installations of small capacity, or to other special cases is subject to agreement of CCS. In such cases a service limitation may be made to the ship.

1.1.4.2 Cargo chambers are in general not to be refrigerated by the direct expansion pipe grid system when ammonia is used as refrigerant. However, in the case of a ship engaged in restricted service where the total capacity of its refrigerated cargo chambers is less than 500 m^3, a direct expansion ammonia pipe grid system may be adopted.

1.1.5 Plans and documents

1.1.5.1 The following plans and documents are to be submitted for approval. Where necessary, additional plans and documents may be required:

(1) General arrangement of insulated chambers (including neighbouring tanks and holds);

(2) Detailed plans showing the construction of insulation within refrigerated chambers;

(3) Details of insulation of piping and supports;

(4) General arrangement of refrigerating machinery space;

(5) Ventilation details of refrigerating machinery space;

(6) Arrangement of air cooling system;

(7) Arrangements of air cooler defrosting and drainage;

(8) Arrangement of brine grids or refrigerant grids in refrigerated chambers and method of construction;

(9) Piping diagrams of refrigerant, brine and cooling water systems;

(10) Arrangements of drainage and ventilation in refrigerated chambers;

(11) Arrangement of temperature measuring system in refrigerated chambers;
(12) Sectional arrangement and performance data of refrigeration compressors, detailed dimensioned plans of reciprocating compressor crankshafts;
(13) Plans of condensers, air and brine coolers, oil separators, liquid receivers and other pressure vessels;
(14) Schematic diagrams of automatic control, safety and alarm systems (including the specifications, types and functions).
1.1.5.2 The following plans and documents are to be submitted for information:
(1) Specifications for refrigerating plant (including centralized control and monitoring) and for insulation of refrigerated chambers;
(2) Calculations for refrigerating capacity.
Note: Plans and documents of the products which have been approved by CCS need not be resubmitted for approval.

1.1.6 Novel arrangement and construction

1.1.6.1 Where the proposed construction of the refrigerating unit or refrigerated chambers is novel in design or involves the use of unusual material, details are to be submitted for approval, and special tests may be required when necessary.

Section 2 TESTS

1.2.1 Pressure tests

1.2.1.1 Pressure tests after completion of manufacturing
(1) On completion of manufacturing, components and parts exposed to the pressure of the refrigerants are to be subject to strength and leak tests as detailed in Table 1.2.1.1.

Test Pressure **Table 1.2.1.1**

Component or part	Strength test (hydraulic)	Leak test (pneumatic)
Pressure vessels	1.5p	1.0p
Compressors:		
Cylinders	1.5p	1.0p
Crankcase	1.5p	1.0p
Valves and fittings	2.0p	1.0p
Pressure piping, welded fabricated headers, air coolers, etc.	1.5p	1.0p

Notes: ① p is the design pressure, see Table 2.1.4.1.
② The leak test normally requires an air pressure to be applied to the component while submerged in water. Alternative methods for leak test may be considered if practicable.

(2) Components exposed to the pressure of brine or cooling water are to be hydraulically tested to 1.5p, but in no case less than 0.34 MPa.
1.2.1.2 Pressure tests after installation on board ship
(1) For pressure piping welded in place, hydraulic tests of the welds are to be carried out at a test pressure of 1.5p.
(2) For pressure piping welded in place, the hydraulic tests required in 1.2.1.2(1) may be omitted provided non-destructive tests by ultrasonic or radiographic methods are carried out with satisfactory results on the entire circumferential butt welds.
Where ultrasonic tests have been carried out, the manufacturer is to provide the Surveyor with a test report confirming that ultrasonic examination has been carried out and that there were no indications of defects which could be expected to have a prejudicial effect on the service performance of the piping.
(3) After completion of the test required in 1.2.1.2(1) or (2), a leak test is to be carried out at a pressure given in Table 1.2.1.1 of this Section, in the presence of the Surveyor.
1.2.1.3 After tightness testing and before charging with refrigerant and oil, the complete plant is to be dried by a method of evacuation. The plant is to be evacuated until the minimum absolute pressure is reached as far as practicable, which is to be held constant until all water is evaporated. The plant is then to be refilled with air and the same procedure is to be repeated until no water is left in the plant.

1.2.2 Operation tests

1.2.2.1 Preparations for tests
(1) Before the operation test, all thermometers or temperature measuring equipment fitted in the refrigerated chambers or on the refrigerating machinery are to be checked for accuracy, and a statement is to be given to the Surveyor. The Surveyor may require a random test if deemed necessary.

(2) Pressure gauges and other measuring instruments are, before the operation test, also to be checked to the satisfaction of the Surveyor.

1.2.2.2 Air cooler fans are to be tested under working conditions after the air circulating system has been completed. During the test, the static pressure of air outlet, the volume of air circulated per minute, the fan speed and the power consumption are to be recorded. The air circulation arrangements in the chambers are to be checked.

A statement of the results for each chamber is to be handed to the Surveyor on completion of tests.

1.2.2.3 Refrigeration tests

(1) All refrigerating units of the refrigeration system are to be subject to refrigeration tests under working conditions. The refrigeration test is to be carried out for a period of at least 12 h after the chamber temperatures have been lowered to the minimum temperature as required. However, the total time is not to be less than 24 h throughout the test.

In general, the refrigeration test may be carried out with all chambers empty. The hatch covers, access plugs or doors and air refreshing arrangements are to be closed up and liquid sealed traps for scuppers are to be primed with brine.

(2) At the beginning of the refrigeration test, all refrigerating units are to be put into action. After the chamber has been cooled down to the design temperature, the test may be carried on with one of the units out of action in turn in accordance with the requirements of 2.1.3, Chapter 2 of this PART, provided that the minimum required temperature in the chamber is maintained constant throughout the test. During the test, each unit is to operate for about the same time.

(3) Refrigeration systems are to be tested during a period when a reasonable difference between the external and internal temperatures exists.

1.2.2.4 Thermal balance tests

(1) During the refrigeration test of newly designed refrigeration systems, a thermal balance test is to be carried out to the plant in combination with the insulated chambers, so as to determine the minimum chamber temperature as required in the design and the running conditions when the chamber temperature and the capacity of the plant are balanced. The thermal balance test is to be carried out in the presence of the Surveyor.

(2) When the chambers are cooled down to the minimum designed temperature, the thermal balance test is to be commenced after such a temperature has been maintained constant for a stabilizing period during which heat is removed from the insulation etc. The heat balance test is to last for 8 h. During the test, the temperature of the chambers is to be maintained at the minimum designed temperature and is not to be reduced by more than 1℃. The thermal test may be evaluated in accordance with the relevant programme or standard accepted by CCS.

On completion of the thermal balance test, a thermal balance calculation is to be carried out and the calculations are to be submitted.

1.2.2.5 Temperature rise test for the refrigerated cargo chambers

With the chambers at the minimum designed temperatures, a test for the capability of insulation is to be carried out. The temperature rises in the chambers are to be logged hourly for a period of 6 h.

The total temperature rise t_G (average value of all measuring points) after 6 h temperature rise test is not to be greater than that obtained from the following formula based on the initial temperature difference between the external and chamber temperatures at the beginning of the temperature rise test:

$$t_G = 0.24 t_F \quad ℃$$

where: t_F — initial temperature difference between the external and chamber temperatures, in ℃.

1.2.2.6 Other tests

(1) The air refreshing arrangements, if fitted, are to be tested under operating conditions.

(2) The automatic monitoring system is to be subjected to operation test. This test is, in general, to be carried out when the refrigerating machinery is in running condition, but the functions of alarm and safety devices may be tested under simulated fault conditions if necessary.

(3) Prior to, or on completion of the refrigeration test, the defrosting arrangements of the air coolers are to be tested as per different methods of defrosting. The drainage of bilge water in refrigerated chambers and defrosting water from air coolers may be carried out in conjunction with the refrigeration test.

CHAPTER 2 REFRIGERATING PLANT

Section 1 GENERAL PROVISIONS

2.1.1 Definition of a unit

2.1.1.1 A refrigerating unit comprises one (or a group of) independent refrigeration compressor(s), its driving motor and one gas condenser. Where a secondary refrigerant of brine is employed, the unit is also to include a brine cooler. It is usual for the compressor and the condenser of the refrigerating plant to be permanently connected to the installation with all necessary piping, fittings and electrical equipment.

Two or more refrigeration compressors driven by a single motor, or having only one condenser or brine cooler, are to be regarded as one unit. Where a refrigerating plant is provided for sub-cooling the liquid refrigerant of other units, but is not arranged for cooling the cargo chambers independently, it will not be regarded as a unit.

2.1.1.2 Refrigerating units for refrigerated cargo installations must be completely independent of any refrigerating machinery associated with air conditioning plant, or any domestic refrigerated installation, unless otherwise approved by CCS.

2.1.2 Number of units

2.1.2.1 In ships intended for the carriage of refrigerated cargo, at least two complete refrigerating units are to be provided.

Where only two refrigerating units are fitted, the working parts are to be interchangeable.

2.1.2.2 In ships classed for restricted service where the total capacity of the refrigerated chambers is less than 1,500 m^3, only one complete refrigerating unit may be provided, but a standby compressor is to be fitted as an addition.

2.1.3 Refrigerating capacity

2.1.3.1 Where a ship is classed for unrestricted service and is intended to carry cargoes requiring different refrigerating temperatures, the refrigerating capacity of the units is to be calculated according to the minimum temperature required to be maintained by the various cargo chambers, with the outside seawater temperature being assumed not less than 32℃.

2.1.3.2 The refrigerating capacity of the refrigerating plant is to be sufficient to maintain the minimum design temperatures in the refrigerated cargo chambers when operating 24 h per day with any one of the refrigerating units out of operation.

2.1.3.3 In order to compensate for possible deterioration of the refrigerating capacity of compressors and the performance of insulation material over the life of the installation, the actual capacity of the refrigerating units is to have at least 5% excess capacity over that required for maximum design output.

2.1.3.4 Where the units are not connected in common to all refrigerated chambers, the refrigerating capacity of the unit serving each chamber (or a group of chambers) is to comply with 2.1.3.2 and 2.1.3.3 of this Section.

2.1.4 Design pressure of refrigerating plant

2.1.4.1 The design pressure of the high pressure side and the low pressure side of the refrigerating plant is to be not less than the values given in Table 2.1.4.1 respectively.

Design Pressure of Refrigerating Plant **Table 2.1.4.1**

Refrigerant	Design pressure of high pressure side① (MPa)	Design pressure of low pressure side② (MPa)
R717	2.2	1.7
R22	2.2	1.7
R134a	1.4	1.1

Notes: ① High pressure side means the pressed parts of the compressor between its exhausting side and expansion valve.

② Low pressure side means the pressed parts from behind the expansion valve to suction valve of the compressor. Where the change-over of the plant (e.g. for defrosting) will put these parts under high pressure, they are to be designed and tested to the specified pressure of high pressure side.

2.1.4.2 Where any other refrigerant is used, the design pressure of high pressure side and low pressure side of the refrigerating plant is to be not less than the saturated vapour pressure at 56℃ and 46℃ respectively.

Section 2 REFRIGERATING MACHINERY

2.2.1 Reciprocating compressors

2.2.1.1 The diameter d of the crankshaft of a reciprocating compressor is not to be less than that determined by the following formula, when all cranks are located between two main bearings:

$$d = C\sqrt[3]{\frac{D^2 p(\frac{S}{16}+\frac{ab}{a+b})Z}{7.55}} \quad \text{mm}$$

where: C — constant, to be determined in accordance with the specific arrangement of cranks and cylinders as shown in Table 2.2.1.1.

D — diameter of compressor cylinder, in mm;

p — design pressure as defined in Table 2.1.4.1 of this Chapter, in MPa;

S — length of piston stroke, in mm;

a — distance between inner edge of one main bearing and the centreline of the crankpin nearest the center of the span, in mm;

$a + b$ — span between inner edges of two main bearings, in mm;

Z — strength coefficient of material, to be determined by the following formula:

For steel:

$$Z=\frac{560}{R_m+160}$$

For spheroidal or nodular graphite cast iron:

$$Z=\frac{700}{R_m+260-0.059d_p}$$

For grey cast iron:

$$Z=\frac{700}{R_m+260-0.069d_p}$$

where: R_m — specified minimum tensile strength of crankshaft material, in N/mm^2;

d_p — proposed minimum diameter of crankshaft, in mm;

Arrangement of Cranks and Cylinders **Table 2.2.1.1**

Number of crankpins	Number of cylinders per crank	Angle between adjacent cylinders (°)
1 or 2	2	45 60 90
3	2	45 60
4	2	45 60
1	3	45 60 90
2	3	45 60
3	3	45
1	4	45 60
2	4	45

For shafts having one cylinder per crank:

$$C = 1.0$$

For shafts having several cylinders, with 90° between adjacent cylinders on the same crankpin:

$$C = 1.05$$

For shafts having several cylinders, with 60° between adjacent cylinders on the same crankpin:

$$C = 1.18$$

For shafts having several cylinders, with 45° between adjacent cylinders on the same crankpin:

$$C = 1.25$$

2.2.1.2 Where the shaft is supported additionally by a centre bearing, the diameter is to be evaluated from the half shaft between the inner edges of the centre and outer main bearings. The diameter so found for the half shaft is to be increased by 6% for the full length shaft diameter.

2.2.1.3 The dimensions of crankwebs are to be such that bt^2 is to be not less than given by the following formulae:

For the web adjacent to the main bearing:

$$bt^2 = 0.4d^3$$

For intermediate webs:

$$bt^2 = 0.75d^3$$

where: b — breadth of web, in mm;
t — axial thickness of web which is to be not less than $0.45d$ for the web adjacent to the main bearing, or $0.60d$ for intermediate webs, in mm;
d — minimum diameter of crankshaft as required in 2.2.1.1 of this Section, in mm.

2.2.1.4 Fillets at the junction of crankwebs with crankpins or journals are to be machined to a radius r not less than $0.05d$. Smaller fillets, but of a radius not less than $0.025d$, may be used provided the diameter of the shaft is not less than the product of c and d, where: $c = 1.1 - 2r/d$, but not to be taken as less than 1.0.

2.2.1.5 Fillets and oil holes on the crankshafts are to be rounded to an even contour and smooth finish.

2.2.1.6 The crankcase of a trunk piston type compressor is to be designed to withstand an internal pressure at least equal to the maximum working pressure of the refrigerating system.

2.2.2 Strength of materials for the compressor crankshafts

2.2.2.1 The specified minimum tensile strength of castings and forgings for crankshafts is to be selected within the following limits:
(1) carbon and carbon-manganese steel forgings (normalized and tempered): 400 to 600 N/mm^2;
(2) carbon and carbon-manganese steel forgings (quenched and tempered): not exceeding 700 N/mm^2;
(3) carbon and carbon-manganese steel castings: 400 to 550 N/mm^2;
(4) spheroidal or nodular graphite iron castings: 370 to 800 N/mm^2;
(5) grey iron castings: not less than 300 N/mm^2.
Where it is proposed to use materials other than those listed above, details are to be submitted to for approval.

Section 3 PIPING AND ACCESSORIES

2.3.1 Pressure vessels

2.3.1.1 Welded steel cylindrical pressure vessels for refrigerants R717 and R22 are to be constructed in accordance with the relevant provisions for Class II pressure vessels specified in Chapter 6 of PART THREE of the Rules, and in CCS Rules for Materials and Welding. The design pressure is to comply with the requirements of Table 2.1.4.1 of this Chapter.

2.3.1.2 Where pressure vessel cylinders are made of steel tubes, these are to be seamless, electrical resistance welded or longitudinally submerged arc welded. Forge butt welded and spirally welded tubes are not to be used.

2.3.1.3 All pressure vessels with a design temperature below -40℃ and also vessels with a design temperature below 0℃ where the pressure/saturation temperature relationship does not apply, are to be manufactured from steels with mechanical properties, including notch toughness, suitable for the thickness and the lowest design temperature, and relevant information is to be submitted.

2.3.2 Pressure piping

2.3.2.1 The wall thickness of all steel pressure pipes for the refrigerating plant is to be determined in accordance with the relevant provisions specified in Chapter 2 of PART THREE of the Rules.

2.3.2.2 Pipes for the condensers are to be made of corrosion-resistant material. Pipes for condensers suitable for refrigerants R22 and R134a are to be made of corrosion-resistant copper.
Condenser tube plates are to be made of corrosion-resistant material on the seawater side, or alternatively, means capable of efficiently protecting against corrosion may be used.

2.3.2.3 Materials used for refrigerant, brine or seawater cooling piping and accessories are to be suitable for use with the liquids flowing within the pipes. Copper, brass, bronze and other copper alloy are not to be used for ammonia refrigerant. Magnesium alloy is not to be used for fluorine-substituted hydrocarbon refrigerant, and zinc is not to be used for ammonia and fluorine-substituted hydrocarbon refrigerants.

2.3.2.4 Refrigerant and brine pipes are to be seamless, of which the ammonia and brine pipes are to be of seamless steel.
Pipe fittings for the ammonia unit are to be made of steel, but malleable cast iron may be accepted. Pipe fittings for the fluorine-substituted hydrocarbon unit are to be made of steel or bronze.

2.3.2.5 The joints of steel refrigerant pipes are to be butt welded. Where the piping is galvanized in lengths and then joined by welding, the galvanizing is to be removed in way of the pipe ends before welding. Butt joints of copper pipes are to be brazed. If necessary, a particular length of piping may be connected by means of welded-on flanges having grooves in a raised face and with gaskets fitted between them, or by means of screw joint sleeves.
The gaskets for the pipe joints are to be approved by CCS.

2.3.2.6 The stop valves in the refrigerant piping are to be so constructed and arranged as to ensure safe renewal of the packings in the valve stuffing boxes without removing the refrigerant. The stop valves in the R22 and R134a refrigerant piping are to be constructed without stuffing boxes. If safety valves with soft stuffing boxes are adopted, they are to be provided with sealing glands.

2.3.3 Oil separators

2.3.3.1 Suitable oil separators with drains are to be provided in the refrigerant lines. If wire gauze is used in the separator, it is to be sufficiently robust and supported to prevent disintegration.

2.3.4 Filters

2.3.4.1 Suitable filters are to be provided in the refrigerant gas lines in the following positions:

(1) suction lines to compressors;

(2) liquid lines before expansion valves.

Wire gauze in filters is to be sufficiently robust and well supported to prevent disintegration. The material of wire gauzes is to be corrosion-resistant to refrigerants. The refrigerant piping is to be designed according to the characteristics of refrigerants, and pipelines are to be fitted with suitable means for separating, storing and purifying refrigerants.

2.3.5 Driers

2.3.5.1 Driers are to be fitted in R22 and R134a refrigerant systems and the arrangement is to be such that a drier can be by-passed, isolated and opened up without interrupting plant operations.

2.3.6 Thermometers

2.3.6.1 Thermometers are to be provided in systems of the refrigerating plant in the following positions:

(1) suction and delivery lines to compressors;

(2) inlet and outlet cooling water lines to condensers;

(3) brine inlet and outlet lines;

(4) refrigerant return pipes to air coolers of direct expansion type.

2.3.7 Pressure gauges

2.3.7.1 Pressure gauges are to be provided in systems of the refrigerating plant in the following positions:

(1) suction and delivery lines to compressors;

(2) delivery lines to brine pumps;

(3) all refrigerant return pipes to air coolers;

(4) lubricating oil inlets to compressors with pressure lubrication.

2.3.8 Liquid level indication

2.3.8.1 Refrigerant liquid receivers are to be provided with liquid level indicators. The indicator is to be provided with a valve which is capable of being closed so as to prevent the loss of refrigerant in the event of breakage of the indicator.

2.3.9 Cooling appliances

2.3.9.1 Chambers may be refrigerated by pipe grids on the ceiling, bulkheads and sides or by the circulation of air over air coolers.

2.3.9.2 Except in the case of chambers employing direct expansion pipe grids as specified in 1.1.4.2 of this PART, refrigeration in the chambers is to be effected by the circulation of brine. The brine pipe grids in each chamber are to be arranged in not less than two sections, each section is to be provided with valve(s) or cock(s) for closing. For a refrigerated chamber with a capacity of less than 300 m^3, one section may be permitted.

2.3.9.3 Steel piping used to convey brine or primary refrigerants within the refrigerated cargo chambers, or where embedded in insulation, is to be galvanized externally. Alternative equivalent methods of protecting the piping against corrosion may be accepted.

Brine piping and tanks are not to be galvanized on the brine side. However, if any parts of the brine system have been galvanized, the brine cooling and return tanks, if closed, are to be provided with a ventilating pipe or pipes led to the atmosphere in a location where no damage will arise from the gas discharged, and the ventilating pipes are to be fitted with wire gauze diaphragms which can readily be renewed.

Where the brine tanks are not closed, the compartments in which they are situated are to be efficiently ventilated.

2.3.9.4 Where the steel pipes used to convey primary or secondary refrigerants are connected by butt welds or by screwed couplings, the ungalvanized portion of the joints is to be suitably coated and taped after hydraulic testing to reduce the incidence of corrosion. The locations of the joints are to be marked on the outside of the insulation.
2.3.9.5 Where cooling pipes pass through watertight bulkheads or decks, the construction of penetrations and packings are to be in accordance with the requirements of 3.1.1.5 of this PART.
2.3.9.6 Either brine or direct expansion of the refrigerant may be employed in the coils of air coolers for each of the chambers. The coils are to be arranged in not less than two sections, each of which is to be fitted with a valve capable of being readily isolated when necessary. The chamber is to be provided with at least one air pipe length and two grids in a certain distance. If the coils are not arranged in sections, at least two independent air coolers of single coil are to be fitted.
A single coil cooler may be provided for a chamber with a net capacity of less than 300 m^3.
2.3.9.7 Means are to be provided for effectively defrosting air coolers. Air coolers are to be provided with trays arranged to collect all condensate. The trays are to be provided with drains at their lowest points to enable the condensate to be drained away when the chambers are in service. The inside diameter of drains is not to be less than 40 mm.
2.3.9.8 Air coolers including fans and motors are to be, as far as practicable, separated from the refrigerated spaces loaded with cargo, and adequate space is to be provided such that both the fan and the motor may be readily removed for repair or renewal. Access for servicing only is required where several fans and motors are installed in a chamber.
2.3.9.9 In order to minimize the dehydration of the cargo and the frosting of the cooling appliances in the refrigerated cargo chambers, the plant is to be designed to maintain the required minimum temperature with a minimum of difference between the cooling medium and chamber temperatures.

2.3.10 Heating arrangements
2.3.10.1 Where it is intended to carry fruit cargoes which may be adversely affected by ambient temperatures which may be below the carrying temperatures, facilities for heating the cargo chambers are to be provided.

2.3.11 Air refreshing arrangements in cargo chambers
2.3.11.1 Where chambers are intended for the carriage of refrigerated cargoes requiring controlled ventilation, air refreshing means are to be provided. The positions of the air inlets are to be carefully selected to minimize the possibility of contaminated air entering the chambers. A distance of at least 3 m is to be maintained between inlet and exhaust vents so as to prevent them from being choked.
Chambers or spaces are to be provided with separate inlet and discharge vents. Each vent is to have a positive airtight valve capable of closing onto a seat.

2.3.12 Pumps
2.3.12.1 The refrigerating units are to be provided with at least two separate cooling water pumps, one of which may be a standby pump. This pump may be used for other purposes provided that it is of adequate capacity and its use on other services does not interfere with the supply of cooling water to the units.
2.3.12.2 Where the primary and/or secondary refrigerants are circulated in the system by pumps, a standby pump, which is not to be used for other purposes and capable of operating on all cargo chambers, is to be provided.

2.3.13 Sea connections
2.3.13.1 The refrigerant gas condenser cooling pump is to be supplied by two sea valves, one of which is provided on the port and the other on the starboard side.

2.3.14 Motive power
2.3.14.1 Where the refrigerating plant is electrically driven, the electrical power is to be supplied by at least two generators. Where any one of the generators is out of operation, the ratings of remaining generators are to be sufficient to maintain, at the seawater temperature specified in 2.1.3.1 of this Chapter, the required minimum temperatures specified in 2.1.3.2 or 2.1.3.3 of this Chapter for the refrigerated cargo chambers, and to ensure the simultaneous operation of other services essential for the propulsion and safety of the ship.

Section 4 CONTROL, ALARM AND SAFETY SYSTEMS

2.4.1 Automatic control for refrigerating plant

2.4.1.1 Where refrigerating plants are operated automatically, efficient manual controls are also to be provided so that manual control can be effected in the event of failure of the automatic control. The automatic control for the plant is to comply with the provisions set forth in 2.4.1.2 to 2.4.1.4 below.
2.4.1.2 The basic performances of all equipment in the refrigerating plant automatic control systems are to comply with the relevant requirements of Chapter 2 of PART SEVEN of the Rules.
2.4.1.3 The refrigerating plant automatic control system is to cover the following:
(1) the control of the temperature in the refrigerated cargo chambers within the predetermined temperature limits;
(2) the control of the temperature of cooling air at the outlet not less than the minimum permissible temperatures when the chamber is air-cooled.
2.4.1.4 When the automatic thermostatic control mentioned in 2.4.1.3(1) above is changed over to manual control, the arrangement is to be such that thermostatic controls can be bypassed and isolated. As an alternative, duplicate thermostatically operated refrigerant control valves may be fitted, each valve is to be capable of the required duty and operable with the other out of action.

2.4.2 Alarm

2.4.2.1 The items of monitoring and alarms are not to be less than hose given in Table 2.4.2.1. Audible and visual fault alarms for the refrigerating plant are to be given at the appropriate control station or room.

Items of Monitoring and Alarms for the Refrigerating Plant Table 2.4.2.1

No.	Item	Display	Alarm
1	Air temperature in the refrigerated cargo chambers	Temperature	High and low
2	Failure of air cooler fans	−	Failure
3	Bilge water level in the refrigerated cargo chambers	−	High
4	Condenser cooling water outlet temperature	Temperature	High
5	Compressor shutdown in the event of failure	−	Shutdown
6	Lubricating oil pressure of compressors	Pressure	Low
7	Suction pressure of compressors	Pressure	Low
8	Exhaust pressure of compressors	Pressure	High
9	Failure of seawater circulating pumps	−	Failure
10	Ammonia leakage in refrigerating machinery spaces	−	Leakage
11	Brine cooler inlet and outlet	Temperature	High (outlet)
12	Failure of brine circulating pumps	−	Failure
13	Brine return tank level	−	Low

Note: Where the refrigerating machinery space is unattended, the fault alarms are to be relayed to the engineers' accommodation or other location where an engineer on duty stays.

2.4.3 Safety

2.4.3.1 The refrigerating plant is to be provided with safety systems to automatically shut down the compressors in the following events:
(1) excessively low pressure at the suction side of compressors;
(2) excessively high pressure at the delivery side of compressors and excessively high pressure in condensers;
(3) excessively low lubricating oil pressure in compressors;
(4) before gas concentration attaining to the minimum limit of explosion in the event of ammonia leakage in the refrigerating machinery space;
(5) failure of seawater circulating pumps.

Section 5 LOCATION OF REFRIGERATING MACHINERY SPACE OR UNIT

2.5.1 Refrigerating machinery spaces

2.5.1.1 Where R717 is used as the refrigerant, the machinery compartment is to be isolated by gastight bulkheads and decks from any adjacent accommodation or working spaces. The compartment is to have doors capable of being opened outwards and self-closed.

2.5.1.2 Machinery using R22 and R134a refrigerants will not, in general, be subject to restriction on location. Where relatively large plants are adopted, they are to be installed in a separate compartment.
2.5.1.3 In each R717 refrigerating machinery space at least two gas masks with canisters are to be provided near the entrance to that space and are to be kept in a box with glass window for immediate use when necessary.
2.5.1.4 The arrangements of the refrigerating machinery are to be such that all components are to be easily accessible for inspection or overhaul. Sufficient space is to be provided for cleaning and renewal of the tubes in brine coolers and condensers.

2.5.2 Ventilation
2.5.2.1 Any refrigerating machinery space is to be provided with an efficient mechanical ventilation system. The ventilation is to provide at least 30 air changes per hour in the refrigerating machinery space. The R717 refrigerating machinery space is to be provided with a ventilation system separated from other ventilation systems.
2.5.2.2 The suction ducts of the ventilation systems are to be constructed of steel or other equivalent material, and the exhaust ports of the ventilation systems are to be located in positions where no danger will arise. In the case of R22 or R134a refrigerating machinery spaces, power exhaust ventilation systems are to be fitted with the suction inlets located at the lowest part of such spaces.
2.5.2.3 The R717 refrigerating machinery space is to be provided with an emergency ventilation system, and the capacity of which is to provide at least 40 air changes per hour. If the capacity of the normal ventilation system in the refrigerating machinery space is increased to an amount of not less than 40 air changes per hour for that space, the emergency ventilation system may be dispensed with.
2.5.2.4 Where the R717 refrigerating machinery space is provided with an emergency water-spraying system capable of being operated from a position outside such space, the emergency ventilation system may be dispensed with.
2.5.2.5 The mechanical ventilation for the refrigerating machinery space is to be capable of being controlled from two positions, and one of which is to be situated in a suitable position outside such space.

2.5.3 Use of ammonia as a refrigerant
2.5.3.1 Ammonia refrigerating machinery is to be installed in dedicated gastight compartments. Except for small compartments, at least two access doors are to be provided.
2.5.3.2 Compartments containing ammonia machinery (including process vessels) are to be fitted with:
(1) a negative ventilation system independent of ventilation systems serving other ship spaces and having a capacity of not less than 30 changes per hour based upon the total volume of the space; other suitable arrangements may be considered;
(2) a fixed ammonia detector system with alarms inside and outside the compartment;
(3) water screens above all access doors, operable manually from outside the compartment;
(4) an independent bilge system.
2.5.3.3 At least two sets of breathing apparatus and protective clothing are to be available.
2.5.3.4 Ammonia piping is not to pass through accommodation spaces.
2.5.3.5 In case of ammonia plants of fishing vessels under 55 m in length or other ammonia plants with a quantity of ammonia not greater than 25 kg, the plants are permitted to be located in the machinery space, provided that:
(1) the area where the ammonia machinery is installed is served by a hood with a negative ventilation system, so as not to permit any leakage of ammonia from dissipating into other areas in the space;
(2) a water spray system is provided for the said area;
(3) the requirements in 2.5.3.2(2), 2.5.3.3 and 2.5.3.4 above are met.

Section 6 SAFETY DEVICES

2.6.1 Relief valves and safety valves
2.6.1.1 A pressure relief valve and/or safety disc is to be fitted between each compressor and its gas delivery stop valve. The safety devices are to come into action in case of excessive refrigerant pressure, the discharge being led to the suction side of the compressor. No closing appliances are to be permitted in the backflow pipes.
2.6.1.2 The opening pressure or bursting pressure of relief valves and/or safety discs at the delivery side of compressors is to be not greater than the design pressure of high pressure side given in Table 2.1.4.1, according to different refrigerants.

2.6.1.3 Where the power of the compressor prime mover does not exceed 10 kW, the relief valves and/or safety discs at the delivery side of the compressors may be omitted.

2.6.1.4 All pressure vessels or other components of refrigerant systems which could become filled with liquid refrigerant and isolated are to be provided with safety discs and relief valves in series, the discharge being led to a safe place above deck. Pressure gauges showing intermediate pressure are to be fitted between the safety discs and relief valves in series.

2.6.1.5 In the fluorine-substituted hydrocarbon systems, the safety valves and safety discs may be substituted by fusible plugs having a fusion point of 65℃, provided that the individual capacity of the above-mentioned pressure vessels is less than 100 *l*.

2.6.1.6 The opening pressure or bursting pressure of relief valves and/or safety discs as required in 2.6.1.4 is to be not greater than the design pressure of the system or components given in Table 2.1.4.1.

2.6.1.7 Suitable safety valves are to be provided to the cooling water side of condensers and the brine side of evaporators where the discharge pressure from any cooling water pump or brine circulating pump in the circuit could exceed the design pressure of the piping or any component forming part of the cooling system.

2.6.2 Emergency drainage

2.6.2.1 The R717 systems are to be provided with emergency drain pipes so as to immediately drain off the ammonia overboard in case of accident. Stop valves fitted in such pipes are to be situated outside the refrigerating machinery spaces and to be placed in a sealed box with glass window. The outlets of the drain pipes at the ship's side are to be placed below the light ballast waterline, and are to be provided with non-return valves.

2.6.3 Emergency stopping devices

2.6.3.1 For a refrigerating plant using R717 refrigerant, the prime mover of the compressors is to be provided with an emergency stopping device which is to be situated outside the refrigerating machinery space, and provision is to be made for preventing the inadvertent touching by unauthorized persons.

2.6.4 Alarm buttons in the refrigerated cargo chambers

2.6.4.1 Alarm buttons are to be fitted in the refrigerated cargo holds/chambers for giving alarms to the refrigerating machinery space, engine room and navigation bridge in case of emergency.

CHAPTER 3 REFRIGERATED CARGO HOLDS/CHAMBERS

Section 1 DESIGN OF CARGO HOLDS/CHAMBERS

3.1.1 Airtightness of holds/chambers

3.1.1.1 Each individual hold/chamber is to be of steel construction throughout and hose-tested for tightness, or alternatively, air pressure test may be accepted.

Special consideration will be given to the construction of divisional bulkheads of materials other than steel, between refrigerated cargo holds/chambers, where the holds/chambers concerned are intended for cargo which will not taint or otherwise adversely affect the cargo in any other hold/chamber.

3.1.1.2 Hatch closing appliances, access doors, bilge and manhole plugs are to be made airtight. Where hatch covers or plugs are exposed to ambient conditions, they are to be provided with a double seal.

3.1.1.3 Air ducts and insulation linings are to be so constructed and fitted that moving air is prevented from entering the insulation. Special care is to be taken where cooling pipes, air refreshing ducts, fan supports, etc. protrude through the lining.

3.1.1.4 Refrigeration pipes passing through bulkheads or decks of refrigerated cargo holds/chambers are not to be in direct contact with the steelwork, and the holes through which they pass are to be true and of suitable finish for effectively sealing by the method intended so as to maintain the airtightness of the bulkheads or decks.

The temperature of ship’s steelwork close to low temperature refrigeration piping is not to be lower than that acceptable for the steel grade.

3.1.1.5 Where cooling pipes pass through watertight deck plating and bulkheads, the fittings and packing of the glands are to be both fire resisting and watertight. Refrigerating pipelines are to be effectively insulated outside the chambers they serve, except within insulated brine coolers and control rooms.

3.1.2 Air circulation

3.1.2.1 When frozen cargo is carried, provision is to be made for adequate circulation of air between the frozen cargo and all the insulation lining surfaces. When cooled cargo of a type which may generate heat or emit gas is carried, provision is to be made for the adequate circulation of air through all the stacks.

3.1.2.2 For the purpose of providing air passage in the refrigerated cargo holds/chambers, cargo battens fastened to or temporary dunnage added during cargo loading to the exposed vertical or near vertical surfaces of the insulation linings may be used. They are to be arranged to suit the air flow.

3.1.2.3 Adequate air flow is to be maintained between cargo and cooling grids, where fitted.

3.1.3 Galvanizing of fixtures

3.1.3.1 All steel bolts, nuts, hangers, brackets and fixtures which support or secure cooling appliances, insulation, meat rail, etc., are to be galvanized.

3.1.4 Oil-impervious coatings of oil tank tops and bulkheads

3.1.4.1 Before insulating the oil tank tops and bulkheads, successive coatings impervious to oil are to be applied. The total thickness of the coating required is to depend on the construction of the tank and the composition of the coating used.

3.1.5 Liquid-tightness

3.1.5.1 Tank top insulation in way of manholes and bilge hats is to be provided with a liquid-tight steel coaming to prevent seepage into the insulation.

Section 2 ACCESSORIES

3.2.1 Temperature measurement instruments in cargo holds/chambers

3.2.1.1 Each refrigerated cargo hold/chamber is to be provided with a suitable number of thermometers, and the exact number and positions of which are subject to approval.

The inside diameter of thermometer tubes is not to be less than 50 mm, and the tubes are not to be in contact with cold decks. Thermometer tubes with their flanges and covers are to be insulated from the deck plating.

Thermometer tubes are to be so arranged on weather decks that water will not run down the tubes when temperatures are being taken.

Where thermometer tubes pass through compartments other than those which they serve, they are to be efficiently insulated.
3.2.1.2 Where electrical remote reading thermometers are adopted for the refrigerated cargo chambers, they are to be fitted in accordance with the relevant requirements in 3.2.2 of this PART. Such thermometers are also to comply with the relevant requirements specified in Chapters 1 and 2 of PART SEVEN of the Rules.
3.2.1.3 Where the hold/chamber is intended for the carriage of frozen cargo only, the temperature readings are to be accurate to within ±0.5℃ of the true temperature. Where the hold/chamber is intended for the carriage of fruit, the readings are to be accurate to within +0.2℃ to -0.1℃ of the true temperature in the range -3℃ to +3℃, and to +0.3℃ to -0.2℃ in other parts of the range.
For scale instruments, the scale deflection is to be not less than 5 mm/℃ with division markings enabling the indication to be estimated within 0.1 of a degree.

3.2.2 Installation requirements for remote reading temperature instruments
3.2.2.1 At least two instruments are to be provided for each refrigerating system, with the sensing elements so connected that in the event of a failure of any one instrument, at least one sensing element will be operative for each hold/chamber either in the hold/chamber or in its air circulating system.
Where a data logger is installed and all the sensing elements are connected to this single instrument, at least one sensing element in each hold/chamber or in its circulating air system is to be connected to a separate instrument.
The display of data loggers is to be in digital form or other equally effective visual indication, registering to 0.1 of a degree.
Where the equipment controlling the temperature of the air delivered from the cooler is equipped with a temperature indicator, this indicator will be given consideration as a standby instrument provided that the readings are accurate to within ±0.5℃ of the true temperature.
3.2.2.2 Where galvanometers are fitted, two are to be provided for each indicating instrument and a checking resistance is to be fitted.
3.2.2.3 Where the instruments have individual power supply units, a spare power unit (e.g. transformer and rectifier or battery) is to be provided for each instrument.

3.2.3 CO_2 indication equipment
3.2.3.1 All holds/chambers designed for carriage of fruit in general are to be fitted with permanently installed equipment for indication of CO_2 content.

3.2.4 Sounding, air and drain pipes
3.2.4.1 All sounding pipes, whether for compartments or tanks, which pass through refrigerated spaces or the insulation thereof, in which the temperatures contemplated are 0℃ or below, are to be not less than 65 mm bore.
3.2.4.2 Sounding pipes to oil compartments are not to terminate within refrigerated cargo holds/chambers or in the fan and cooler rooms for these holds/chambers, nor are these pipes to terminate in enclosed spaces from which access is provided to refrigerated cargo holds/chambers or their fan and cooler rooms.

3.2.5 Drainage from refrigerated cargo spaces
3.2.5.1 Provision is to be made for the continuous drainage of the inside of all insulated holds/chambers and cooler trays.
3.2.5.2 Drains which are led from lower holds/chambers and cooler trays situated on the tank top are to be fitted with liquid sealed non-return bilge traps. Drains from 'tween decks and from cooler trays which are situated well above the tank top are also to be fitted with liquid sealed traps, but the non-return valves may be omitted if desired.
3.2.5.3 Where drains from separate holds/chambers join a common main, the branch pipes are each to be provided with a liquid sealed trap.
3.2.5.4 The liquid sealed traps are to be of adequate depth, and arrangements are to be made for ready access to the traps for cleaning and refilling with brine.
3.2.5.5 Screwed plugs or other means for blanking off scuppers draining insulated holds/chambers and cooler trays are not to be fitted. If, however, it is specially desired to provide means for temporarily closing these scuppers, they may be fitted with shut-off valves controlled from readily accessible positions on a deck above the load waterline.
3.2.5.6 Drainage from compartments outside the insulated holds/chambers is not permitted to be led into the bilge of the latter.

Section 3 INSULATION

3.3.1 General requirements

3.3.1.1 All steel bulkheads and shell plating inside the refrigerated cargo holds/chambers are to be covered with insulation material. Metallic lining or other equivalents are to be fitted for the protection of the outer surface of the insulants. Such linings are to be constructed and fitted in accordance with 3.1.1.3 of this Chapter.

3.3.1.2 Insulation linings and air screens, together with supports, are to be strong enough to withstand the loads imposed by either refrigerated or general cargo.

3.3.2 Insulation material

3.3.2.1 The insulants, linings, sealants and paints are not to emit odours which may taint subsequent cargo.

3.3.2.2 The insulants used for the refrigerated cargo holds/chambers are to be of low flame spread. The materials used and their adhesives are to be subject to approval by CCS.

3.3.3 Fitting of insulation material

3.3.3.1 Steelwork is to be thoroughly cleaned and dried, and suitably coated against corrosion before insulation is applied.

3.3.3.2 The insulation is to be efficiently packed and, where it is of slab form, the joints are to be butted closely together and staggered. Unavoidable crevices are to be filled with insulating material, but bitumen is not to be used for filling crevices.

3.3.3.3 If the cargo to be loaded on to tank top insulation could cause damage to the lining, then additional protection is to be provided in way of the hatch and 0.6 m beyond. The protection may either be of a permanent or temporary nature.

3.3.4 Insulated plugs and panels

3.3.4.1 Insulated removable plugs are to be provided in the insulation where required for easy access to the bilge, bilge suction wells, cooler and chamber drains and tank manhole lids.

Insulated removable panels are to be provided for access to tank air and sounding pipes and drains.

3.3.4.2 Insulation linings, bilge limbers and plugs, hatch covers and plugs and chamber access doors are to be made of water-vapour resisting material, or covered with such material and, where exposed to bilge or external conditions, they are to be sealed.

3.3.5 Insulation of pipes

3.3.5.1 Where the pipes, including scupper pipes, air pipes and sounding pipes, pass through refrigerated holds/chambers intended for temperatures of 0℃ or below, they are to be insulated from the steel structure, except in positions where the temperature of the structure is mainly controlled by the external temperature and will normally be above freezing point. Pipes passing through a deck plate within the ship side insulation, where the deck is fully insulated below and has an insulation ribband on top, are to be attached to the steel deck plating. In the case of pipes adjacent to the shell plating, metallic contact between the pipes and the shell plating or frames is to be avoided in so far as practicable.

The air refreshing pipes described in 2.3.11.1 need not, however, be insulated from the steelwork.

3.3.5.2 All pipes passing through the refrigerated cargo chambers mentioned in 3.3.5.1 above are to be well insulated.

CHAPTER 4 CARRIAGE OF REFRIGERATED CONTAINERS IN CARGO HOLDS

Section 1 GENERAL PROVISIONS

4.1.1 Class notation

4.1.1.1 The ships carrying refrigerated containers in cargo holds and complying with the requirements of this Chapter may be assigned the following class notation:

CRC (×× holds), AC f/WC

where: AC — air-cooled refrigerated containers;

f — the simultaneity factor for the refrigerating plant, refer to 4.3.2.3 of this Chapter;

WC — water-cooled refrigerated containers.

4.1.2 Plans and documents

4.1.2.1 The following plans and documents are to be submitted for approval:

(1) Calculations of hold ventilation;
(2) Arrangement of hold ventilation system;
(3) Arrangement of power sockets of refrigerated containers;
(4) Arrangement of hold temperature measuring and monitoring system (where fitted);
(5) Arrangement of refrigerated containers;
(6) Arrangement of safety passageway for personnel.

Section 2 ARRANGEMENT

4.2.1 General requirements

4.2.1.1 A passageway or platform for operators with a width of not less than 2 frames or 1 m, whichever is less, is to be provided on transverse bulkheads at a position corresponding to the height of each tier of containers. Handrail or portable rail is to be fitted at the outside of the passageway for the safety of operators.

4.2.1.2 Where torsion boxes are used as ventilation duct, the size of openings on longitudinal bulkheads is to be minimized as possible so as not to affect the overall longitudinal strength.

4.2.1.3 The deck of the passageway or platform for operators is to be of coarse lattice construction as possible to facilitate air flow.

4.2.2 Arrangement of ventilating equipment

4.2.2.1 In general, the supply fan and air inlet are to be arranged at the fore end of holds and the discharge fan and air outlet at the aft end.

4.2.2.2 The air inlet and outlet on deck are to be located as far apart from each other as is practicable. The height of ventilator coaming above deck is to comply with the relevant requirements of Load Line Convention. Where the ventilator is fitted in the masthouse, openings of a size sufficient for ventilation on both fore and aft end bulkheads are to be considered. Roller blinds are to be fitted on the openings to protect the masthouse from flooding. Suitable drainage means in the masthouse are to be considered for preventing water accumulation.

4.2.2.3 Supply fans or discharge fans may be arranged in holds if necessary.

4.2.2.4 Ventilation ducts are to be arranged as reasonably and uniformly as possible. Air supply ducts are to be extended to the refrigerating units of containers of the lowest tier or the bottom of hold as possible, and air vents are to be provided at each tier of stowed containers as possible. The air vents are to be directly facing the discharge fans of container condensers. The upper and lower air vents are to be spaced according to the general container size. Where stowage of superhigh containers is not specified, the spacing is to be determined according to the standard container size, i.e. approximately 2.5 m.

4.2.2.5 The ventilation duct and air inlet and outlet within a hold are to be evenly arranged as possible so that all spaces of the hold are well ventilated.

4.2.2.6 The ventilating equipment is to be capable of being switched on or off remotely from the bridge where it is to be clearly indicated whether the equipment is switched on or off.

4.2.3 Arrangement of refrigerated containers in hold

4.2.3.1 The distance between the containers and the longitudinal bulkhead is in general not to be less than 250 mm.

4.2.3.2 In case of mixed stacks of refrigerated and non-refrigerated containers, the refrigerated containers are to be stowed at the lower tiers and at both ends of the transverse bulkhead as possible. The refrigerating units of containers are to face the transverse bulkhead.

Section 3 VENTILATION WITHIN HOLDS

4.3.1 General requirements

4.3.1.1 This Section applies to cargo holds carrying refrigerated containers. In addition to the requirements of this Section, the corresponding requirements in this PART are to be complied with.
4.3.1.2 The ventilation of holds carrying refrigerated containers is to be determined mainly according to size, type, number of containers, type of refrigerated cargo to be carried and service area of the ship.
4.3.1.3 The design of ventilation is to comply with the following criteria:
External environment: Air temperature 35℃, relative humidity 70%, seawater temperature 32℃
Temperature in hold: Maximum permissible temperature 45℃.

4.3.2 Air supply required for holds carrying air-cooled refrigerated containers

4.3.2.1 Heat balance calculations are to comply with the following:
(1) The minimum power required for cooling of each refrigerated container:

20 ft 7.5 kW
40 ft 11.0 kW

(2) The effective power loss of supply fan is also to be taken into account.
4.3.2.2 For air supply required in each refrigerated container, the following values are applicable:

20 ft 3,100 m^3/h
40 ft 4,500 m^3/h

4.3.2.3 In general, the simultaneity factor for the refrigerating plant is to be taken as 1. Where the ventilation system of the hold is specially designed for refrigerated containers carrying sharp frozen products, the simultaneity factor may be taken as 0.7 ~ 0.8.

4.3.3 Air supply required for holds carrying water-cooled refrigerated containers

4.3.3.1 Heat balance calculations are to comply with the following:
(1) The minimum power required for cooling of each refrigerated container:

20 ft 1.5 kW
40 ft 2.1 kW

(2) The effective power loss of supply fan is also to be taken into account.
4.3.3.2 For air supply required in each refrigerated container, the following values are applicable:

20 ft 460 m^3/h
40 ft 700 m^3/h

4.3.4 Air inlet and distribution

4.3.4.1 The design of air inlet and distribution is to ensure that refrigerated containers will be effectively cooled under circumstances not related to loading conditions and the occurrence of hot spots is to be avoided. For the design conditions stated in 4.3.2 of this Section, it is recommended that air supply inlets be so arranged and distributed that air flow will directly face the refrigerating units of containers; for the design conditions stated in 4.3.3 of this Section, air supply is to be led into the lowest area in the hold.

4.3.5 Air inlets and outlets on deck

4.3.5.1 The air inlets and outlets of hold ventilation system are to be so arranged as to ensure air supply to refrigerated containers in holds under all weather conditions, and choking of air flow of inlets and outlets is to be avoided.

4.3.6 Bilge arrangement

4.3.6.1 Where the length of the hold carrying refrigerated containers is over 12 m, bilge drainage means are to be arranged both at the fore and aft parts of the hold.

4.3.7 Temperature measuring in holds

4.3.7.1 Temperature measuring devices are to be provided in the holds carrying refrigerated containers, and generally one measuring point each before, after, left of and right of containers above the second tier in each hold.

Section 4 ELECTRICAL INSTALLATIONS

4.4.1 General requirements

4.4.1.1 This Section applies to ships carrying refrigerated box containers in holds and on deck. In addition to the requirements of this Section, the corresponding requirements in PART FOUR of the Rules are to be complied with.

4.4.2 Capacity of power plant

4.4.2.1 Where refrigerated containers are supplied by the main power plant of the ship, the number and capacity of the main generating sets are to be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide normal operational condition of propulsion and safety as well as refrigerated containers.
4.4.2.2 For ships adapted to carry refrigerated containers, the containers may be supplied by a leased temporary power plant on deck. If impracticable, standby generating sets are not necessary for power supply of the containers subject to agreement of CCS.
4.4.2.3 For calculation of the capacity of generating sets, see 2.1.1.4 of Chapter 2, PART FOUR of the Rules.

4.4.3 Power distribution for refrigerated containers

4.4.3.1 The sockets of refrigerated containers are to be supplied by special distribution panel which is to be capable of indicating whether the sockets are live and which feeders are electrically connected.
4.4.3.2 The sockets of several containers may be combined to be supplied by one cable, but the connection line of each socket is to be provided with individual short-circuit and overload protection. The common power cable is to be determined according to the total capacity required and the diversity factor specified in 4.4.3.3 of this Section may be used if necessary.
4.4.3.3 Where no exact data are available, the following values may be used as diversity factor for the circuit of container sockets:

20 and less sockets: 0.8;
20 and more sockets: 0.65.

4.4.3.4 The sockets of refrigerated containers are to comply with the standard acceptable to CCS (see ISO 1496-2), and they are to be so fitted as to enable easy use and maintenance.
4.4.3.5 All socket outlets of refrigerated containers are to be provided with a switch, and be interlocked such that the plug cannot be inserted or withdrawn when the switch is in the ‘on’ position.

4.4.4 Monitoring of refrigerated containers

4.4.4.1 In general, the following conditions of refrigerated containers are to be monitored:
FULL COLD, LOW COLD, NULL, DEFROST, HEAT and NO UNIT, actual temperature of air supply and return, set values, etc. The codes of containers for which alarms are initiated may also be monitored.
4.4.4.2 The information on monitoring is generally to be transmitted to the bridge or management center.
4.4.4.3 The automatic monitoring of refrigerated containers may be replaced by manual inspection where practicable.