Volume 5

OMCS CLASS

Overseas Marine Certification Services

Your Reliable
Classification Society

OMCS CLASS
Overseas Marine Certification Services

REFRIGERATION INSTALLATIONS

VOLUME V

CHAPTER 1: CLASSIFICATION AND SURVEYS OF REFRIGERATED CARGO INSTALLATIONS

CHAPTER 1: CLASSIFICATION AND SURVEYS OF REFRIGERATED CARGO INSTALLATIONS

1.1 GENERAL REQUIREMENTS

1.1.1 Conditions for classification

1.1.1.1 Refrigerated cargo installations which have been surveyed by the Society and found in compliance with the relevant requirements of this PART, will be assigned a class of refrigerated cargo installations as appropriate. The class assigned will be entered in the Register of Ships of the Society.

1.1.1.2 For a ship having her refrigerated cargo installations classed with the Society, when the class of hull (including equipment) and/ or the class of machinery (including electrical installations) is withdrawn, the refrigerated cargo installations thereof are also to be regarded as in a condition unsuitable for classification.

1.1.1.3 For the purpose of maintaining the class, refrigerated cargo installations are to be subjected to the surveys for the maintenance of class as specified in 1.4 and are to be kept in a fit and eflicient condition.

1.1.1.4 Any damage or breakdown which could affect the maintenance of class is to be reported to the Society at the earliest opportunity and application is to be made to the Society for examination.

1. 1. 2 Applications

1.1.2.1 Application for the classification of refrigerated cargo installations is to be made with specified form by the shipbuilder (for new ships) or by the Owner or his agent (for existing ships).

1.2 CHARACTERS OF CLASSIFICATION AND CLASS NOTATIONS

1.2.1 Character of classification

1.2.1.1 Refrigerated cargo installations, when classed with the Society, will be assigned either of the following characters of classification as appropriate:

★ CSR
★ CSR

★CSR indicates that the refrigerated cargo installation has been constructed, installed and tested under the survey of the Society in accordance with this PART and found in good and eflicient condition.
★ CSR indicates that the refrigerated cargo installation has been constructed, installed and tested not under the survey of the Society but it has been examined, surveyed and tested by the Society and found in compliance with the requirements of this PART.

1.2.2 Class notation

1.2.2.1 The refrigerated cargo installation classed with the Society will be assigned the class notations affixed to the character of classification, depending on the performance or service of the installation, e.g. : Quick freezing-This notation will be assigned to refrigerated cargo installations having a quick-freezing capability for fishing vessels.

1.2.2.2 The class of a refrigerated cargo installation generally assigned will be the character of classification followed by a notation of minimum temperature(s) which can be maintained by the installation with the maximum sea water temperature stated, e. g. :xx Holds/Chambers — 22°C , xx Holds/ Chambers 0°C with sea water temperature 32°C .

1.2.2.3 For refrigerated cargo installations aboard container ships with approved refrigerating plant and arrangements to supply refrigerated air ducting to insulated containers, the class notation assigned will additionally specify the maximum number and characteristics of the containers, e.g. : Refrigerating air at — 25°C is supplied to 700 certified insulated containers with an average thermal transmittance per container of 27W/°C and with sea water temperature 32°C max.

1.3 CLASSIFICATION SURVEYS

1.3.1 New installations

1.3.1.1 New refrigerated cargo installations intended for classification are to be constructed and tested in accordance with relevant requirements of this PART, under the survey of the Surveyor.

1.3.1.2 During the construction, the installation, arrangement of the installations is to examined and tested by the Surveyor. The materials, installation, workmanship and tests are to be to the satisfaction of the Surveyor. Any defects or any items not in compliance with this PART or the approved specifications and plans are to be rectified.

1.3.1.3 The materials used for the construction are to be tested in accordance with the relevant provisions of the Rules for Materials and Welding. Materials for which provision is not made in the Rules may be tested in accordance with the technical specifications recognized by the Society.

1.3.1.4 Plans, information and technical documents of refrigerated cargo installations are to be submitted for approval in accordance with relevant requirements as specified in this PART. Additional plans, information and technical documents may be required if considered necessary by the Society.

1.3.1.5 Any subsequent modifications or alterations to the approved plans, information or technical documents are to be resubmitted to the Society for approval.

1.3.1.6 Where refrigerated cargo installations are fitted with remote or automatic controls, the information and specifications of the remote or automatic controls are to be submitted for approval.

1.3.1.7 The principal materials and essential components such as compressors, condensers and oil separators, etc., intended for the refrigerated cargo installations are to be subject to products approval surveys.

1.3.1.8 On completion of the construction, and after being subjected to a refrigeration test and a thermal resistance test of the cargo chambers, the refrigerated cargo installation is to be subjected to a thermal balance test to determine the capability of the installation to perform its maximum duty. For similar type of ships with similar refrigerated cargo installations, subsequent thermal balance test may be waived, provided that the results of refrigeration test and the thermal resistance test of refrigerated holds/ chambers are satisfactory.

1.3.1.9 Where the proposed construction of the refrigerated cargo installations is novel in design or involves the use of unusual material, additional tests may be required by the Society.

1.3.2 Installations constructed not under the survey of the Society

1.3.2.1 When classification is desired for an installation constructed not under the survey of the surveyor, an application is to be made, and plans, information and technical documents as specified in 2.1.5 to be submitted to the Society by the Owner or his agent, in so far as practicable.

1.3.2.2 In addition to the above-mentioned plans, information and technical documents, relevant information and documents for the construction and/ or alteration of the installation as well as certificates and survey reports issued by other classification societies are to be submitted.

1.3.2.3 Examinations and tests are to be made at least to the extent required for the second and subsequent special surveys as specified in 1.6, and when deemed necessary, a thermal balance test may be required.

1.3.2.4 Materials, components, construction, arrangement and performance of the installation are to be in compliance with the relevant requirements of the Rules or the equivalent thereto.

1.3.2.5 The material and thickness of the insulation, the particulars of the frames, beams, stiffeners and other steelwork within the insulation, the air coolers and/or chamber grid piping, the compressors, evaporators and condensers are to be verified in so far as practicable.

1.3.2.6 Where the installation has a valid classification certificate issued by a recognized society, special consideration will be given to the scope of survey of this installation.

1.3.3 Reclassification and conditions for maintenance of class

1.3.3. 1 The provisions for reclassification as detailed in 4.1.1 and the conditions for maintenance of class as detailed in 4.2.1 are also applicable to refrigerated cargo installations.

1.4 SURVEYS FOR MAINTENANCE OF CLASS

1.4.1 General requirements

1.4.1.1 For the purpose of maintenance of class, refrigerated cargo installations are to be surveyed by the Surveyor in accordance with the requirements of this Section.

1.4.2 Annual Surveys

1.4.2.1 Refrigerated cargo installations are to be subject to annual surveys as detailed in 1.5.

1.4.2.2 An annual survey of the refrigerated cargo installation is to be held within three months before or after each anniversary date of completion of classification survey or special survey of the installation.

1.4.3 Special Surveys

1.4.3.1 Refrigerated cargo installations are to be subject to special surveys as detailed in 1.6.

1.4.3.2 Special surveys are to be held at 5-yearly intervals, the first special survey being held 5 years from the date of completion of classification survey of the installation, and thereafter 5 years from the date of the previous special survey.

1.4.3.3 A special survey may be commenced not more than 12 months before its due date. If it is completed more than 3 months before the due date, the date of the next special survey is to start from the completion date of this survey.

1.4.4 Extension

1.4.4.1 Where it is inconvenient for an Owner to submit the installation for a special survey at its due date, the Owner is to provide an opportunity of assessing the technical condition of the installation, and the Society may grant an extension of not more than three months, but the date of the next special survey is

not to be postponed consequently.

1.4.5 Continuous Surveys

1.4.5.1 Upon the application by the Owner, the Society may agree that the special survey of the refrigerated cargo installations be carried out on the continuous survey basis.

1.4.5.2 A continuous survey cycle is not to exceed 5 years. Where the special survey is carried out on the continuous survey basis, the annual survey is normally to be carried out as usual.
When a continuous survey is dealt with, it will be normally required that 1/5 of the special survey items as detailed in 1.6 is surveyed annually, and all the items are to be surveyed in rotation in so far as practicable, to ensure that the interval between consecutive examinations of each item will not normally exceed 5 years. The various items of machinery are to be opened up for examination.

1.4.6 Alteration Surveys

1.4.6. 1 Drawings and particulars of any proposed alterations to a classed refrigerated cargo installation are to be submitted for examination and approval, and the work is to be carried out under the survey of, and to the satisfaction of, the Surveyor.

1.4.7 Repair Surveys

1.4.7.1 Any essential repairs or renewals of components affecting the class of an installation are to be subject to inspection and/ or test by, and to the satisfaction of the Surveyor.

1.5 ANNUAL SURVEYS

1.5.1 General requirements

1.5.1.1 For the interval of annual surveys, see 1.4.2.

1.5.1.2 For the annual survey of classed refrigerated cargo installations, opening up for examination of the machinery or dismantling of the insulation arrangements is not normally required. If any defects or indications of deficiency in the installation affecting the class or the temperature notation assigned are found, the Surveyor may require to open up the suspected items for examination to assure the installation to be in an eflicient working condition.

1.5.1.3 An examination of the refrigerated cargo installation log book or other records is to be made, and any breakdown or malfunction of the installation during the last 12 months is to be noted in the survey reports.

1.5.1.4 Examination of the machinery is to be made under working conditions.

1.5.2 Examination of holds/chambers

1.5.2.1 A superficial inspection of the insulated holds/ chambers is to be carried out, and the condition of insulation linings and fastenings on the sides, bulkheads and deck heads is to be ascertained.

1.5.2.2 The covering on deck, tank top and tunnel top insulation are to be examined.

1.5.2.3 Any indication of dampness or deterioration of the insulation is to be investigated.

1.5.2.4 The condition of air ducting, cooler casings, hatch plugs, patent hatch covers and seals, assess doors and fastenings, bilge and manhole plugs, and air refreshing pipes with their closing appliances, is to be ascertained.

1.5.2.5 Scuppers for chambers and cooler trays are to be examined to ascertain that they are in good working order.

1.5.3 Examination of refrigeration equipment and thermometers

1.5.3.1 Air cooler coils, cooling grids, brine cooler coils and grids, and the shells of shell-and-tube and double-pipe type condensers and evaporators, oil separators, receivers, driers, filters and other pressure vessels, piping and arrangements are to be examined as far as practicable.

1.5.3.2 Any evidence of corrosion of water end covers of shell and-tube and double-pipe type condensers is to be examined.

1.5.3.3 All pressure vessels, including fittings and safety devices, are to be externally examined.

1.5.3.4 If there is evidence of dampness of the insulation covering pressure vessels, their connections and/ or piping, the cause is to be ascertained.

1.5.3.5 Thermometers and apparatus used for measuring the temperature in the holds/chambers, and of the air inlet and outlet ducting are to be examined. A random test for thermometers is to be made to verify their accuracy.

1.5.4 Electrical equipment

1.5.4.1 A general examination is to be made for electrical motors driving refrigerant compressors, pumps and fans, together with their control gear and cables. A random test for insulation resistance relative to

earth is to he made on the cables, switchgear, motors, etc. The installation may be divided for the purpose of this test, and the Surveyor may at his discretion accept the results of testing carried out by competent personnel.

1.5.4.2 A random test is to be made to demonstrate that the automatic controls, safety devices and alarms are in good working order.

1.5.5 Refrigeration tests

1.5.5.1 Refrigeration tests and thermal insulation tests for holds/ chambers are to be made for the refrigerated cargo installations.

1.6 SPECIAL SURVEYS

1.6.1 General requirements

1.6.1.1 For the interval of special surveys, see 1.4.3.

1.6.1.2 Special surveys are to be carried out in accordance with the requirements of annual surveys as specified in 1.5 in addition to the requirements of 1.6.

1.6.2 First special survey after construction

1.6.2.1 Examination of compressors and pumps

a. Each reciprocating compressor is to be opened out. Cylinder bores, pistons, piston rods, connecting rods, crankshafts, valves and seats, glands, relief devices, suction filters and lubricating arrangements are to be examined. Crankcase glands and the lower halves of main bearings need not he exposed provided that the Surveyor is satisfied as to the alignment and wear.
b. Screw-type compressors are to be opened out and examined.
c. Refrigerant condenser cooling water pumps, including standby pump(s) which may be used on other services, are to be opened out and examined.
d. Brine and refrigerant circulating pumps are to be opened out and examined. Special consideration will be given to survey requirements for refrigerant circulating pumps of the hermetically sealed type.

1.6.2.2 Examination of pressure vessels and heat exchangers

a. The water end covers of shell-and-tube and double—pipe type condensers are to be removed for examination of the tubes, tub plates and covers.

b. The shells and connections of shell—and—tube and double-pipe type condensers and evaporators, separators, receivers, driers, filters and other pressure vessels, and the coil terminals of coil-in-casing type condensers and evaporators, are to be examined in so far as practicable.
c. In the case of pressure vessels covered by insulation, any evidence of dampness or deterioration of the insulation which could lead to external corrosion of the vessels or their connections is to be investigated.
d. When in doubt, sufficient insulation is to be stripped from insulated pressure vessels to permit the condition of the vessels to be ascertained. Care is to be taken that in replacement of the insulation, the vapour sealing of the outer covering is made good.

1.6.2.3 Examination of piping and fittings

a. The condition of the insulation of pipes carrying the refrigerant both outside and inside the insulated chambers is to be ascertained in good order, and the pipes, including their connections, are to be under the normal circumstances when in working conditions. Care is to be taken that in replacement of the insulation, the vapour sealing of the outer covering is made good.
b. The condition of all pressure relief valves and/ or safety discs throughout the refrigerating plant is to be ascertained in good order. However, no attempt is to be made to test primary refrigerant pressure relief valves on board ship.
c. Sea connections to refrigerant condenser cooling water pumps are to be opened out on the occasion of the hull and/ or machinery special surveys.

1.6.2.4 Examination of electrical equipment

a. The electrical motors driving refrigerant compressors, pumps and fans, together with their control gear and cables, are to have their insulation resistance relative to earth tested. For the purpose of this test, the installation may be subdivided to any desired extent.
b. All automatic controls and alarms are to be tested.

1.6.2.5 Examination of refrigerated chambers

a. The insulation and air trunking of the holds/chambers overhead and vertical surfaces are to be ascertained in normal conditions. Care is to be taken that in repair the insulation or the ducts are sealed against air blowing into the insulation, or against moisture ingress from refrigerated cell or space atmosphere.
b. The tank top insulation and protection are to be ascertained in normal conditions. Care is to be taken that in repair or in replacement the insulation and the protection are sealed against air blowing into the insulation, or against moisture ingress from refrigerated cell or space atmosphere.
c. Due consideration is to be given to the type of insulation used in the holds/chambers determining the insulation to be repaired or replaced. Where organic foam insulants have been used, including

foamed in-situs or other insulant in slab form, the condition of the insulation may be ascertained by means of test bore holes at the discretion of the Surveyor.

d. Under normal circumstances, the condition of ho1d/ chamber insulation, grounds, etc. , can be ascertained when the special survey of the ship's steel word is being held.
e. Arrangements made for defrosting air coolers, and for draining condensate from trays below coolers, are to be examined to ascertain that they are in a good condition.
f. Any air refreshing arrangements are to be examined.

1.6.3 Second and subsequent special surveys

1.6.3.1 The second and subsequent special surveys are to include the items as specified in 1.6.2.

1.6.3.2 Gas condensers of the shell-and-tube type, and gas evaporators (brine coolers) of the shell-and-tube type in which refrigerant condenser is in the shell, are to have the water or brine end covers removed and the shell pneumatically tested with the refrigerant or air, or a mixture of inert gas and refrigerant, to the pressures as required in Table 3.1.4.1, depending on the different refrigerants used.

1.6.3.3 Gas evaporators (brine coolers) of the shell-and-tube type in which the refrigerant is in “coil-in - casing”, are to have the refrigerant condenser end covers removed and the shell hydraulically tested to 1.5 times the designed pressure, but not less than 0.34 MPa.

1.6.3.4 Heat exchangers used for cooling refrigerant liquid would normally require to be specially examined internally only if leakage is suspected between high and low pressure side. This type of heat exchangers is to be examined and tested at the discretion of the Surveyor according to the design of such equipment.

1.7 LOADING PORT SURVEYS

1.7.1 General requirements

1.7.1.1 At the request of the Owner, the Surveyor may carry out a loading port survey and issue a loading port certificate. The certificate is not in respect of the cargo to be loaded or the manner in which it is to be stowed.

1.7.1.2 Loading port survey is not mandatory for the maintenance of class of refrigerated cargo installations.

1.7.2 Refrigerating installation

1.7.2.1 The refrigerating installation is to be examined under working conditions, and the temperatures in the cargo chambers are to be recorded.

1.7.3 Power supplies

1.7.3.1 A general examination is to be made to the generating plant supplying electric power to the refrigerating machinery to confirm that the plant is in a good and efficient condition.

1.7.4 Cargo holds/chambers

1.7.4.1 The cargo holds/chambers are to be examined in empty state to ascertain that they are clean and free from dour which may adversely affect the cargo to be loaded, that the brine or other refrigerant pipe grids, cooler coils and connections are free from leakage, that cargo battens are in good order, that cargo gratings or tonnage battens are available and that no damage has been sustained to the insulation or its lining.

1.7.4.2 All scuppers, bilge suction draining insulated spaces and liquid seals are to be examined and arc to be in a good and efficient condition.

1.7.5 Ship's loading at more than one port

1.7.5.1 If a ship loads at more than one port, one survey only at the first loading port will be required, provided that all the chambers used for refrigerated cargo during the voyage are examined and that general cargo is not subsequently carried in any of the chambers prior to loading the refrigerated cargo.

1.7.6 Ships engaged on short voyages

1.7.6.1 In the case of ships engaged on short voyages of less than two months duration, a loading port certificate will generally be considered as valid for 2 months, provided that the cargoes carried are of such a nature as not to damage the insulation or appliances in the insulated chambers, nor to affect, by taint or mould, the refrigerated cargoes loaded during that period.

1.7.7 Non-availability of the Surveyor

1.7.7.1 If there is no Surveyor to the Society available at the loading port(s), or if none is obtainable from a port within a reasonable distance, the Society will accept the report of survey held at the loading port by a surveyor appointed by the Society or its agent. Or in any case where there is no Society's agent, the report of a survey held by a reliable surveyor, if available. If no such surveyor is available, a report signed by two competent engineers of the ship will be accepted.

CHAPTER 2: GENERAL PROVISIONS

2.1 GENERAL REQUIREMENTS

2.1.1 Application

2.1.1.1 The provisions of this PART are applicable to the refrigerated cargo installations classed with the Society.

2.1.1.2 In addition, the refrigerated cargo installations are to comply with the requirements as appropriate in 14.6 in TOMO I of the Rules.

2.1.2 Refrigerants

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

R717 Ammonia (NH_3)
R22 Monochlorodifluoromethane ($CHClF_2$)
R134 a Tetra fluoro ethame (CHZF - CFs)

Proposals to use other refrigerants are subject to agreement of the Society.

2.1.3 Operating conditions

2.1.3.1 The refrigerated cargo installations are to operate satisfactorily when the ship is under the following condition:

a. Permanent list up to 15° and permanent trim up to 5°;
b. Rolling: 22.5°, and pitching: 7.5°.

2.1.3.2 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 these regulations.

2.1.4 Special cases

2.1.4.1 Any relaxation proposed to ships engaged on voyages of short duration, to installations of small capacity, or to other special circumstances is subject to agreement of the Society. In such cases a service limitation or other restriction may be made to the ship.

2.1.4.2 Cargo chambers are in general not to be refrigerated by the direct expansion pipe grid system irrespective of the refrigerants used in the refrigerating plant. In the case of a ship with restricted service where the total capacity of this refrigerated cargo chambers is less than 500 m^3, subject to agreement of the Society, a direct expansion ammonia pipe grid system may be adopted; where the total capacity of its refrigerated cargo chambers is less than 1000 m^3, a direct expansion R22 or R134 a pipe grid system may be adopted.

2.1.5 Plans and documents

2.1.5.1 The following plans and documents are to be submitted to the Society for approval. Additional plans and documents may be required if considered necessary by the Society:

a. General arrangement of insulated chambers (including neighbouring tanks and holds) ;
b. Detailed plans showing the construction of insulation within refrigerated chambers;
c. General arrangement of refrigerating machinery mom;
d. Arrangement of air cooling system;
e. Air cooler defrosting arrangements;
f. Arrangement of chamber brine grids or refrigerant grids and method of construction;
g. Circuit diagrams of refrigerant, brine and cooling water;
h. Arrangements of drainage and ventilation in refrigerated chambers;
i. Arrangement of thermometers and/or temperature sensor devices in refrigerated chambers;
j. Sectional arrangement of refrigerant compressors and dimensioned plans of reciprocating compressor crankshafts;
k. Plans of condensers, air and brine coolers, oil separators, liquid receivers and other pressure vessels;
l. Schematic diagrams of self-control, safety and alarm systems (including the specifications, types and functions);
m. List of spare parts.

2.1.5.2 The following plans and documents are to be submitted to the Society for information:

a. Specifications for refrigerating plant (including centralized control and monitoring) and for insulation of refrigerated chambers;
b. Calculations for refrigerating capacity.

Note: Plans and documents of the products which have been approved by the Society need not be resubmitted for approval.

2.1.6 Novel arrangement and construction

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

2.2 TESTS

2.2.1 Pressure tests

2.2.1.1 Pressure tests after completion

a. On completion of manufacturing, components intended for use with a primary refrigerant arc to be subject to strength and leak tests as detailed in Table 2.2.1.1.

Table 2.2.1.1
Test pressure

Components	Strength tests (hydraulic)	Leak test (air)
Pressure vessels	1.5 p	1.0 p
Compressors:		
Cylinders	1.5 p	1.0 p
Crankcase	1.5p	1.0p
Valves and fittings	2.0 p	1.0 p
Pressure piping, welded fabricated	1.5p	1.0 p
Headers, air coolers, ect.		

Note:
①p is the design pressure given in Table 3.1.4.1.
②The leak lest 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.

b. Components for use with brine or cooling water are to be hydraulically tested to 1.5 p but not less than 0.34 MPa.

2.2.1.2 Pressure tests after erection on board ship

a. For pressure piping welded in place, hydraulic tests of the welds am to be carried out at a test pressure of 1.5 p.

b. For pressure piping welded in place, the hydraulic tests required in 2.2.1.2 (a) may be omitted provided non-destructive tests by ultrasonic or radiographic methods am 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.
c. After completion of the test required in2.2.1.2 (a) and (b), a leak test is to be carried out at a pressure given in Table 2.2.1.1, in the presence of the Surveyor.

2.2.1.3 After tightness testing and before charging with refrigerant and oil, the complete plant is to be dried by 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 filled with air and the same procedure is to be repeated until no water is left in the plant.

2.2.2 Operation Test

2.2.2.1 Preparation for tests

a. Before the operation test, all thermometers or equipment for measuring temperatures 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.
b. Pressure gauges and other measuring instruments are, before the operation test, also to be checked to the satisfaction of the Surveyor.

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

2.2.2.3 Refrigeration tests

a. All refrigerating units of the plant 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.

b. 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 3.1.3, provided that the minimum required temperature in the chamber are to be maintained constant throughout the test. During the test, each unit is to operate for about the same time.
c. Where an installation is to be tested during a period when extremely low external temperatures are probable, and a reasonable difference between the external and internal temperatures will not be possible, the case is to be submitted to the Society for special consideration.

2.2.2.4 Thermal balance tests

a. During the refrigeration test of newly designed installations, a thermal balance test is to be carried out to the plant in combination with the insulation 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 under the supervision of the Surveyor.
b. 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 be lasted for 8h. 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°C . The thermal test may be evaluated in accordance with the relevant programme or standard approved by the Society.
   On completion of the thermal balance test, a thermal balance calculation is to be carried out and the calculations are to be submitted to the Society.

2.2.2.5 Temperature rise test for the refrigerated cargo chambers

a. 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 6h.

The total temperature rises (average value of all measuring points) after 6 h temperature rise test are not to be greater than that given in Table 2. 2. 2.5 based on the initial temperature difference between the external and chamber temperatures at the beginning of the temperature rise test.

Table 2.2.2.5
Total temperature rises for refrigerated cargo chambers

Initial difference between the external and chamber temp., °C	60	55	50	45	40	35	30	25	20	15
Total temperature rises in chambers, °C	14.4	13.2	12	10.8	9.6	8.4	7.2	6	4.8	3.6

2.2.2.6 Other tests

a. The air refreshing arrangements, if fitted, are to be tested under operating conditions.
b. 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 function of alarm and safety devices may be tested under simulated fault conditions.
c. 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.

CHAPTER 3: REFRIGERATING PLANT

3.1 GENERAL REQUIREMENTS

3.1.1 Definition of a unit

3.1.1.1 A refrigerating unit comprises one (or a group of) independent refrigerant gas 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 refrigerant gas 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.

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

3.1.2 Number of units

3.1.2.1 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.

3.1.2.2 In ships classed for restricted service where the total capacity of the refrigerated chambers is less than 1500 m^3, only one complete refrigerating unit may be provided, but a stand-by gas compressor is to be fitted as an addition.

3.1.3 Refrigeration to be provided

3.1.3.1 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°C.

3.1.3.2 The refrigeration provided by the refrigerating plant is to be capable of continuously maintaining the minimum temperatures in the refrigerated cargo chambers specified by the design when operating 24 h per day with any one of the refrigerating units out of operation.

3.1.3.3 In order to compensate for deterioration of machinery and insulation over the life of the installation, the actual capacity of the refrigerating plant is to have at least 5% excess capacity over that required for maximum design output.

3.1.3.4 Where the units are not connected in common to all refrigerated chambers, the refrigeration of the unit serving each chamber (or a group of chambers) is to comply with 3.1.3.2 and 3.1.3.3.

3.1.4 Design pressure of refrigerating installations

3.1.4.1 The design pressure for high pressure side and low pressure side of refrigerating installations is to be not less than the value given in Table 3.1.4.1 respectively.

Table 3.1.4.1

Design pressure of refrigerating installations

Refrigerant	Design pressure of high pressure side (MPa)①	Design pressure of low pressure side (MPa)②
R717	2.2	1.7
R22	2.2	1.7
R134a	1.4	1.1

Notes:
1. High pressure side means the pressed part between exhausting side of compressors and expansion valves.
2. Low pressure side means the pressed parts from behind expansion valves to suction valve of compressors. In case where the changeover (e. g. for defrosting) of the installation makes them under high pressure, those parts are to be considered as part of high pressure side.

3.1.4.2 Where the other refrigerant approved by the Society is used, the design pressure of high pressure side and low pressure side of the refrigerating installation are to be not less than the saturated vapour pressure at 56°C and 46 °C respectively.

3.2 REFRIGERATING MACHINERY

3.2.1 Reciprocating compressors

3.2.1.1 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 am 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:
D - diameter of compressor cylinder, in mm;
P - design pressure as defined in Table 3 . 1 .4.1 of this Section, 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:

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

For spheroidal or nodular graphite cast iron:

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

For grey cast iron:

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

Where:

σ_b – specified minimum tensile strength of crankshaft material, in N/mm;

d_p - proposed minimum diameter of crankshaft, in mm;

C - coefficient, to be determined in accordance with the arrangements of cranks and cylinders as shown in Table 3.2.1.1.

For shafts having one cylinder per crank:

c = 1.0

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

c = 1.05

For shafts having several cylinders, with 60between 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

Table 3.2.1.1

Crank and cylinder combinations applicable to the Rules

Number of crankpin	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

3.2.1.2 Where the shaft is supported additionally by a centre bearing, the diameter is to be evaluated born 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.

3.2.1.3 The dimensions of crankwebs are to be such that bt! is to be not less than that 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 0.45 d for the web adjacent to the main bearing, or 0.60 d for intermediate webs, in mm;
d - Minimum diameter of crankshaft as required in 3.2.1.1, in mm.

3.2.1.4 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 not less than 0.025 d, may be used provided the diameter of the shaft is not less than the product of c and d. Where: c-=: 1,1- 2 r/d but not to be taken as less than 1.0.

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

3.2.1.6 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.

3.2.2 Strength of materials for the refrigerant gas compressor crankshafts

3.2.2.1 The specified minimum tensile strength of castings and forgings for crankshafts is to be selected within the following limits:

a. Carbon and carbon-manganese steel forgings (normalized and tempered) : 400 to 600 N/mm
b. Carbon and carbon-manganese steel forgings (quenched and tempered): not exceeding 700 N/mm2 ;
c. Carbon and carbon-manganese steel castings: 400 to 550 N/mm2 ;
d. Spheroidal or nodular graphite iron castings: 370 to 800 N/mm2 ;
e. Grey iron castings: not less than 300 N/mm2.

Where it is proposed to use materials other than those listed above, details are to be submitted to the Society for approval.

3.3 PIPING AND ACCESSORIES

3.3.1 Pressure vessels

3.3.1.1 Welded cylindrical pressure vessels for refrigerant, R717 and R22 which are of steel construction are to be constructed in accordance with the relevant provisions for Class II pressure vessels specified in Chapter 6 of TOMO III of the rules, and in the Rules for Materials and Welding. The design pressure is to comply with the requirements of Table 3.1.4.1.
The specified tensile strength of the steel plates used for the construction of pressure vessels is not to exceed 430 N/mm2.

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

3.3.1.3 All pressure vessels with a design temperature below - 40°C and also vessels with a design temperature below 0°C 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. Details of the proposed specifications for these steels are to be submitted for approval.

3.3.2 Pressure piping

3.3.2.1 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 TOMO III of the rules.

3.3.2.2 Pipes for the gas 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 alloy.
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 for substitution.

3.3.2.3 Materials used for refrigerant, brine or sea water cooling piping and accessories are to be appropriate to 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 refrigerants, and zinc is not to be used for ammonia and fluorine-substituted hydrocarbon refrigerants.

3.3.2.4 Refrigerant and brine pipes are to be of seamless, in 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 fitting for the fluorine-substituted hydrocarbon unit are to be made of steel or bronze.

3.3.2.5 The joints of steel refrigerant pipes are to be butt welded. Where the piping is galvanized in lengths and then jointed 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 pipes 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 the Society.

3.3.2.6 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.

3.3.3 Oil separators

3.3.3.1 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.

3.3.4 Filters

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

a. Suction lines to compressors;
b. Liquid lines to regulators.

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. A filter may be combined with the oil separator.

3.3.5 Driers

3.3.5.1 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.

3.3.6 Thermometers

3.3.6.1 Thermometers are to be provided in the refrigerating systems in the following positions:

a. Suction and delivery lines to gas compressors;
b. Inlet and outlet cooling water lines to condensers;
c. Inlet and outlet brine lines;
d. Refrigerant return pipes to air coolers of direct expansion type.

3.3.7 Pressure gauge

3.3.7.1 Pressure gauges am to be provided in the refrigerating systems in the following positions:

a. Suction and delivery lines to gas compressors;
b. Delivery lines to brine pumps;
c. All refrigerant return pipes to air coolers ;
d. Lubricating oil inlets to gas compressors with pressure lubrication.

3.3.8 Liquid level indication

3.3.8.1 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.

3.3.9 Cooling appliances

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

3.3.9.2 Except in the case of chambers employing direct expansion pipe grids as specified in 2.1.4.2, 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 subject to agreement of the Society.

3.3.9.3 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 methods of protecting the piping against corrosion may be accepted subject to agreement of the Society.
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, am 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 am 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.

3.3.9.4 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.

3.3.9.5 Where cooling pipes pass through watertight bulkheads or decks, the construction of penetrations and packings are to be in accordance with the requirements of 4.1.1.5.

3.3.9.6 Either brine or direct expansion of the refrigerant may be employed in the coils of air coolers for each of the chamber. 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 for substitution.
Subject to agreement of the Society, a single coil cooler may be provided for a chamber with a capacity of less than 300 m^3.

3.3.9.7 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 the bottom so that whole of the condensate can be drained away when the chambers are in service. The inside diameter of drams is not to be less than 40 mm.

3.3.9.8 Air coolers including fans and motors are to be, as far as practicable, separated from the refrigerated chambers. If the air coolers are situated in the refrigerated cargo chambers, access arrangements are to be such that both the fan and the motor may be readily removed for repair or renewal when the chamber is loaded with refrigerated cargo. Access for servicing only is required where several fans and motors are installed in a chamber.

3.3.9.9 In order to minimize the dehydration of the cargo and the frosting of the cooling appliances in the refrigerated cargo chambers, it is recommended that the installation be designed to maintain the required minimum temperature under the minimum temperature difference between the cooling medium and the chamber.

3.3.10 Heating arrangements

3.3.10.1 Where it is intended to carry fruit cargoes which may be adversely affected by low temperatures into areas where the ambient temperature may be below the carrying temperature, facilities for heating the chambers are to be provided.

3.3.11 Air refreshing arrangements in cargo chambers

3.3.11.1 Where chambers are intended for the carriage of refrigerated cargoes requiring controlled ventilation, air refreshing appliances 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.
Each individual chamber is to be provided with its own separate inlet and discharge vent. Each vent is to have a positive airtight valve capable of closing on to a seat. It is recommended that a distance of at least 3 m be maintained between inlet and exhaust vents in order to ensure the air quality.

3.3.12 Pumps

3.3.12 The refrigerating units are to be provided with at least two independent cooling water pumps, one of which is 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.

3.3.12.2 Where the primary and/or secondary refrigerants am circulated round the system by pumps, a standby pump, which is not to be used for other purposes, capable of operating on all cargo chambers is to be provided.

3.3.13 Sea connections

3.3.13.1 Refrigerant gas condenser cooling water is to be taken from two sea valves, one of which is provided on the port and the other on the starboard side.

3.3.14 Motive power

3.3.14.1 Where the refrigerating plant is electrically driven, the 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, under the sea-water temperature specified in 3.1.3.1, the required minimum temperatures in the refrigerated cargo chambers specified in 3.1.3.2 or 3.1.3.3, and to ensure the simultaneous operation of the services essential for propulsion and safety of the ship.

3.3.15 Automatic control for refrigerating plant

3.3.15.1 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 3.3.15.2 to 3.3.15.6 below.

3.3.15.2 The basic performances of all equipment in the refrigerating plant automatic control systems are to comply with the relevant requirements of these regulations.

3.3.15.3 The refrigerating plant automatic control systems are to consist of the following:

a. The control of the temperature in the refrigerated cargo chambers within the predetermined temperature limits;
b. The control of the temperature of cooling air at the outlet not less than the minimum permissible temperatures when the chamber is air-cooled.

3.3.15.4 When the automatic thermostatic control mentioned in 3.3.15.3(a) 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.

3.3.15.5 The items of monitoring and alarms are not to be less than that given in Table 3.3.15.5. Audible and visual fault alarms for the refrigerating plant are to be given at the appropriate control station or mom

Table 3.3.15.5
Items of monitoring and alarms for the refrigerating plant

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 in the refrigerant liquid	--	High
4	Expansion pressure of refrigerant liquid	Pressure	--
5	Internal pressure of condensers	Pressure	High
6	Lub. Oil pressure of gas compressors	Pressure	Low
7	Suction side pressure of gas compressors	--	Low
8	Exhaust pressure of gas compressors	Pressure	High
9	Failure of seawater cooling circulating pumps	--	Failure
10	Refrigerant leakage in refrigerating machinery spaces	--	Leakage

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

3.3.15.6 The refrigerating plant is to be provided with safety systems to automatically shut down the gas compressors in the following events:

a. Excessively low pressure at the suction side of gas compressors ;
b. Excessively high pressure at the delivery side of gas compressors and excessively high pressure in the condensers;
c. Excessively low lubricating oil pressure in gas compressors;

d. Before attaining to the minimum gas concentration of explosion in the event of refrigerant leakage in the refrigerating machinery space;
e. Failure of sea water cooling circulating pumps.

3.4 LOCATION OF REFRIGERATING MACHINERY

3.4.1 Refrigerating machinery spaces

3.4.1.1 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.

3.4.1.2 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 separate compartment.

3.4.1.3 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.

3.4.1.4 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 clean and renewal of the tubes in brine coolers and condensers.

3.4.2 Ventilation

3.4.2.1 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.
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.

3.4.2.2 The R717 refrigerating machinery space is to be provided with an emergency ventilation system, and the ventilation 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.
Where the R717 refrigerating machinery space is provided with an emergency water-spraying system capable of being operated born a position outside such space, the emergency ventilation system may be dispensed with.

3.4.2.3 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.

3.4.3 Use of ammonia as a refrigerant

3.4.3.1 Ammonia refrigerating machinery is to be installed in dedicated gastight compartments. Except for small compartments, at least two access doors are to be provided.

3.4.3.2 Compartments containing ammonia machinery (including process vessels) are to be fitted with:

a. A negative ventilation system independent of ventilation systems serving other ship spaces and having a capacity not less than 30 changes per hour based upon the total volume of the space; other suitable arrangements may be considered;
b. a fixed ammonia detector system with alarms inside and outside the compartment;
c. Water screens above all access doors, operable manually from outside the compartment;
d. An independent bilge system.

3.4.3.3 At least two sets of breathing apparatus and protective clothings are to be available.

3.4.3.4 Ammonia piping is not to pass through accommodation spaces.

3.4.3.5 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:

a. The area where the ammonia machinery is installed is to be 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;
b. A water spray system is to be provided for the said area.
c. The above-mentioned requirements in 3.4.3.2(b), 3.4.3.3 and 3.4.3.4 are to be met.

3.5 SAFETY DEVICES

3.5.1 Relief valves and safety valves

3.5.1.1 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.

The opening pressure or bursting pressure of relief valves and/or safety discs at the delivery sides of the compressors are to be not greater than the design pressure of high pressure side given in Table 3.1.4.1,

according to different refrigerants. 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.

3.5.1.2 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.
In the fluorine-substituted hydrocarbon systems, the safety valves and safety discs may be substituted by fusible plugs having a fusion point of 65°C, provided that the individual capacity of the above-mentioned pressure vessels is less than 100 litres.

3.5.1.3 The opening pressure or bursting pressure of relief valves and/or safety discs as required in 3.5.1.2 are to be not greater than the design pressure of the system or components given in Table 3.1.4.1.

3.5.1.4 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.

3.5.2 Emergency drainage

3.5.2.1 The R717 systems are to be provided with emergency drain pipes so as to immediately drain off the ammonia to 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 ship´s side outlets of the drain pipes are to be placed bellow the waterline and are to be provided with non-return valves.

3.5.3 Emergency stopping devices

3.5.3.1 In a ship where R717 refrigerant is used, 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.

3.5.4 Alarm buttons in the refrigerated cargo chambers

3.5.4.1 Alarm buttons am to be fitted in the refrigerated cargo holds/chambers for giving alarms to the refrigerating machinery space and engine room in case of emergency.

3.6 SPARE PARTS

3.6.1 Spare parts of refrigerating plant

3.6.1.1 The refrigerating plant is to be provided with spare parts not less than those given in Table 3.6.1.1.

Table 3.6.1.1
Spare parts for the refrigerating plant

No.	Spare parts	Number required
1	Reciprocating gas compressor: Piston complete with connecting rod Shaft seal Complete assembly of suction and delivery valves Crankshaft coupling bolts Packings Driving belts	 1 set for each size and type used for each compressor 1 set for each size and type used for each compressor 1 set for each compressor 1 set for each compressor 1 set for metallic packing for each compressor 1 set for each compressor
2	Pumps and fan motors: Blade impeller for brine pump Blade impeller, shaft and bearings for the fan of air cooler	 1 for each type 1 set for each type
3	Gas regulator valve and float regulator valve	1 set for each type
4	Safety valve and disc: Safety valve springs Safety discs	 2 for each size fitted 6 for each size used
5	Instruments for measurement: Electrical or tube thermometers Standard thermometers Pressure gauges Brine Hydrometer Halide lamp leak detector or leak instrument for refrigerants	 5% of the total number fitted but not less that two of each type 2 l for each type fitted 1 1

3.6.1.2 In cases where rotary type compressors are employed, alternative spare gear will be required according to the circumstances of the case.

3.6.1.3 For components of the refrigerating units that are electrically driven, the spare gear is to be in accordance with the requirements specified in these requirements.

3.6.1.4 It is the responsibility of the Owner to arrange for the necessary reserve supply of the refrigerant, calcium chloride and oils for the voyage intended.

CHAPTER 4: REFRIGERATING CARGO HOLDS/CHAMBERS

4.1 CONSTRUCTION OF CARGO CHAMBERS AND ACCESSORIES

4.1.1 Air tightness of chambers

4.1.1.1 Each individual 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 chambers, where the chambers concerned am intended for cargo which will not taint or otherwise adversely affect the cargo in any other chamber, for example, gases given off by fruit of one category may adversely affect fruit or another category by promoting rapid ripening.

4.1.1.2 Hatch closing appliances, access doom, tonnage doors, bilge and manhole plugs forming part of the insulated envelope of independently refrigerated chambers, are to be made airtight. Where hatch covers or plugs are exposed to ambient conditions, they are to be provided with a double seal.

4.1.1.3 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.

4.1.1.4 Refrigeration pipes passing through bulkheads or decks of refrigerated cargo 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 air tightness 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.

4.1.1.5 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 pipe lines are to be effectively insulated outside the chambers they serve, except within insulated brine cooler and control rooms.

4.1.2 Temperature measurement in cargo chambers

4.1.2.1 Each refrigerated cargo chamber is to be provided with a sufficient number of thermometers, and the number and position of which are subject to agreement of the Society.
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.

4.1.2.2 Where electrical remote reading thermometers are adopted for the refrigerated cargo chambers, they are to comply with the relevant requirements specified in these requirements.

4.1.3 CO_2 indication equipment

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

4.1.4 Accuracy of temperature measurement

4.1.4.1 Where the installation is intended for the carriage of frozen cargo only, the temperature readings are to be accurate to within 0.5°C of the true temperature. Where the installation is intended for the carriage of fruit, the readings are to be accurate to within +0.2°C to -0.1°C of the true temperature in the range -3°C to +3°C, and to +0.3°C to -0.2°C in other parts of the range.
For scale instruments, the scale deflection is to be not less than 5 mm/°C with division markings enabling the indication to be estimated within 0.1 of a degree.

4.1.5 Installation requirements for remote reading temperature instrument

4.1.5.1 At least two instruments are to be provided for each installation, 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 chamber either in the 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 chamber or in its circulating air system is to be connected to a separate instrument of approved type.
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°C of the true temperature.

4.1.5.2 Where galvanometers are fitted, two are to be provided for each indicating instrument and a checking resistance fitted.

4.1.5.3 Where the instruments have individual power supply units, a spare power unit (e . g . transformers and Rectifier or battery) is to be provided for each instrument.

4.1.6 Air circulation

4.1.6.1 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.

4.1.6.2 For the purpose of providing air passage in the refrigerated cargo chambers, cargo battens fastened to or temporary tonnage 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.

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

4.1.7 Galvanizing of fixtures

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

4.1.8 Sounding, air and drain pipes

4.1.8.1 All sounding pipes, whether for compartments or tanks, which pass through refrigerated spaces or the insulation thereof, in which the temperatures contemplated are 0°C or below, are to be not less than 65 mm bore.

4.1.8.2 Sounding pipes to oil compartments am not to terminate within refrigerated cargo chambers or in the fan and cooler moms for these chambers, nor are these pipes to terminate in enclosed spaces from which access is provided to refrigerated cargo chambers or their fan and cooler moms.

4.1.8.3 Where the pipes, including scupper pipes, air pipes and sounding pipes, pass through refrigerated chambers intended for temperatures of 0°C 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 3.3.11.1 need not, however, be insulated from the steelwork.

4.1.8.4 All pipes passing through the refrigerated cargo chambers mentioned in 4.1.8.3 are to be well insulated.

4.1.9 Drainage from rekigerated cargo spaces

4.1.9.1 Provision is to be made for the continuous drainage of the inside of all insulated chambers and cooler trays.

4.1.9.2 Drains which are led from lower holds and cooler trays situated on the tank top are to be fitted with liquid sealed non-return bilge traps.
Drains from tween deck chambers and from cooler trays which am 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.

4.1.9.3 Where drains from separate chambers join a common main, the branch pipes are each to be provided with a liquid sealed trap.

4.1.9.4 The liquid sealed traps are to be of adequate depth, and arrangements am to be made for ready access to the traps for cleaning and refilling with brine.

4.1.9.5 Screwed plugs or other means for blanking off scuppem draining insulating 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.

4.1.9.6 Drainage from compartments outside the insulated chambers is not permitted to be led into the bilge of the latter.

4.2 INSULATION

4.2.1 Insulation material and its application

4.2.1.1 All steel bulkheads and shell plating inside the refrigerated cargo chambers are to be covered with insulation material approved by the Society. Steelwork is to be thoroughly cleaned and dried, and suitably coated with an approved composition before insulation is applied. The outer surfaces of insulation are to be protected by lining complying with the provisions of 4.1.1.3.

4.2.1.2 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.

4.2.1.3 The insulant, linings, sealants and paints am not to emit odors' likely to cause taint.

4.2.1.4 The insulants used for the refrigerated cargo chambers are to be of low flame spread. Such organic foam insulants and their adhesives used are to be subject to approval of the Society. Metallic lining or other equivalents are to be fitted for the protection of the outer surface of the insulants.

4.2.1.5 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.

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

4.2.1.7 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.

4.2.2 Insulated plugs and panels

4.2.2.1 Insulated removable plugs are to be provided in the insulation where required for easy access to the bilge, bilge suction roses, 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.

4.2.2.2 Insulation linings, bilge limbers and plugs, hatch 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.

4.2.3 Oil-impervious composition for oil tank tops and bulkheads

4.2.3.1 When insulation is fitted to the oil storage tank tops and bulkheads, successive coatings of oil-impervious composition are to be applied beforehand. The total thickness of the coating required is to depend on the construction of the tank and the nature of the composition used.

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- **Panama Head Office**

Address:	No.0750-D Williamson Place La Boca, Balboa, Panama, Rep. of Panama.
E-mail:	omcs@omcsclass.org
Telephone:	(507)314-1756 / 52
Telefax:	(507)314-1757
24 / 7 Contact Number:	(507) 6780-5046
Mail Address:	(507) 6676-8505 P.O. Box 0843-02416, Balboa, Ancon, Panama.

- **Far East Regional Office (FERO)**

Address:	Room 1506, Suncome Liauw´s Plaza, No. 738, Shangcheng Road, Pu-Dong New Area; Shanghai, R.P.C.
E-mail:	china@omcsclass.org
Telephone:	(86) 21 58360772 / 73
Telefax:	(86) 21 58360772 - 616 (86) 21 58360773 - 616
24 / 7 Contact Number:	(86) 18721978211

- **Middle East Regional Office (MERO)**

Address:	P. O. Box 487211, Dubai / UAE
E-mail:	dubai@omcsclass.org
24 / 7 Contact Number:	(971) 501048562

www.omcsclass.org

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