GUIDELINES FOR POLAR SHIP

2023

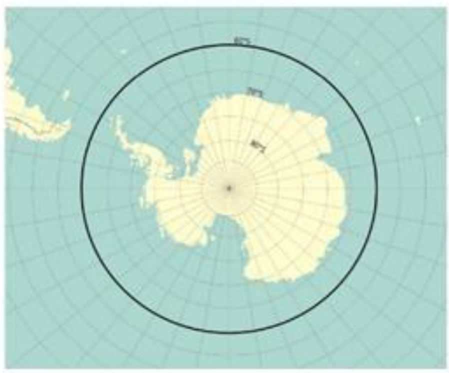
Effective from 1 April 2023

INTRODUCTION

Covering the Antarctic and the Arctic, the polar region is the coldest area on earth and has remained silent for years due to the snow and ice coverage all year round and the adverse weather conditions. Due to global warming over the past 20 years, the sea ice in the Arctic area is melting at a faster pace with a shrinking coverage area, creating the normally navigable open waters in summer. Since the Arctic Passages save 40% of the voyage compared to traditional Asia-European and Asia-American routes, its shipping benefits have attracted much attention. On the other hand, the Arctic area is rich in oil gas and mineral resources, among which the proved reserve of oil accounts for 13% of the world reserve and the reserve of natural gas accounts for 30% of the world total. This area is embracing the age of natural resource development. As for the Antarctic area, its geographic position and legal situation are totally different. With the protection of *Antarctic Treaty*, this area has no prospect for commercial shipping, except for the Antarctic scientific research. The tourism in this area, however, grows by 10 to 15% each year. Entering the 21^{st} century, the polar region has attracted the attention of people all over the world, who would like to pursue the opportunities in the future development of the Arctic and achieve the expected shipping development in the Arctic.

Given the unique geographic position and special environmental conditions of the polar waters, there are additional risks for ships when navigating in these waters due to the ice and/or cold climate and other conditions that cannot be underestimated. Navigational hazards lie in not only the “ship-ice” collision, which may affect the strength of hull structure, but also the cold climate, which may result in weak ship stability, freezing piping, navigational equipment failure, and weak executive force of the crew. All these hazards will impair the safety of the ship.

In order to decrease and eliminate major incidents affecting human safety and environmental protection in polar waters as best as possible and realize the safe and sustainable shipping development in the polar region (especially the Arctic area), IMO (International Maritime Organization) issued the *International Code for Ships Operating in Polar Waters* and respectively adopted the newly-added Chapter XIV “*Safety Measures for Ships Operating in Polar Waters*” of SOLAS and the amendments to MARPOL Annexes I, II, IV and V. The Polar Code will enter into force on 1 January 2017 and apply to all passenger ships and ships of 500 gross tonnage and upwards operating in polar waters (hereinafter referred to as “polar ship”).



Geographic area of the Antarctic

The major purpose of the Polar Code is to protect the fragile ecological environment of the polar region and exempt this region from the influence of increasingly frequent shipping activities. With the principle of decreasing incidents and promoting environmental protection, the Code provides the goals and functional requirements for the construction, equipment, operation, training, SAR and environmental protection of polar ship, so as to deal with special risks in polar waters based on risk-based procedures and supplement the existing IMO conventions and codes. All ships berthing at Arctic ports, crossing the Arctic, and navigating in the Antarctic area are to be subject to the Code.

ISC has issued the rules requirements for the ice strengthening and anti-cold climate of ships, which constitutes a comprehensive system of ship rules. But the specific ship design plan and operation procedure requirements are to depend on the actual demand of shipowners. There are different modes of operation for polar ship, including the navigation in polar waters in severe cold winter weather, occasional navigation in cold climate, and navigation in polar waters in summer. The design of these operation modes should be reviewed and determined based on economic means. The Guidelines are intended to provide technical guidance on the implementation of ISC ice class rules, ISC anti-cold climate rules and *International Code for Ships Operating in Polar Waters* of IMO.

Arctic waters

CONTENTS

CHAPTER 1   GENERAL

Section 1   GENERAL PROVISIONS

1.1.1   Purposes

1.1.1.1   The Guidelines are intended to provide guidance for design, provision of equipment, operation, survey and certification of polar ship.

1.1.1.2   The Guidelines also provide shipowners and designers with information on national decrees, regulations and criteria related to Arctic Passages of polar ship.

1.1.2   Application

1.1.2.1   The designed operational capability of polar ship depends on the purpose predetermined by shipowner, including icebreakers, carriers having icebreaking ability and carriers having ice resistance ability and their intended operating conditions, including geographical boundaries, ice conditions, seasons, etc.

1.1.2.2   The Guidelines include the relevant requirements of Polar Code and applicable rules, as well as guidance contents on implementation of these requirements. The Guidelines are to be applied together with mandatory rules and regulations, and any guidance contents are the optional measures. When the Guidelines are applied, full consideration of hazard sources of intended operation of ship and its equipment based on operational evaluation is encouraged.

1.1.2.3   The Guidelines will be reviewed and updated based on feedback from practical experience in design, construction, plan approval, survey and certification of polar ship.

1.1.3   Definitions

1.1.3.1   The definitions in ISC Rules for Classification of Sea-going Steel Ships (hereinafter referred to as ISC rules) and IMO International Code for Ships Operating in Polar Waters (hereinafter referred to as IMO Polar Code) are applicable to the Guidelines.

1.1.3.2   Unless expressly provided otherwise, the definitions of the Guidelines are as followings:

(1) Polar ship means any ship engaged on navigating in polar waters, which is divided into the following categories:

Category A ship means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions.

Category B ship means a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions.

Category C ship means a ship designed to operate in open water or in ice conditions less severe than those included in categories A and B.

(2) Escort means any ship with superior ice capability in transit with another ship.

(3) Escorted operation means any operation in which a ship's movement is facilitated through the

intervention of an escort.

(4) Habitable environment means a ventilated environment that will protect against hypothermia.

(5) Icebreaker means any ship whose operational profile may include escort or ice management functions, whose powering and dimensions allow it to undertake aggressive operations in ice-covered waters.

(6) Ice Class means the notation assigned to the ship showing that the ship has been designed for navigation in sea-ice conditions, including the ice class which is applicable to first-year ice and the polar class which is applicable to old ice.

(7) Polar Class (PC) means the ice class assigned to the ship based upon IACS Unified Requirements.

(8) Icebreaking capability means an independent capability of a ship to navigate in ice-covered waters with a constant speed so as to prevent the insufficient power supply of ship due to ice beset, or lack of response ability in the harsh climate condition. In general, icebreaking capability of ship is designed according to the intended operational requirements in ice zone, and divided into unidirectional (heading) icebreaking capability and bidirectional (heading and stern) icebreaking capability.

(9) Maximum expected time of rescue (MaxETR) means the time adopted for the design of equipment and system that provide survival support. It is never to be less than 5 days.

(10) Machinery Installations means equipment and machinery and its associated piping and cabling, which is necessary for the safe operation of the ship.

(11) Polar Service Temperature (PST) means a temperature specified for a ship which is intended to operate in low air temperature, which is to be set at least 10℃below the lowest MDLT for the intended area and season of operation in polar waters.

(12) Design Service Temperature (DST) means a temperature index set for a designed ship to measure service performances of material, equipment and system in low air temperature, which is to be determined by the shipowner according to the purpose and working condition of the ship, and generally to be set at least 10℃ below the lowest MDLT for the intended area and season of operation in polar waters. The DST is to be equal to PST.

(13) Ship intended to operate in low air temperature means a ship which is intended to undertake voyages to or through areas where the lowest Mean Daily Low Temperature (MDLT) is below -10℃.

(14) POLARIS is the abbreviation of Methodology for Assessing Operational Capabilities and Limitations in Ice: Polar Operational Limit Assessment Risk Indexing System issued by IMO Circular.

(15) PSC means the Polar Ship Certificate.

(16) PWOM means the Polar Water Operational Manual.

(17) FSICR is the abbreviation of Finnish-Swedish Ice Class Rules.

(18) NSR is the abbreviation of Northern Sea Route in the Arctic Pole declared by Russian federation. The Rules of Navigation on the Water Area of the Northern Sea Route issued by

Russian federation is referred to as NSR Rules.

(19) ASPPR is the abbreviation of the Arctic Shipping Pollution Prevention Regulations issued by Canada.

Section 2 ENVIRONMENTAL RISKS

1.2.1 General

1.2.1.1 The polar ship is to be designed, equipped and constructed to have the operational capability in polar waters in order to withstand the environmental risks, such as anticipated ice condition, low air temperature, icing, high latitude, polar day/night, harsh climate, remoteness, etc., taking into consideration the applicable operational limitations in polar waters.

1.2.1.2 Shipowners are to confirm that the polar ship has the operational capability best fit for their demands. The Master is to be responsible for evaluating the actual ice and temperature conditions during operation of ship and ensure that the ship is operated within the designed range of operational capability.

1.2.1.3 The Polar Water Operational Manual provided onboard the polar ship is to include the designed ice class, polar service temperature, any operational limitation and ice condition for safety operation.

1.2.2 Sea ice conditions

1.2.2.1 The sea ice type and thickness defined by WMO in Table 1.2.2.1 below are used in the Guidelines.

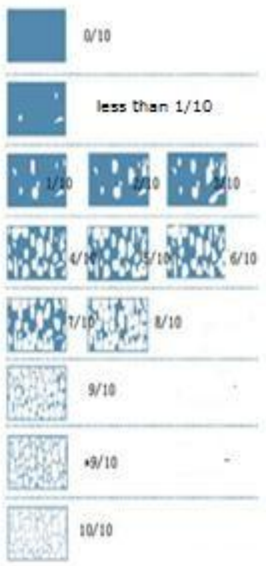
Definitions of Ice Type **Table 1.2.2.1**

Ice Type		Thickness (cm)
New Ice		⩽10
Young Ice	Grey Ice	10-15
	Grey-White Ice	15-30
First Year	Thin First Year Ice, First Stage	30-50
	Thin First Year Ice, Second Stage	50-70
	Medium First Year Ice	70-120
	Thick First Year Ice	⩾120
Old Ice	Second-Year	⩾250
	Multi-Year	⩾300
	Ice of Land Origin	
Ice Shelf	A floating ice sheet of thickness showing 2 to 50 m or more above sea-level, attached to the coast	
Fast Ice	Sea ice which forms and remains fast along the coast, where it is attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs	

1.2.2.2 Ice concentration means the proportional of floating ice covering sea level within field of vision, measured by in-tenth method. Eight grades of ice concentration are listed in Table 1.2.2.2. The grade of ice concentration indicates the difficulty level for the ship navigating in ice zone.

1.2.2.3 Ice condition means the degree of sea ice existing in water area, generally indicated by features of one or more ice types and corresponding thickness, ice concentration and scantling of floating ice, etc.

Ice Concentration **Table 1.2.2.2**

Ice concentration	Interpretation	Graphic	Navigable ability
0/10	Ice Free		Navigating freely
<1/10	Open Water		
1/10~3/10	Very Open Drift		Not navigating as per intended course
4/10~6/10	Open Drift		Having obstacles for navigating
7/10~8/10	Close Pack		
9/10	Very Close Pack		Difficult to navigate independently without icebreaker
*9/10	Compact Ice		
10/10	Consolidated Ice		

1.2.2.4 Ice regime means a description of an area with a relatively consistent distribution of any mix of ice types, including open water.

1.2.2.5 Bergy waters mean an area of freely navigable water in which ice of land origin is present in concentrations less than 1/10. There may be sea ice present, although the total concentration of all ice is not to exceed 1/10.

1.2.2.6 EGG Code is a methodology to numerically display the risk level of ship navigating in ice zone by ice charts consolidating all related information on ice regime, including ice concentration, grade of ice condition, scantling of ice block, etc., according to the WMO principles and terminology.

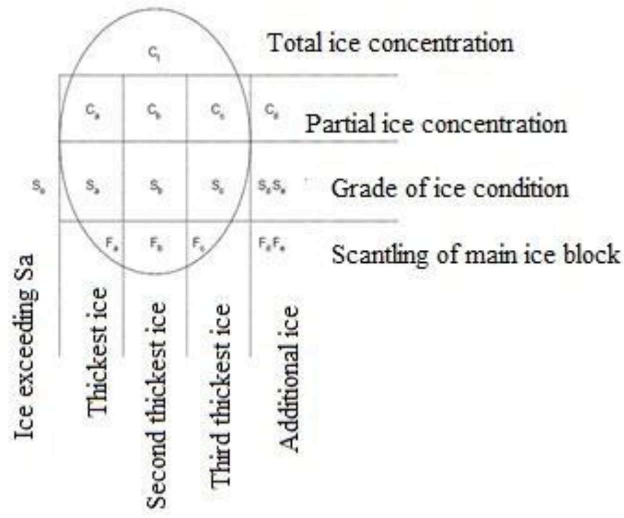


Figure 1.2.2.3 Diagram of EGG Code

Note: C_t – proportion of ice zone in the whole area of waters;

C_a, C_b and C_c – proportions of ice with different thickness in the whole area of waters;

S_a, S_b and S_c – grades of ice conditions with different thickness;

F_a, F_b and F_c – scantlings of ice blocks.

1.2.3 Low air temperature environment

1.2.3.1 For polar ship operating in low air temperature areas and/or seasons, consideration is to be given to ambient temperature the surfaces of exposed structures, equipment and systems are subject to, and proper protection and/or anti-cold climate measures for operational control are to be taken so as to ensure the ships and equipment have the operational capabilities in PST. For the anti-cold climate protection measures refer to Chapter 23 “Additional Requirements for Ships Operating in Low Temperature Environments”, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships.

1.2.3.2 Polar service temperature (PST) is to be taken 10℃ below the lowest MDLT for the intended area and season of operation in polar waters. The diagram of definition of air temperature is indicated in Figure 1.2.3.2, of which:

(1) “Mean” means the mean value over a minimum 10 year period.

(2) “Low temperature” means the lowest temperature within a day of 24 hours period.

(3) “Lowest” means the lowest temperature within a year period.

(4) “MDHT” means the mean daily highest temperature.

(5) “MDAT” means the mean daily average temperature.

(6) “MDLT” means the mean daily lowest temperature.

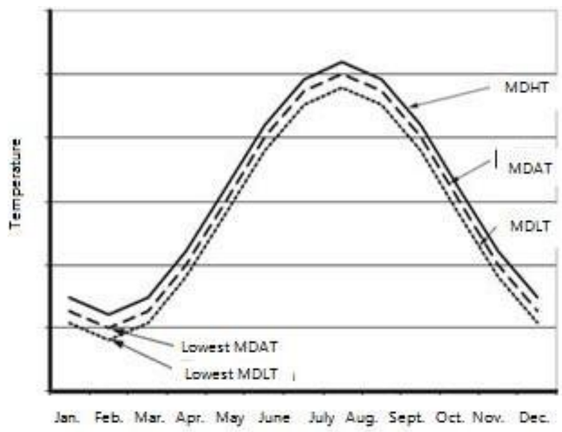


Figure 1.2.3.2 Definitions of air temperature

1.2.3.3 PST of polar ship is to be determined by shipowners or designers according to the MDLT in the intended area of operation in polar waters. If reliable ambient temperature records are available for such area, PST could be obtained by statistics after deducting all recorded values with the probability of occurrence lower than 2.5%. For ships operating with seasonal limitation, the lowest value during the operating period may be taken.

1.2.3.4 PST

(1) DST of materials for hull structure and equipment, deck machinery, fire protection equipment and system, life-saving appliances are to be taken as PST determined by shipowners or designers.

(2) For the heating arrangement of structures, equipment and piping, as well as anti-freezing protection for tanks and compartment heating system, consideration is to be given to anticipated MAT of ship operation, and the temperature is determined by shipowners and designers. If the anticipated MAT data is unavailable, it is to be taken at least 10℃ below the lowest PST.

1.2.3.5 LMDLTs in the Arctic and Antarctic waters are indicated in Figures 1.2.3.5(1) and (2) respectively, for reference.

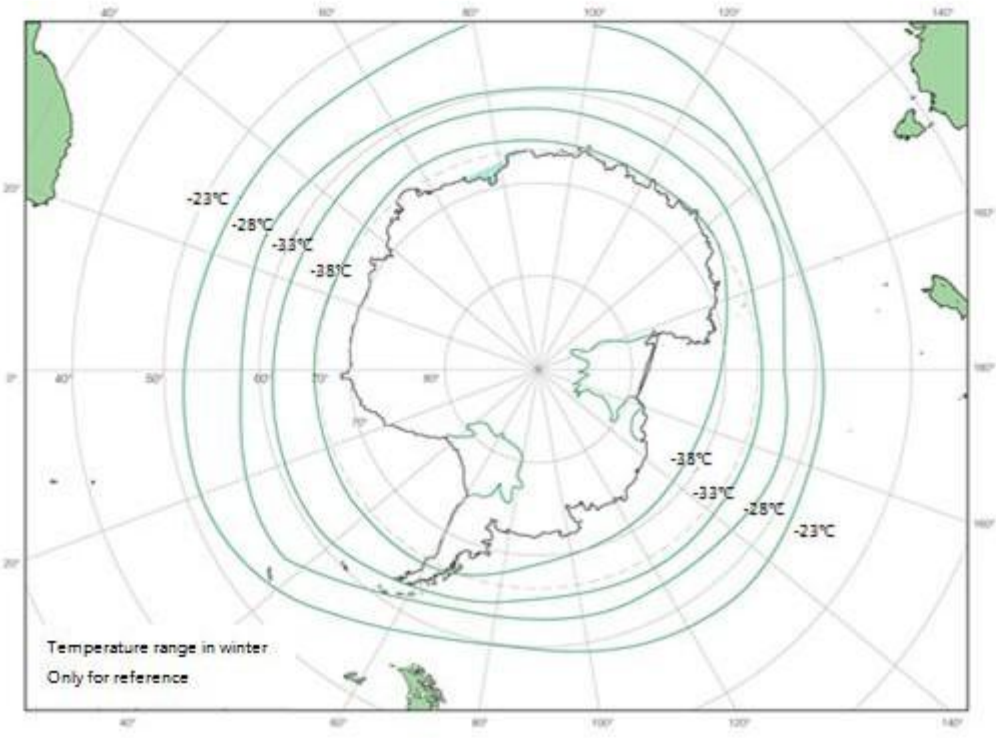


Figure 1.2.3.5(1)　LMDLT of Winter in the Antarctic Waters

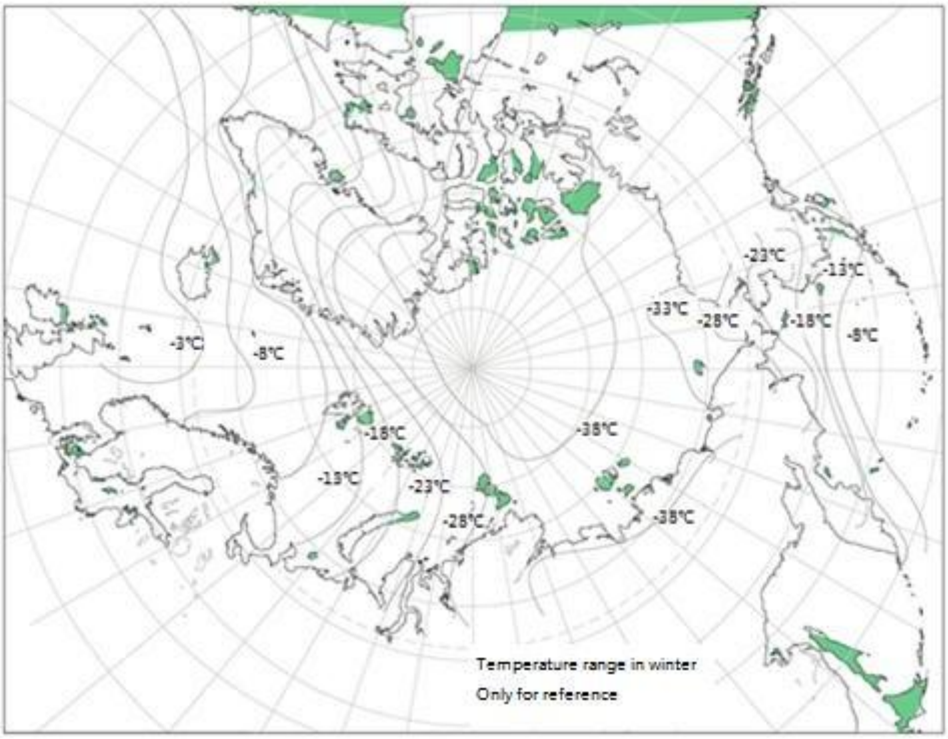


Figure 1.2.3.5(2)　LMDLT of Winter in the Arctic Waters

1.2.3.6　The summer season of northeast passage in the Arctic waters is from the middle of July to the middle of November. During this season, snow begins melting so that air temperature approaches 0℃. With the change of summer to autumn in each area, temperature drops below 0℃. The summer and autumn change in the north of Kara Sea and Laptev Sea and the middle of Eastern Siberia Sea is in late August; Seasonal change in the middle of Kara Sea and Laptev Sea and in the north of the Chukchi Sea and Barents Sea is in late September. The temperature of southwest of Barents Sea might not drop to freezing temperature before the middle of November. In the normal climate condition, the temperature of Northeast passage in summer will not be below -10℃.

1.2.4 Icing

1.2.4.1 For polar ship operating in areas and during periods where ice accretion is likely to occur, consideration is to be given to icing on surfaces of exposed structures and equipment so as to eliminate the influences of ice to ship's stability and equipment and system onboard.

1.2.4.2 Icing is to be considered for hips operating in the following areas (indicated in Figure 1.2.4.2):

(1) The area north of latitude 65°30′ N, between longitude 28°W and the west coast of Iceland; north of the north coast of Iceland; north of the rhumb line running from latitude 66°N, longitude 15°W to latitude 73°30′ N, longitude 15°E, north of latitude 73°30′ N between longitude 15°E and 35°E;

(2) The Bering Seas during the icing season; and

(3) South of latitude 60°S.

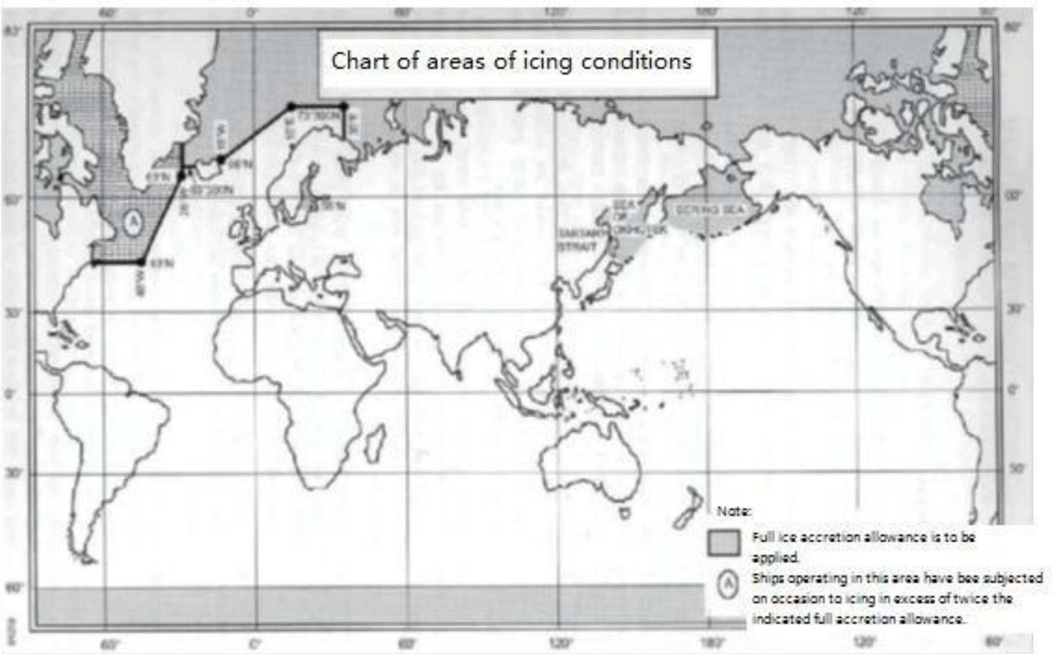


Figure 1.2.4.2 Distribution of Icing Areas

1.2.4.3 Icing occurs at the temperature of 0 ℃ and below, combined with precipitation and/or sea water spray conditions. Icing degree is related to air temperature, wind speed and water temperature, the relationship is indicated in Figure 1.2.4.3. The icing degree on the surface of hull structures depends on the following factors:

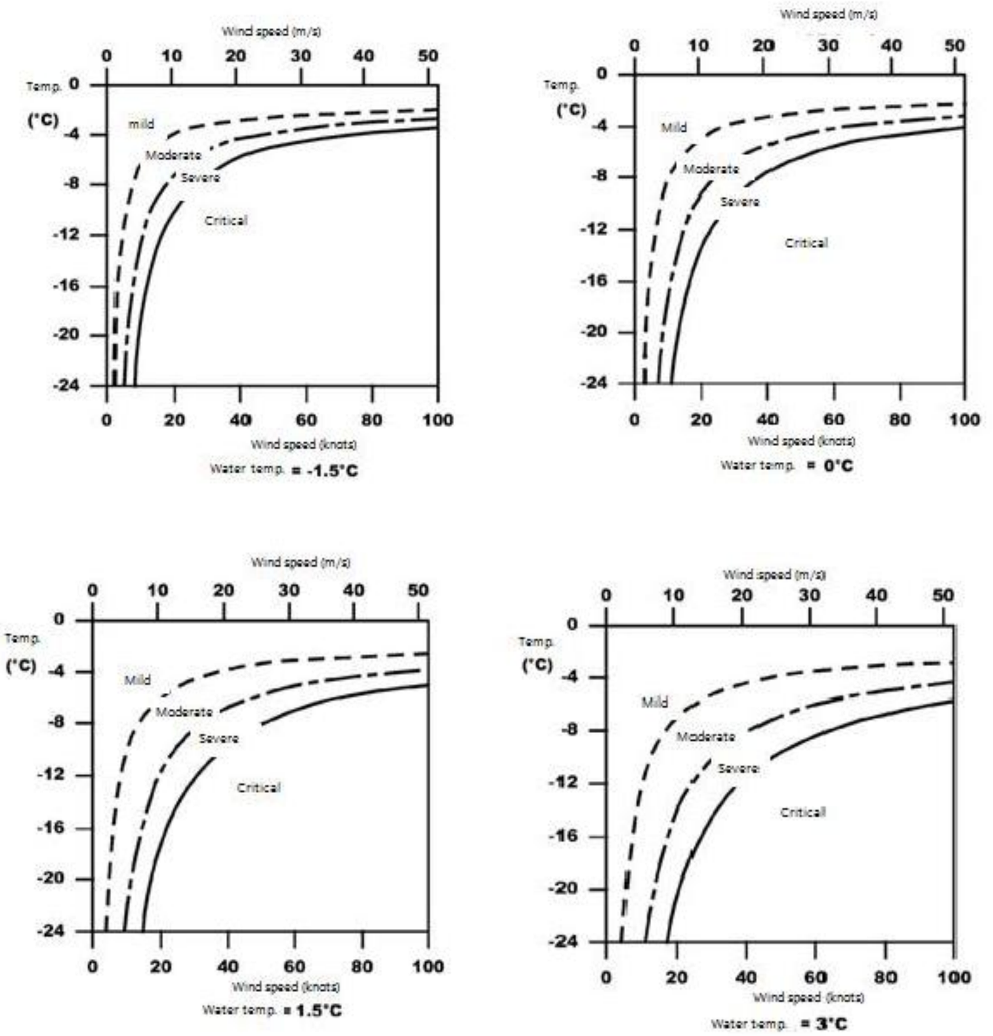
(1) speed;

(2) course relative to wind, wave and current;

(3) length of ship; and

(4) height of freeboard.

Icing degree	Mild	Moderate	Severe
Icing rate（cm/hr.）	<0.7	0.7~2.0	2.0-4.0



Note: sourced from MSA Guidelines of Navigation in the Arctic (Northeast Routes).

Figure 1.2.4.3 Wind Speed and Icing Condition

1.2.4.4 For polar ship operating in areas and during periods where ice accretion is likely to occur, the maximum icing allowance is to be determined by stability calculation so as to provide the parameters of monitoring icing conditions of ship to the master and crew. The icing monitoring and removal procedure is to be included in PWOM, and measures are to be taken to reduce and remove the ice accumulation so as to ensure that the icing condition is maintained within the extent of design. If the accumulated ice could not be controlled or removed, the ship is to navigate to a sheltered or warm area as practicable as possible. The thresholds of wind speed for different ship lengths under severe icing condition are given in Table 1.2.4.4.

Thresholds of Wind Speed for Different Ship Lengths under Severe Icing Condition

Table 1.2.4.4

Length of ship (m)	15	30	50	75	100	150
Significant wave height $h_{1/3}$ (m)	0.6	1.2	2.0	3.0	4.0	6.0
Wind speed (m/s)	5.0	7.4	9.8	12.5	15.0	20.0

1.2.5 High latitude

1.2.5.1 Currently, the signals of communication equipment related to global maritime digital communication satellite are unstable and/or interrupted in the areas with the latitude of 80º and above due to the fact that the communication satellite system has not covered the polar waters. In addition, horizontal component of magnetic field at high latitude is very small, magnetic compass force is very week, and error of magnetic compass at the latitude above 80º is greater due to the effect of local magnetic and magnetic storms, and/or aurora magnetic interference. In the high latitude areas, it is also very difficult to identify celestial constellations, and there is less opportunity for observing celestial bodies. Therefore, ship's operation at high latitude areas will influence the quality of navigational system, communication system and ice condition imagery information.

1.2.5.2 Polar ship operating in the waters with latitude of 80º and above is to be provided with communication and navigational equipment fit for use at high latitude.

1.2.6 Miscellaneous

1.2.6.1 Polar day or night occurs in the Arctic and Antarctic with high latitude:

(1) Long darkness duration in winter months leads to the constant poor visibility and has influence on safety of navigation. Additional lighting, e.g. searchlights are to be equipped onboard the polar ship, and additional watch is to be arranged for navigation in ice-covered waters so as to reduce the crew's fatigue caused by observation of ice regime.

(2) Long day duration in summer months causes crew fatigue and affects ice zone watchkeeper's eye. Measures are to be taken to avoid the influences on crew's efficiency.

1.2.6.2 Due to remoteness and possible lack of accurate and complete hydrographic data and information, reduced availability of navigational aids and seamarks with increased potential for groundings compounded, limited readily deployable SAR facilities, delays in emergency response and limited communications capability, polar ship is to be strengthened in terms of provision of emergency response capabilities.

1.2.6.3 Due to potential lack of ship crew experience in polar operations, with potential for human error, polar ship is to be manned with crew with sufficient training and experience.

1.2.6.4 Due to rapidly changing and severe weather conditions, with the potential for escalation of incidents, sufficient voyage planning, with the weather forecast information and analysis channel is to be made for polar ship.

1.2.6.5 Due to the environment with respect to sensitivity to harmful substances and other environmental impacts and its need for longer restoration, polar ship is to be constructed, operated and controlled to maintain zero emission.

Section 3 RULES AND REGULATIONS

1.3.1 General

1.3.1.1 The polar waters are characterized by a sensitive environment. Based on the goal of sustainable safety of navigation and environmental protection for polar waters, it is required in the relevant conventions, codes and rules that polar ship and its equipment are to be designed and provided to have sufficient operational capabilities in polar waters so as to withstand anticipated environmental risks which include:

(1) Hull structure and propulsion system in compliance with the proper ice class requirements;

(2) Propulsive power and machinery equipment having shifting capability in waters covered by ice;

(3) Equipment onboard ship having the capabilities to withstand low air temperature and icing condition;

(4) Communication and navigational equipment being fit for intended voyage at high latitude;

(5) Emergency equipment and system having the emergency response capabilities in remote areas.

1.3.1.2 Specified operational limitations are to be implemented so as to ensure the practical navigation in polar waters does not exceed the designed operational capability, including:

(1) PWOM specific to ship is to be provided;

(2) Voyage planning of polar waters is to be carried out and a scheme is to be developed;

(3) Crew with proper operational qualification in polar waters is to be manned onboard.

1.3.1.3 In accordance with SOLAS Chapter XIV, Safety Measures for Ships Operating in Polar Waters and International Code for Ships Operating in Polar Waters (IMO Polar Code) referenced therein, only a polar ship holding Polar Ship Certificate issued by flag State Administrations or organizations authorized could operate in polar waters.

1.3.1.4 In Article 234 of UNCLOS, it is required "Coastal States have the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered waters within the limits of the exclusive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance. Such laws and regulations shall have due regard to navigation and the protection and preservation of the marine environment based on the best available scientific evidence." Relevant coastal states of the Arctic waters have established the following control systems for ships navigating in ice-covered waters under the Article 234, including:

(1) Russia: Rules of Navigation on the Water Area of the Northern Sea Route (NSR rules);

(2) Canada: Arctic Shipping Pollution Prevention Regulations (ASPPR).

1.3.1.5 The conventions, codes and rules applicable to polar ship are shown in Figure 1.3.1.5.

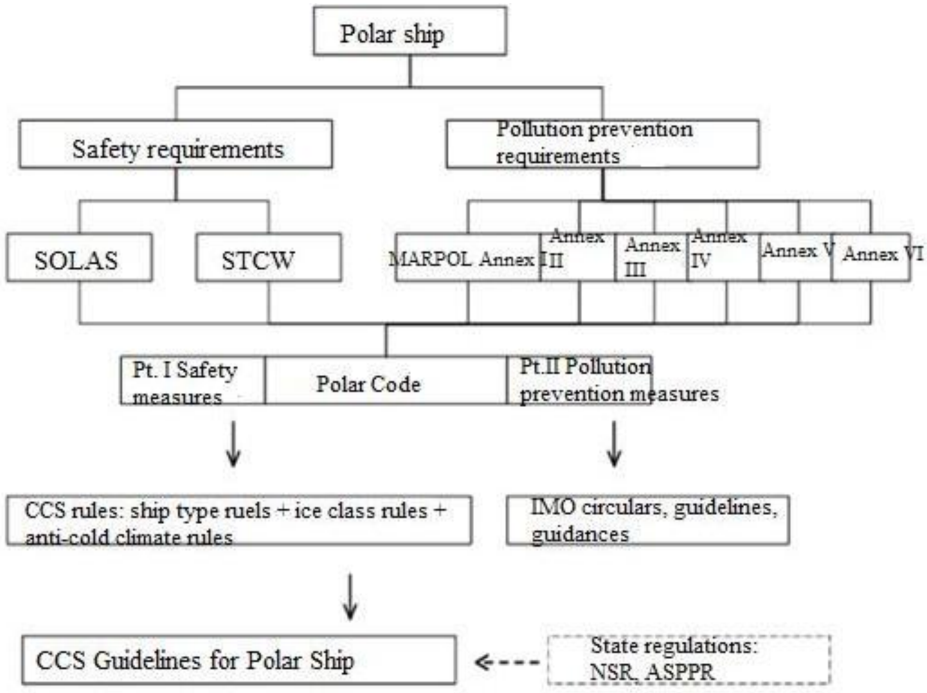


Figure 1.3.1.5 Frame Diagram of Applicable Requirements for Polar Ship

1.3.2 Typical damages of polar ship

1.3.2.1 The main challenges for ships navigating in polar waters are ice and low temperature. The exact ice load resulting from impacts are difficult to determine for every ship in all conditions due to the varied ice conditions. Hence, many rules are based on service experience and damage statistics.

1.3.2.2 Damage may be in the form of many different scenarios, the typical damages are given in Table 1.3.2.2.

Table 1.3.2.2

Scenario	Potential cause	Typical damaged area
Proceeding in ice	Ship proceeds at high speeds[1] in ice covered waters, then impacts with the ice	Bow area and bow intermediate area
	Impact with ice pieces of ice ridges and edges of channels extending below the water level	Side, bilge and bottom areas along the length of the hull
	Ship is going astern in heavy ice conditions	Aft ship areas, especially the rudder and propeller
	Ice channel may close in due to the moving ice field, and the ship may get stuck and be exposed to high ice pressures	Midship area on the flat of side region
	Abrasive effects of ice on the ship hull painting	Increased rate of corrosion
	Ice loading	Severe structural vibration
	Sea ice suctioned by inlets	System could not be operated in a normal order
Operation with escorted ships	The first ship is small and has low propulsive power and the following ship is much bigger	The next ship may collide with the first
	The lead distance of an icebreaker is short and it gets stuck in ice	The escorted ship is collided with icebreakers
Operation in	Ice rubble in harbour may become several	Damage of several parts of ship hull and

[1] Ships with high propulsive power compared to their size are more prone to increase speed and for this reason the strengthening of the hull is to match the propulsive power.

Scenario	Potential cause	Typical damaged area
harbour	meters thick and in addition, there may be fragments of rocks, wood, and other materials	machinery components
Operation in low temperature	The low temperatures experienced effect materials properties both by increased brittleness and thermal expansion, reducing the allowable stresses	Equipment damaged when used
	Oil viscosity for fuel, hydraulic and lubricating oils may become thicker or even frozen	Equipment inoperable
	Moisture condenses and freezes on cold surfaces of deck and cargo equipment	Difficulties in use
	Risk of hypothermia to crew personnel	Frostbite, even death, effect of thermophilic bacteria
	Sea water and rain spray onto the ship superstructure is supercooled to freeze on exposed surfaces	Stability is reduced, closing devices are inoperable and effect on ventilation of equipment

1.3.3 International Code for Ships Operating in Polar Waters (IMO Polar Code)

1.3.3.1 The International Code for Ships Operating in Polar Waters was adopted by IMO Resolutions MEPC.264(68) and MSC.385(94), which will will take effect on 1 January 2017 upon entry into force of the respectively adopted amendments of the new SOLAS Chapter XIV "Safety Measures for Ships Operating in Polar Waters" and amendments to Annex I, II, IV and V of MARPOL. The Code is applicable to all passengers ships and ships of 500 gross tonnage and upwards operating in polar waters (hereinafter referred to as polar ship). The existing polar ship is to be in compliance with the applicable requirements of the Polar Code by the first intermediate/renewal survey after 1 January 2018.

1.3.3.2 IMO Polar Code provides the requirements for ship and equipment as well as operation in terms of hull structures, machinery installations, stability, watertight and weathertight closing devices, fire-protection equipment, life-saving appliances, navigation safety, communication, voyage planning, crew manning & training, and environmental protection so as to supplement the relevant provisions in existing SOLAS, MARPOL and STCW.

1.3.3.3 In IMO Polar Code, it is required that the ice class of polar ship is to meet the IACS rules of polar class. Equivalent ice class assessment is to be carried out for polar ship designed according to other ice class rules.

1.3.3.4 The scope of application of IMO Polar Code, including selection of ice class, operation capacities in low air temperature depends on the anticipated operational conditions in polar waters fit for ship's intended purpose so as to reach the equilibrium between ship and equipment strengthening level and open water performances, including:

(1) Areas and seasons;

(2) Operational mode and supporting extent;

(3) Operational flexibility;

(4) Requirements of Administration.

1.3.4 Rules for ice class

1.3.4.1 The additional requirements in Chapter 23, PART EIGHT of ISC Rules for

Classification of Sea-going Steel Ships directly incorporates the provisions of IACS URI1, I2 and I3. The polar class is listed in Table 1.3.4.1, which is applicable to Category A and B polar ship and any ships navigating in waters covered by multi-year ice. It is the responsibility of shipowner to select a suitable polar class. PC1 is the highest class.

Polar Class **Table 1.3.4.1**

Category of ship	Ice class	Ice description (based on WMO sea ice nomenclature)	Polar operational limitation		
		Type of ice	Maximum thickness	Season	Mode
A	PC1	All polar waters	No restriction		
	PC2	Moderate multi-year ice conditions	3.0 m	Year-round	Independent *
	PC3	Second-year ice which may include multi-year ice inclusions	3.0 m	Year-round	Independent *
	PC4	Thick first-year ice which may include old ice inclusions	2.0 m	Year-round	Independent *
	PC5	Moderate first-year ice which may include old ice inclusions	1.2 m	Year-round	Independent *
B	PC6	Moderate first-year ice which may include old ice inclusions	0.95 m	Summer/autumn	Independent #
	PC7	Thin first-year ice which may include old ice inclusions	0.70 m	Summer/autumn	Independent #

Note: (1) *PC means the ship is required to navigate independently and continuously, if not, operational limitation is to be required. The notation of "Icebreaker" could be assigned if the ship meets the relevant requirements of the rules.

(2) For #PC6 and PC7, if bulbous bows are used, operational limitation is to be required so as to prevent ramming operation.

1.3.4.2 The supplementary provisions of ships navigating in polar waters are divided into two parts: structural and machinery requirements.

(1) The ice loads for the hull scantlings are due to a typical collision scenario of hull and floating ice. The ice loads are derived based on the assumption that the effective kinetic energy of the ship will be absorbed by crushing ice, taking account of ice thickness, strength (scrunching pressure), hull type, ship size and speed. For the longitudinal strength calculation for polar ship having icebreaking capability and icebreakers, consideration is also to be given to ramming icebreaking modes.

(2) Machinery requirements cover the propeller/ice interaction loads based on a block of ice in contact with the propeller, the size of ice block varying with the ice class.

1.3.4.3 Except for ice class B, The requirements of Finnish-Swedish Ice Class Rules (FISCR) are directly incorporated in Section 2, Chapter 4, PART TWO "Hull Strengthening In Ice zones" and Chapter 14, PART THREE "Strengthening Requirements for Ships Navigating in Ice Waters" of ISC Rules for Classification of Sea-going Steel Ships, which are applicable to ships operating in first-year ice waters. Based on the recommendations provided by the Baltic Marine Environment Protection Committee (HELCOM), Ice class IA SUPER and IA are corresponding to ISC ice class B1* and B1, which are equivalent to PC6 and PC7 respectively according to "HELCOM Recommendation 25/7", Safety of Winter Navigation in the Baltic Sea Area.

FSICR is developed on the basis of ice zone management mode in Baltic Sea. The icebreakers provide all-weather assistance to ships, other than opening an ice channel to escort. It provides the requirements of minimum power for main engines so as to ensure that ships could navigate independently at least 5 knots in an ice channel opened by icebreakers. The calculation for main engine power is based on the type of hull, ships designed to have icebreaking capability will reduce the main engine power, vice versa. Results of ice basin model testing could be accepted as a ship's performance standard, i.e. for ice class B1, an ice basin model testing is carried out for a ship processing at 5 knots in a brash ice channel with the ice thickness of 1 m.

The correlation of ISC ice class, FSICR ice class and ASPPR ice class is given in Appendix 1. It is the responsibility of shipowner to select a most suitable ice class for the ship. B1* is the highest class.

1.3.5 Rules for anti-cold climate

1.3.5.1 Additional Requirements for Ships Operating in Low Temperature Environments in Chapter 23, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships provide the DST, and corresponding anti-cold climate protection and/or anti-icing and deicing measures are to be taken for the followings:

(1) Material properties of exposed hull structures and equipment and system;

(2) Ship's stability under icing conditions;

(3) Accommodation compartments and escape routes keeping smoothly;

(4) Bridge room design and navigational equipment protection;

(5) Machinery installations and piping;

(6) Anchor mooring and cargo handling gear;

(7) Safety equipment and system;

(8) Cargo system;

(9) Ballast system;

(10) Personal protection.

1.3.5.2 The anti-cold climate protection measures are to include the followings:

(1) Low temperature resistant materials and equipment are to be selected so as to ensure the low temperature property;

(2) Sheltering protection is to be arranged so as to prevent icing and snow accumulating;

(3) Shielding is to be provided so as to protect equipment/devices/fittings from icing and snow accumulating;

(4) Heating device, including electric tracer heating device, air conditioning and heating system/equipment is to be installed so as to provide calorific value to equipment and system;

(5) Deicing and anti-icing measures, including vapor, hot water, hot gas, manual tool, drainage arrangement, anti-icing coating, etc. so as to remove ice and snow accumulation;

(6) For personal protection, thermal protective equipment is to be provided so as to prevent frostbite.

(7) For stability reservation, stability calculation check is to be carried out for ships navigating in icing condition.

1.3.5.3 Any anti-cold climate measures are not to affect the ship and equipment functions and safety production.

1.3.5.4 The class notation of anti-cold climate is indicated in Table 1.3.5.4.

Categories of ACC Class Notation for Polar Ship Table 1.3.5.4

Operational condition	Applicable ship category	Class notation	Recommendation for DST selection
Year-round operation in polar waters	Category A	ACC-POLAR（DST）	-40℃ and below
Operation seasonally in low temperature environments in polar waters	Category A and B		-15 ℃ ～ -40 ℃ for operational seasons and areas
Operation occasionally in polar waters	Category B and C	DE-ICE	
Only hull structural materials meeting the DST requirements	A, B, C	H（DST）	

Note: DST is to be in consistent with PST required in Polar Ship Certificate.

1.3.6 IMO guidelines and guidance notes

1.3.6.1 The polar ship is to be designed and operated by taking into account the following IMO guidelines and guidance notes:

(1) Resolution A.852 (20) — Guidelines for A Structure of an Integrated System of Contingency Planning for Shipboard Emergencies

(2) Resolution A.893 (21) — Guidelines for Voyage Planning

(3) Resolution A.999 (25) — Guidelines on Voyage Planning for Passenger Ships Operating in Remote Areas

(4) Resolution MSC.191 (79) — Performance Standards for the Presentation of Navigation-Related Information on Shipborne Navigational Displays

(5) MSC.1/Circ.1184 — Enhanced Contingency Planning Guidance for Passenger Ships Operating in Areas Remote from SAR Facilities

(6) MSC.1/Circ.1185 — Guide for Cold Water Survival

(7) MSC/Circ.504 — Guidance of Design and Construction of Sea Inlets under Slush Ice Conditions

(8) Resolution MEPC.163 (56) — Guidelines for Ballast Water Exchange in the Antarctic Treaty Area

(9) MEPC.1/Circ.674 —Guidance Document for Minimizing the Risk of Ship Strikes with Cetaceans

CHAPTER 2 SURVEY AND CERTIFICATION

Section 1 GENERAL PROVISIONS

2.1.1 Application

2.1.1.1 This Chapter applies to the following surveys of polar ship:

(1) Statutory survey authorized by the government of the flag State, and a Polar Ship Certificate is issued.

(2) Classification survey of the Society, ice class and/or anti-cold climate notation is (are) assigned.

2.1.1.2 This Chapter also provides that the polar ship issues International Oil Pollution Prevention Certificate (IOPP certificate), to ensure its compliance with the requirements of Part II-A of Polar Code.

2.1.2 Issue of Polar Ship Certificate

2.1.2.1 The polar ship other than category C cargo ship is to be issued with Polar Ship Certificate, after initial survey or renewal survey is carried out and compliance with the relevant requirements of IMO Polar Code is confirmed.

2.1.2.2 For category C cargo ship, Polar Ship Certificate is to be issued based on verification of the documents if the results of the operational assessment comply with IMO Polar Code and no equipment is required to be added or no structure is required to be modified. The survey on board is to be carried out at the next scheduled survey to confirm the certificate continues to be valid.

2.1.2.3 Unless expressly provided otherwise, various surveys relevant to issue and endorsement of Polar Ship Certificate may be carried out in conjunction with the same type surveys of statutory certificates of Chapter I of SOLAS listed in Table 2.1.2.3. Period of validity of certificates, date of survey and endorsement of the certificates are to be in harmonization with those of relevant statutory certificates of the ship in accordance with the requirements of Regulation I/14 of SOLAS.

Harmonization of Polar Ship Certificate with Other Statutory Certificates of SOLAS **Table 2.1.2.3**

No.	Statutory Certificates in Chapter I of SOLAS		Certificate in Part I-A/1.3 of Polar Code	
	Type of Certificates	Reference	Certificate	Reference
1	Cargo Ship Safety Construction Certificate	I/12, II-1, II-2, XII	Polar Ship Certificate	Part I-A/Ch 3, 4, 5, 6, 7
2	Cargo Ship Safety Equipment Certificate	I/12, II-1, II-2, III, V		Part I-A/Ch 7, 8, 9
3	Cargo Ship Safety Radio Certificate	I/12, IV		Part I-A/Ch 10
4	Cargo Ship Safety Certificate	I/12, II-1, II-2, III, IV, V		Part I-A/Ch 3, 4, 5, 6, 7, 8, 9, 10
5	Passenger Ship Safety Certificate	I/12, II-1, II-2, III, IV, V		

Note: The Polar Ship Certificate is supplemented by a Record of Equipment, stating the equipment required by

IMO Polar Code.

2.1.3 Assignment of notations

2.1.3.1 The polar ship may be assigned the notations indicated in the Table 2.1.3.1 in accordance with its expected operational conditions in polar waters.

Table 2.1.3.1

Operational Conditions	Notations	Reference
Expected operation in ice zone of polar waters	Ice class notation	1.3.4 of chapter 1 of the Guidelines
Expected operation in low air temperature	Anti-cold climate notation	1.3.5 of chapter 1 of the Guidelines

2.1.3.2 Categories A and B polar ships are to meet the requirements of Additional Requirements for Polar Class Ships of Chapter 13, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships. After plan approval or assessment and survey, then confirmation of compliance, the polar ship is to be assigned an appropriate polar class notation:

(1) Category A polar ship: PC1～5;

(2) Category B polar ship: PC6～7.

2.1.3.3 Category C polar ship with an ice class may select an appropriate ice class defined in Ice strengthening of Section 2 of Chapter 4, PART TWO of ISC Rules for Classification of Sea-going Steel Ships. After plan approval or assessment and survey, then confirmation of compliance, the polar ship is to be assigned an ice class notation.

2.1.3.4 An appropriate anti-cold climate notation is selected for polar ship in accordance with the Design Service Temperature by referring to Table 1.3.5.4. After plan approval or assessment and survey, then confirmation of anti-cold climate measures satisfying Additional Requirements for Ships Operating in Low Temperature Environments of Chapter 23, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships, and compliance with the relevant functional requirements in Polar Code, the polar ship is to be assigned an appropriate anti-cold climate notation.

2.1.3.5 Applicable requirements of Part I-A of IMO Polar Code are to be applied to polar ship in accordance with the expected operational conditions. Guidance for implementation of the requirements for plan approval and survey is provided in Table 2.1.3.5.

2.1.3.6 For ice class and anti-cold climate notations, refer to 7 of Appendix 1, Chapter 2, PART ONE of ISC Rules for Classification of Sea-going Steel Ships. The notations are to be appended to characters of classification of ★CSA. For example (in italic):

★CSA, Icebreaking, Research Ship, *PC3, H(-40 °C), ACC-POLAR（-30 °C）*, PSPC(B), Helicopter Facilities, In-Water Survey , CLEAN, GPR, BWMP, COMF(NOISE)2, COMF(VIB)2

★CSM, AUT-0, OMBO, DP-2, PMS, Electrical Propulsion System

Applicable Requirements for Operating in Polar Waters of Part I-A in IMO Polar Code and the Requirements for Plan Approval and Survey

Table 2.1.3.5

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
2.3.1	PWOM shall be carried on board	X								Confirm PWOM available on board, and applicable to the operating features of the ship	X	X	X
2.3.2	PWOM shall contain the methodology used to determine capabilities and limitations in ice	X								Examine PWOM containing methodology approved by the Administration, POLARIS issued by IMO acceptable			
2.3.3	PWOM shall include risk-based procedures for normal operations	X								Examine completeness of procedure			
2.3.4	PWOM shall include risk-based procedures for the event of incidents in polar waters	X								Examine completeness of procedure			
2.3.5	PWOM shall include risk-based procedures for abnormal operations	X								Examine completeness of procedure			
2.3.6	PWOM shall include risk-based procedures for escort operations								X	Examine completeness of procedure			
3.3.1	Materials of exposed structures of hull			X						All relevant plans and documents of hull structure marked with PST or DST and steel grades, confirm compliance with IACS URS6/Rules			

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
3.3.2.1	Scantlings of category A ships		X							Plans of midship section, shell expansion and other relevant plans indicated with polar class/other ice class and ice belt area, and marked with scantlings; review compliance with IACS UR 1 and 2 /Rules. Confirm compliance of fitting on board			
3.3.2.2	Scantlings of category B ships		X										
3.3.2.3	Scantlings of ice strengthened category C ships		X										
3.3.2.4	Scantlings of category C ships which need not to be ice strengthened	X								No special requirements. PSC marked with operating in ice-free waters			
4.3.1.1	Icing allowance shall be made in the intact stability				X					Stability information contains the required calculation of icing allowance, or else operation is limited to area and season of 0℃ and above			
4.3.1.2.1	Designed to minimize the accretion of ice				x					Plans and documents marked with the ice-accretion proof measures and de-icing measures taken together with their positions; confirm fitting and/or provision on board.			
4.3.1.2.2	Means for removing ice				X						X	X	X
4.3.1.3	Information on the icing allowance to be given in the PWOM				X					Examine PWOM containing icing allowance and consistency with stability information			
4.3.1.4	Ice accretion shall be monitored and measures taken				X					Examine PWOM containing procedures of monitoring of ice accretion and measures taken			

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
4.3.2.1	The residual stability of ships of categories A and B following ice damage		X							Damage Stability calculation contains residual stability following ice damage and satisfies requirements			
4.3.2.2	Ice damage extents be assumed		X										
5.3.1	Means shall be provided to remove or prevent ice and snow accretion around hatches and doors				X					Plans and documents marked with the ice-accretion proof measures and de-icing measures taken together with their positions; confirm fitting and/or provision on board	X	X	X
5.3.2	If the hatches or doors are hydraulically operated, means shall be provided to prevent freezing			X						Plans of relevant hatches, doors and hydraulic system and the purchasing order list marked with PST or DST and anti-freezing measures taken; marked with pour-point temperature of low-temperature hydraulic oil if used; confirm fitting on board	X	X	X
5.3.3	Watertight and weathertight doors, hatches and closing devices shall be designed to be operated by personnel wearing heavy winter clothing including thick mittens			X						Plans of watertight and weathertight doors, hatches and closing devices marked with PST or DST; confirm effectiveness of design function in product inspection; product certificate marked with PST or DST; confirm fitting on board	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
6.3.1.1	Machinery installations and associated equipment shall be protected against the effect of ice accretion and/or snow accumulation, ice ingestion from sea water, freezing and increased viscosity of liquids, seawater intake temperature and snow ingestion		X	X	X					Examine plans, documents and lists of machinery installations and associated equipment marked with protective measures, marked with PST or DST if meeting the need of operation in low air temperature is considered; confirm provision of protective measures on board	ⓧ	ⓧ	X
6.3.1.2	Working liquids shall be maintained in a viscosity range			X						If working liquids are used in machinery installations, the viscosity is to be maintained in a viscosity range of the operation temperature of machinery installations, and is indicated in the relevant plans; confirm fitting on board			
6.3.1.3	Seawater supplies for machinery systems shall be designed to prevent ingestion of ice		X							Examine the plan of machinery systems marked with prevention of ice ingestion at sea intakes, PWOM contains its operational procedure; confirm fitting on board	ⓧ	ⓧ	X
6.3.2.1	Exposed machinery and electrical installation and			X						Plans of all exposed machinery and electrical installation and appliances, the purchasing order lists	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	appliances shall function at the polar service temperature									of components and the documents, such as product inspection/audit certificates marked with PST or DST; confirm fitting on board			
6.3.2.2	Means shall be provided to ensure that combustion air for internal combustion engines driving essential machinery is maintained at a temperature in compliance with the criteria provided by the engine manufacturer			X						Examine the plans, instructions and certificates relevant to internal combustion engines marked with PST or DST; and include means of maintaining combustion air at a temperature for preheating of internal combustion engines	X	X	X
6.3.2.3	Materials of exposed machinery and foundations shall be applicable on the polar service temperature			X						Plans and documents of exposed machinery and foundations marked with PST or DST and the used steel grade; confirm compliance with the requirements of Rules			
6.3.3.1	Scantlings of propeller blades, propulsion line, steering equipment and other appendages of category A ships		X							Plans of propeller blades, propulsion line, steering equipment and other appendages marked with polar class/other ice class and the scantlings of relevant components; examine compliance with IACS UR IS3/Rules; confirm compliance of safety on board			
6.3.3.2	Scantlings of propeller blades,		X										

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	propulsion line, steering equipment and other appendages of category B ships												
6.3.3.3	Scantlings of propeller blades, propulsion line, steering equipment and other appendages of ice-strengthened category C ships		X										
7.3.1.1	Isolating and pressure/vacuum valves in exposed locations are to be protected from ice accretion and remain accessible				X					Examine relevant plans of arrangement of fire fighting system marked with isolating and pressure/vacuum valves located in the sheltered position where it is readily available, or other measures of preventing ice accretion taken; confirm fitting on board	X	X	X
7.3.1.2	Two-way portable radio communication equipment shall be operable at the polar service temperature			X						Confirm the equipped two-way portable radio communication equipment having type approval certificates onboard marked with PST, or similar documents of usage experience in low air temperature	X	X	X
7.3.2.1	Fire pumps including emergency fire pumps, water mist and water spray pumps shall be located in				X					Relevant plans of arrangement of fire fighting system marked with the arrangement of fire pumps including emergency fire pumps, water mist and water spray	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	compartments maintained above freezing									pumps; examine compliance with Code and/or Rules. Confirm environmental conditions and control measures of the locations where the equipment was fitted			
7.3.2.2	Fire main is to be arranged so that exposed sections can be isolated and means of draining of exposed sections shall be provided. Fire hoses and nozzles need not be connected to the fire main at all times, and may be stored in protected locations near the hydrants				X					Confirm by plan approval the compliance of fire main isolated and means of draining; Confirm by survey on board the compliance of fitting	X	X	X
7.3.2.3	Firefighter's outfits shall be stored in warm locations on the ship	X								Confirm by survey onboard the compliance of fitting position	X	X	X
7.3.2.4	Where fixed water-based firefighting systems are located in a space separate from the main fire pumps and use their own	X								Examine the plan and documents of fixed water-based firefighting systems marked with prevention of ice ingestion at water intakes; confirm fitting on board	ⓧ	ⓧ	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	independent sea suction, this sea suction is to be also capable of being cleared of ice accumulation												
7.3.3.1	Portable and semi-portable extinguishers shall be located in positions protected from freezing temperatures, as far as practical. Locations subject to freezing are to be provided with extinguishers capable of operation under the polar service temperature			X						Confirm storage position of portable and semi-portable extinguishers onboard	X	X	X
7.3.3.2	Materials of exposed fire safety systems shall be of PST resistant material			X						Examine plans of fire fighting system marked with PST and DST, and steel grades of exposed materials, confirm satisfying requirements of IACS URS 6/Rules; confirm compliance of fitting on board.			
8.3.1.1	Means shall be provided to remove or prevent ice and snow accretion from escape routes, muster stations, embarkation areas, survival craft, its launching appliances and access				X					Examine plans and documents of means of preventing ice and snow accretion; confirm fitting on board	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	to survival craft												
8.3.1.2	For new built ships (A and B), exposed escape routes shall be arranged so as not to hinder passage by persons wearing suitable polar clothing	X								Width of exposed escape routes in the relevant plans and documents applicable to passage by persons wearing suitable polar clothing; confirm fitting onboard	X	X	X
8.3.1.3	adequacy of embarkation arrangements shall be assessed, having full regard to any effect of persons wearing additional polar clothing			X						Consider any effect of persons wearing additional polar clothing in the plans of areas of embarkation arrangements; Confirm embarkation arrangements onboard			
8.3.2.1	Ships shall have means to ensure safe evacuation of persons, including safe deployment of survival equipment, when operating in ice-covered waters, or directly onto the ice		X							Applicable to ships which may operate in ice-covered waters or directly onto ice. Liferafts having capabilities of landing in ice-covered waters and of anti-ice, and subject to type approval; examine provision of group survival appliances in case of ship operating directly onto ice	X	X	X
8.3.2.2	Adding devices requiring a source of power, this source shall be able to operate independently	X								Examine and assess plans and documents of arrangement of life-saving appliances indicated with the arrangement of adding devices requiring a source	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	of the ship's main source of power									of power; confirm fitting on board			
8.3.3.1.1	An immersion suit or a thermal protective aid shall be provided for each person on board the passenger ships	X								Examine plans and documents of arrangement of life-saving appliances indicated with consistency of the number of provided immersion suit with passenger quotas; confirm consistency of provision on board	X	X	X
8.3.3.1.2	Immersion suits shall be of the insulated type	X								Plans and documents of life-saving appliances indicated with applying insulated type immersion suits which have type approval certificates	X	X	X
8.3.3.2	Searchlights shall be provided for each lifeboat						X			Examine plans and documents of life-saving appliances indicated with a searchlight provided for each lifeboat; confirm provision on board	X	X	X
8.3.3.3.1	Lifeboat of partially or totally enclosed type shall be provided	X								Examine plans and documents of life-saving appliances indicated with lifeboat of partially or totally enclosed type; confirm provision on board	X	X	X
8.3.3.3.2	Survival resources which address both individual and shared needs shall be provided							X		Based on the report of operational assessment, examine plans and documents of life-saving appliances indicated with maximum expected rescue time, lists of provision of personal survival equipment and group survival equipment; confirm provision of	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
										approved personal survival equipment and group survival equipment, and compliance of storage			
8.3.3.3.3	Personal and group survival equipment shall be provided							X		Ditto	X	X	X
8.3.3.4	Adequate emergency rations shall be provided							X		Ditto	X	X	X
9.3.1	Ships shall have means of receiving and displaying current information on ice conditions	X								Examine plans and documents of navigational equipment marked with functions of receiving and displaying information on ice conditions and confirm fitting on board	X	X	X
9.3.2.1.1	Two independent echo-sounding devices or one echo-sounding device with two separate independent transducers		X							Examine compliance in plans and documents of navigational equipment; confirm fitting on board	X	X	X
9.3.2.1.2	Ships shall have a clear view forward & astern in compliance with SOLAS regulation V/22.1.9.4	X								Examine arrangement of ship's view, including ship's astern, means of defrost available; confirm fitting on board	X	X	X
9.3.2.1.3	Means to prevent the accumulation of ice on antennas				X					Examine means to prevent the accumulation of ice on antennas in plans and documents of navigation and	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	required for navigation and communication shall be provided									communication; confirm fitting on board			
9.3.2.1.4.1	Sensors that project below the hull shall be protected against ice		X							For sensors that project below the hull, examine means of protection against ice in the plans of arrangement and assess their appropriateness, confirm fitting on board	X	X	X
9.3.2.1.4.2	In category A and B ships, the bridge wings shall be enclosed or designed to protect navigational equipment and operating personnel		X	X						Examine plans of arrangement of the bridge in category A and B ships, confirm fitting on board	X	X	X
9.3.2.2.1	Two non-magnetic means to determine and display their heading. Both means shall be independent and shall be connected to the ship's main and emergency source of power	X								Examine plans and documents of navigational equipment, confirm compliance of fitting on board	X	X	X
9.3.2.2.2	One GNSS compass or equivalent shall be provided					X				Examine plans and documents of navigational equipment, confirm compliance of fitting on board	X	X	X
9.3.3.1	Two remotely rotatable,						X			Examine plans and documents of navigational	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters: General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort	Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction: AS	IS	SS/RS
	narrow-beam search lights controllable from the bridge									equipment, confirm compliance of fitting on board			
9.3.3.2	A manually initiated flashing red light visible from astern to indicate when the ship is stopped shall be provided								X	Examine plans and documents of navigational equipment, confirm compliance of fitting on board	X	X	X
10.3.1.1	The capabilities for ship-to-ship and ship-to-shore communication			X		X				Examine plans and documents of communication equipment marked with PST or DST and the application scope of latitude; confirm compliance of fitting on board	X	X	X
10.3.1.2	A sound signaling system mounted to face astern								X	Examine the list of provision of communication equipment, assess appropriateness of the expected operation; confirm compliance of fitting on board	X	X	X
10.3.1.3.1	Communications with rescue coordination centres	X									X	X	X
10.3.1.3.2	Communications with aircraft on 121.5 and 123.1 MHz	X									X	X	X
10.3.1.4	Communication with a Telemedical Assistance Service (TMAS)	X									X	X	X
10.3.2.1	Rescue boats and lifeboats			X						Examine plans and documents of life saving appliance	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
	communications (1 device for transmitting ship to shore alerts, 1 one device for transmitting signals for location, 1 device for transmitting and receiving on-scene communications)									marked with PST or DST and the lists of provision of communication equipment; confirm provision on board			
10.3.2.2	Other survival craft (1 one device for transmitting signals for location, 1 device for transmitting and receiving on-scene communications)			X						Examine plans and documents of life saving appliance marked with PST or DST and the lists of provision of communication equipment; confirm provision on board.	X	X	X
11.3	The master shall consider a route through polar waters	X								Examine PWOM including the procedure for considering voyage	X	X	X
12.3.1	Masters, chief mates and officers in charge of a navigational watch shall be qualified to operate in polar waters	X								Examine PWOM including the procedure for crew provision and management	X	X	X
12.3.2	The use of a person(s) other than the master, chief mate or officers of the navigational watch	X								Examine PWOM including the procedure for crew provision and management	X	X	X

Paragraph No. of the Code	Requirements	Operating Conditions in Polar Waters								Requirements for Plan Approval, Survey During Construction/initial Survey	Survey after Construction		
		General	Ice area	Low air temperature	Icing	High latitude	Extended periods of darkness or daylight	Remoteness	Escort		AS	IS	SS/RS
12.3.3	The use of a person stated in 12.3.2 does not relieve the master or officer of the navigational watch from their duties and obligations for the safety of the ship	X								Examine PWOM including the procedure for crew provision and management	X	X	X
12.3.4	Every crew member shall be made familiar with the procedures and equipment contained or referenced in the PWOM relevant to their assigned duties	X								Examine PWOM including the procedure for crew provision and management	X	X	X

Note: AS—— Annual survey;

IS—— Intermediate survey;

SS—— Special survey;

RS—— Renewal survey.

2.1.4 Issue of IOPP certificate

2.1.4.1 Survey for issue of IOPP certificate is to be carried out in accordance with the relevant requirements of Annex I of MARPOL.

Section 2 PROCEDURE FOR SURVEY AND CERTIFICATION

2.2.1 Basic procedure

2.2.1.1 For issue of a Polar Ship Certificate and/or assignment of class notations to a newly built polar ship, see the basic flow of survey and certification in Figure 2.2.1.1.

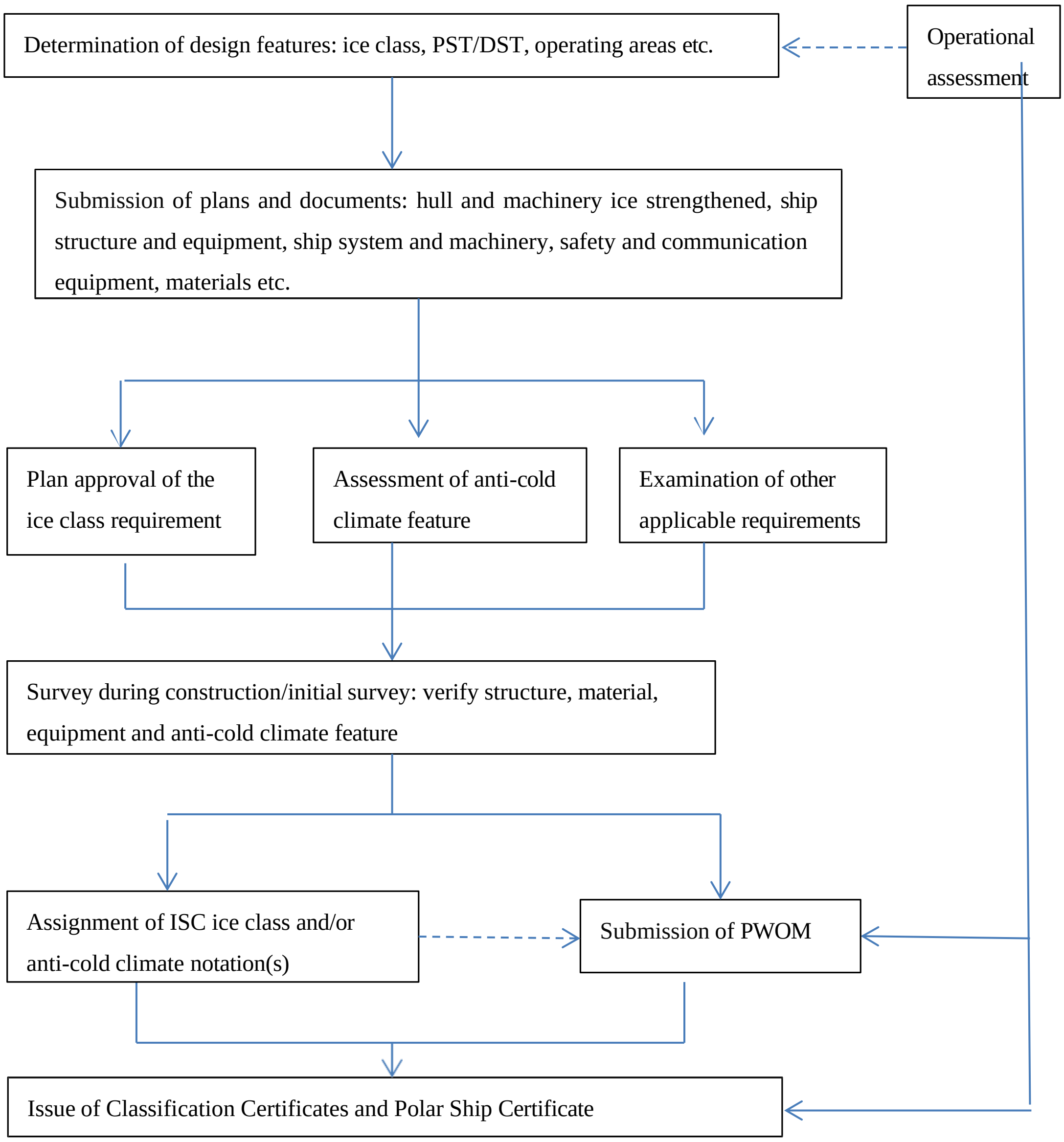


Figure 2.2.1.1 Procedure for Survey and Certification of a Newly Built Polar Ship

2.2.1.2 For issue of a Polar Ship Certificate and/or assignment of class notations to an existing polar ship, see the basic flow of initial survey and certification in Figure 2.2.1.2.

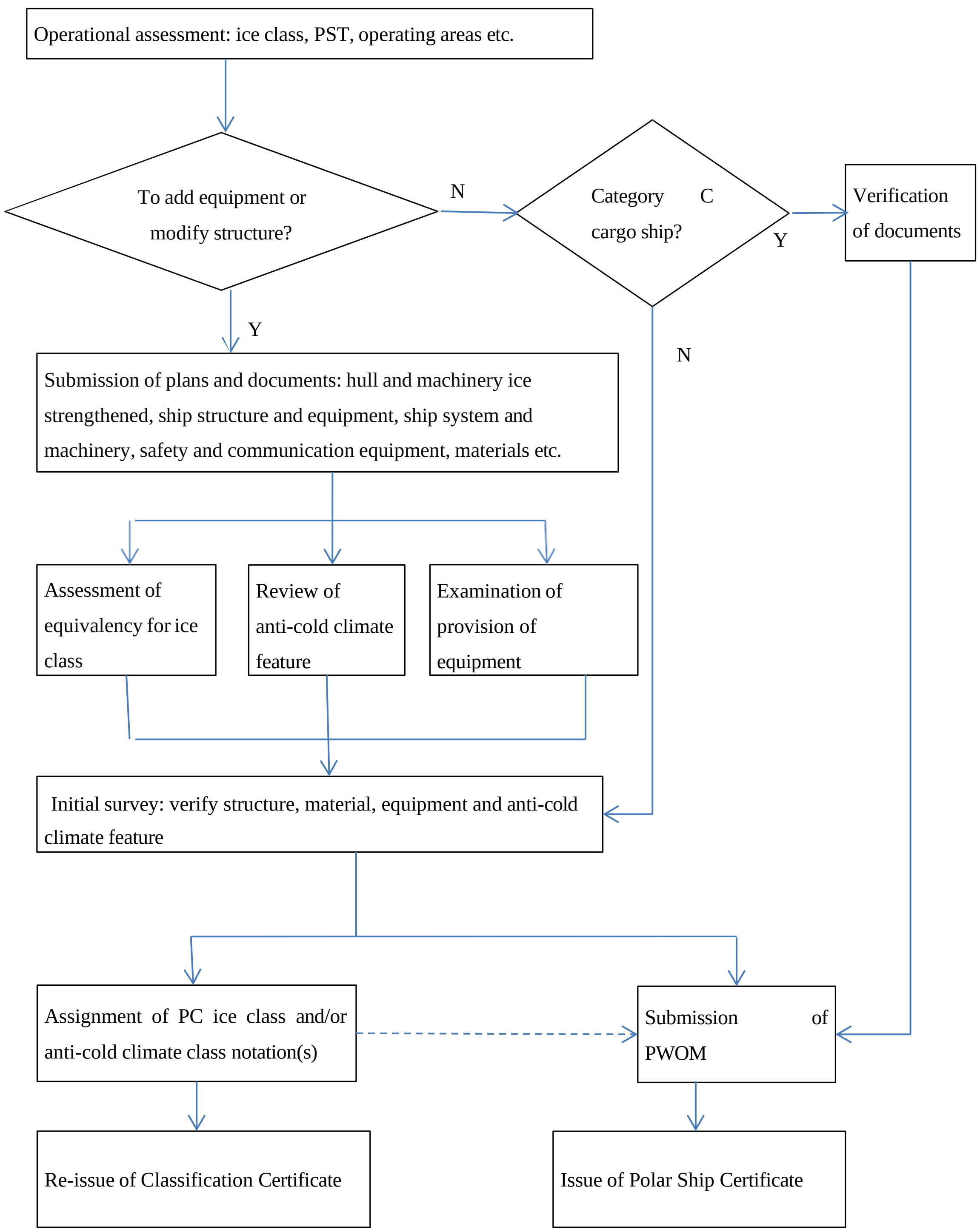


Figure 2.2.1.2 Procedure for Survey and Certification of an Existing Polar Ship

2.2.2 Design features

2.2.2.1 The owner and/or designer are(is) to determine the design features based on the purpose, category, expected operating area and environmental condition, operating mode and other operating conditions of a polar ship, including the following:

(1) selection of ice class;

(2) determination of PST;

(3) highest latitude for operation;

(4) maximum expected rescue time.

2.2.2.2 During the design stage of a polar ship and as early as possible, the owner, designer or other parties concerned, are to consult with the plan approval unit of the Society and if necessary, determine based on the following assessment:

(1) selection of the ice class by a methodology to assess operational capabilities and limitations in ice zone, such as POLARIS (see appendix 2);

(2) operational assessment;

(3) operational experience in polar waters or similar waters.

2.2.2.3 The design features of a polar ship is to be clarified in the application or the contract of plan approval and/or survey, to determine the basis of the ship's plan approval and survey.

2.2.3 Submission of plans and documents

2.2.3.1 All polar ships are to submit the following plans and documents for approval and/or information by the Society:

(1) report of operational assessment (for information), of which, operational capabilities and limitations (for approval);

(2) lists of provision and relevant plans of arrangement of life saving, fire fighting, survival (where applicable), navigational and communication equipment (for approval);

(3) plans and documents describing freezing proof, protective means from ice/snow of main, emergency and auxiliary systems, which have evidence of capabilities of operation in the expected environmental conditions (for approval);

(4) results of ice basin model test(for information).

2.2.3.2 Polar ship with polar class/other ice class is to submit the following plans and documents for approval:

(1) plans of structure indicating the materials and scantling used at the exposed structure in ships;

(2) plans of the attachment to the hull and scantlings;

(3) calculations of damage stability (categories A and B ships);

(4) plans and documents of main propulsion machinery, including the operational limitations of main propulsion, steering gear, emergency and important auxiliary machineries, and the documents of load-control functions of the important main propulsion;

(5) Calculations and documents indicating compliance with the requirements of Additional Requirements for Polar Class Ships of Chapter 13, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships;

(6) Documents for assessing an equivalency for ice class (where applicable).

2.2.3.3 Polar ship operating in low air temperature is to submit the following plans and documents:

(1) structure plans for hull including the grades of materials required by relevant chapters in PART TWO of ISC Rules for Classification of Sea-going Steel Ships;

(2) Plans and documents of design and fitting of applicable anti-cold climate measures of Additional Requirements for Ships Operating in Low Temperature Environments of Chapter 23, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships.

2.2.4 Plan approval and assessment

2.2.4.1 Material and strength of the ship structure and equipment and propulsion machinery are to be checked, for ensuring compliance with the applicable requirements for the polar class/other ice class and/or operational conditions of the Rules.

2.2.4.2 Provision of the safety equipment of the life saving, fire fighting, survival (where applicable), navigational and communication is to be examined, for ensuring compliance with the applicable requirements for operational conditions of Polar Code, taking into consideration the requirements of the Administration of the flag State and/or the Administration which has jurisdiction over the ship's expected operational areas;

2.2.4.3 The design of anti-cold climate measures is to be assessed based on the design booklet of anti-cold climate design for the ship and equipment system:

(1) the contents of the design anti-cold climate booklet are to be explicit, ensuring compliance with the requirements of the Rules and to the satisfaction of plan approval surveyors;

(2) the assessment is neither to verify the technical details of anti-cold climate measures nor to provide verification of the system and equipment;

(3) verify that the anti-cold climate measures do not conflict with the statutory requirements, and pay attentions to the requirements of the national regulations;

(4) consider that the anti-cold climate measures can not violate or weaken the operational function of the equipment or the system;

(5) PST or the lowest expected temperature of the equipment or the components is to be specified. The temperature is to be included in all the relevant lists of order and the plans.

2.2.5 Assessment of equivalent ice class

2.2.5.1 Assessment of equivalent ice class is to be carried out to the polar ship if it is designed and built for the ice class other than polar class. The assessment is to be carried out in accordance with Section 5 of this Chapter.

2.2.6 Survey during construction

2.2.6.1 In accordance with the expected operational conditions, a newly built polar ship is to be surveyed in compliance with the applicable items and requirements listed in Table 2.1.3.5.

2.2.6.2 For a polar ship operating in low air temperature:

(1) verify that the exposed equipment and system have the evidences of the performance at PST, including Marine Product Certificate issued by the Society, or Manufacturer's document, or the document of use experience at similar environmental temperature etc..

(2) the structure, equipment, system and outfitting are to be fitted or tested in accordance with the agreed plan to the satisfaction of the surveyor. Such fitting and test are to verify activation and operation of the system, equipment and outfitting, however, it is not necessary to confirm the performance at PST.

2.2.7 Periodical/annual survey

2.2.7.1 Periodical/annual survey for maintaining Polar Ship Certificate, ice class and anti-cold climate notation is to be carried out in conjunction with the periodical/annual survey for maintaining validity of other SOLAS statutory certificates.

2.2.7.2 The scope of periodical/annual survey is to cover the applicable items and requirements listed in Table 2.1.3.6.

2.2.7.3 For the polar ship operating in low air temperature , the survey of anti-cold climate measures is to be carried out annually. The surveyor is to confirm the arrangement and equipment in compliance with the Rules, and based on the anti-cold climate measures, to verify as far as possible the function of the fitted equipment and relevant system of control and alarm to the satisfaction of the surveyor.

2.2.8 Product inspection

2.2.8.1 The use conditions of the products expected to be used in the polar ship operating in low air temperature , including fitting position, applicable lowest environmental temperature, anti-cold climate measures etc. are to be clarified in the relevant plans, the document of purchase, the notification of survey or the application.

2.2.8.2 The effects of low temperature on the exposed equipment and system are to be considered in relation to the following aspects (when applicable) to verify the integrity of the function at PST.

(1) structural material and welding, including low-temperature-resistant brittle material and welding requirements;

(2) packing material, with low-temperature-resistant performance;

(3) lubrication medium, applying with the grease of low temperature performance;

(4) warm-keeping means, including heat tracing (power), covers;

(5) de-icing method, including limitations and requirements of the de-icing method;

(6) moving parts, low temperature effect;

(7) work medium, applying with the hydraulic oil of the low temperature performance;

(8) driving: hydraulic motor, electric motor, hydraulic pump etc. relating to the above measures;
(9) Control box: effect of the low temperature.

2.2.8.3 Effects of the low temperature on the overall performance and function of the lifesaving equipment and the exposed communication equipment, navigational equipment, fire fighting equipment are to be considered, and type test of the applicable items is to be carried out at the polar service temperature (PST). If the Manufacturer provides the evidence of use experience at relevant environmental temperature, the type test may be omitted.

2.2.8.4 Marine Product Certificate is to be marked with Polar Service Temperature (PST) or Design Service Temperature (DST).

2.2.9 Verification of documents of category C cargo ship

2.2.9.1 If the result of the operational assessment (see Section 3) of category C cargo ship is that no additional equipment or structural modification is required to comply with the Polar Code, the Polar Ship Certificate may be issued based upon documented verification.

2.2.9.2 If the owner or other party concerned deems that the conditions described in 2.2.9.1 are complied with, the Polar Ship Certificate may be issued based upon documented verification, and the following documents are to be submitted together with the application:

(1) Report of Operational Assessment, including the the ship's operational and environmental conditions and modes, operational capabilities and limitations (ice class, PST/DST, operational latitude);
(2) Checklist of Compliance with IMO Polar Code;
(3) PWOM.

2.2.9.3 Based on the ship's operational capabilities and limitations, the adaptability to the ship's operational and environmental conditions, the surveyor is to assess compliance with Polar Code, considering the requirements of the State and coastal states, such as Rules of Navigation on the Water Area of the Northern Sea Route of Russia.

2.2.9.4 A Polar Ship Certificate issued based on documented verification is valid to the date of the next scheduled survey. If the certificate is kept valid, on-site survey on board is to be carried out at the scheduled survey.

Section 3 OPERATIONAL ASSESSMENT

2.3.1 General provisions

2.3.1.1 The owner and/or designer are(is) to carry out an operational assessment of the polar ship and its equipment to:

(1) develop the operational limitations which constitute the contents of the Polar Ship Certificate, including ice condition, temperature, high latitude and other limitations;
(2) develop the operational procedures for the ship and its equipment which constitute the contents of the PWOM;

(3) determine the survival sources for abandonment onto ice or land.

2.3.1.2 Steps for an operational assessment are as follows:

(1) Step 1: identify hazards considering:

① relevant hazards of section 3 of Introduction of IMO Polar Code;

② other hazards based on a review of the intended operations;

(2) Step 2: develop a model to analyse risks considering:

① development of accident scenarios;

② probability of events in each accident scenario; and

③ consequence of end states in each scenario;

(3) Step 3: assess risks and determine acceptability:

① estimate risk levels in accordance with the selected modelling approach; and

② assess whether risk levels are acceptable; and

(4) Step 4: in the event that risk levels determined in steps 1 to 3 are considered to be too high, identify current or develop new risk control options that aim to achieve one or more of the following:

① reduce the frequency of failures through better design, procedures, training, etc.;

② mitigate the effect of failures in order to prevent accidents;

③ limit the circumstances in which failures may occur; or

④ mitigate consequences of accidents; and

⑤ incorporate risk control options for design, procedures, training and limitations, as applicable.

2.3.1.3 The results of the operational assessment are to be submitted to the Society for review, and the operational limitations are to be approved.

2.3.2 Identification of hazards

2.3.2.1 In accordance with the ship's designed operational capabilities, environmental information of the intended operational area of polar ship is to be collected and assessed, where applicable, including:

Table 2.3.2.1

Operational conditions	Operational capabilities	Operational and environmental Conditions
Operation in ice	Ice class	Information about ice condition, including ice type, ice thickness and ice concentration, crew experience, and service institutions of ice area
Operation in low air temperature	Polar service temperature (PST)	Information about meteorology and sea condition, including air temperature, fog, wind, wave height, sea water temperature etc.
Operation at high latitude	Designed operation at high latitude	Information about coverage of digital wireless communication, nautical chart and hydrology, time of day and night, etc.
Abandonment onto ice or land	Maximum expected rescue time	Except for the above information, the nearest distance from the emergency search and rescue institute

2.3.2.2 The risk levels within polar waters may differ depending on the geographical location, time of the year with respect to daylight, ice-coverage, etc. Thus, the hazards of polar ship are to be identified in accordance with the expected operational and environmental conditions. Based on the categories and the definitions of the polar ship, sources of hazards which may relate to various categories of polar ship are listed as in the Table 2.3.2.2 for consideration:

Relationship of Categories A, B and C Polar Ships with Sources of Hazards in Polar Waters

Table 2.3.2.2

Sources of Hazards of Section 3 of Introduction of IMO Polar Code		Relationship of Ship Categories			
Paragraph No.	Type of hazards	A	B	C_i	C_o
3.1.1	Ice, as it may affect hull structure, stability characteristics, machinery systems, navigation, the outdoor working environment, maintenance and emergency preparedness tasks and malfunction of safety equipment and systems	H	H	L	L
3.1.2	Icing, experiencing topside icing, with potential reduction of stability and equipment functionality	H	H	M	L
3.1.3	Low temperature, as it affects the working environment and human performance, maintenance and emergency preparedness tasks, material properties and equipment efficiency, survival time and performance of safety equipment and systems	H	M	L	N
3.1.4	Extended periods of darkness or daylight as it may affect navigation and human performance	H	M	M	M
3.1.5	High latitude, as it affects navigation systems, communication systems and the quality of ice imagery information	H	H	H	H
3.1.6	Remoteness and possible lack of accurate and complete hydrographic data and information, reduced availability of navigational aids and seamarks with increased potential for groundings compounded by remoteness, limited readily deployable SAR facilities, delays in emergency response and limited communications capability, with the potential to affect incident response	H	H	L	L
3.1.7	Potential lack of ship crew experience in polar operations, with potential for human error	H	H	H	M
3.1.8	Potential lack of suitable emergency response equipment, with the potential for limiting the effectiveness of mitigation measures	H	M	M	L
3.1.9	Rapidly changing and severe weather conditions, with the potential for escalation of incidents	H	H	H	L
3.1.10	The environment with respect to sensitivity to harmful substances and other environmental impacts and its need for longer restoration	H	H	H	H

Note:① H—high probability; M—medium probability; L—Low probability; N—Not available

② A, B and C mean respectively category A, category B and category C polar ships operating in polar water defined in IMO Polar Code. Ci means category C ship with ice class; C_o means category C ship navigating in Arctic waters in summer.

2.3.3 Accident scenarios and risk assessment:

2.3.3.1 For identified hazards, the polar ship is to identify the possible accident scenarios, considering operational conditions, environmental conditions, cargo conditions, crew experience, capabilities of the ship and equipment. The typical accident scenarios include, but not limited, as follows:

(1) The typical accident scenarios of the ship operating in ice zones include:

① The ship encounters the ice condition which exceeds the design operational capability, thus causing the damage of the hull structure, thruster and steering gear;

② The ship enters the ice condition which exceeds the design operational capability, thus causing besetting;

③ Ice ingestion occurs in the sea water system when the ship navigates in the ice area, thus causing failure of the machinery equipment and malfunction of the fire fighting system;

④ Abandonment of the ship onto ice or land results in malfunction of lifesaving equipment, thus affecting survival of personnel;

⑤ The ship navigates near icebergs/glaciers, falling of ice results in damage of the ship and equipment;

⑥ Improper operation of the ship results in collision with the escort ship and the ship which manages the ice areas;

⑦ The ship rides up onto the ice block or fixed ice, thus causing a reduced stability (small ships).

(2) The typical accident scenarios of the ship operating in low air temperature include:

① Brittleness/breaking of the material in low air temperature results in flooding and sinking of the ship, release of pollutants, malfunction of the equipment;

② ice/snow accumulation on the surface of the structure and equipment above the hull waterline results in a reduced stability;

③ Icing on the surfaces of the exposed machinery installations, equipment and the system, freezing of hydraulic agent or increased viscosity, freezing of grease oil, result in loss of function;

④ Too low environmental temperature at work and accommodation spaces results in loss of work ability, hypothermia and death to crew personnel;

⑤ Expansion of ballast water, fresh water, cargo due to freezing results in damage of the structure;

⑥ Falling down of the ice blocks when the ballast water is discharged while icing on the upper part of the ballast water occurs results in damage of the structure/system;

⑦ Activities of personnel in low air temperature , wind, ice environment result in frostbite of all extremities, hypothermia and death.

(3) The typical accident scenarios of the ship operating at high latitude include:

① Loss or instability of electronic navigational signals results in yawing, causing grounding, collision with ice floes;

② Malfunction of magnetic compass and deviation of gyro compass result in yawing, causing grounding, collision with ice floes;

③ Loss or instability of wireless communication, thus unable to provide emergency response, causing escalation of accident;

④ Extended periods of darkness and continuous poor visibility cause collision with ice floes;

⑤ Extended periods of daylight causes the eye hurt and work fatigue to the persons on watch;

⑥ Deficiency of aid equipment and deficiency or inaccuracy of hydrographic information cause grounding and collision with ice;

⑦ Deficiency of shore-based emergency response service and lack of repair result in delay in rescue, causing escalation of accident.

2.3.3.2 Based on the design operational capability of the ship and equipment, each identified accident scenario is to be risk assessed, qualitative analysis of possibility and consequence is to be carried out and risk level is to be determined having regard to the following factors:

(1) the design ice class;

(2) performance of the equipment and system;

(3) anti-cold climate measures;

(4) training and experience of the crew;

(5) operational experience of polar ship.

2.3.3.3 The assessment of the risk levels of the accident scenarios is to be carried out by a qualitative risk matrix in Table 2.3.3.3.

Qualitative Risk Matrix **Table 2.3.3.3**

Frequency	High	L=3	Medium	High	High
	Medium	L=2	Low	Medium	High
	Low	L=1	Low	Low	Medium
$R(e)$=2 or 3, low risk; $R(e)$=4, medium risk; $R(e)$=5 or 6, high risk			C=1	C=2	C=3
			Minor	Medium	severe
			Severity		

The risk index $R(e)$ of accident scenarios (e) is to be calculated as follows:

$$R(e) = L(e) + C(e)$$

where:

(1) L is frequency index, the definition of which is in the following Table 2.3.3.3(1):

Definition of Frequency Index of Accident Scenarios **Table 2.3.3.3(1)**

Frequency	L	Definition
Low	1	Likely to occur once in the lifetime of a ship
Medium	2	In the operation time of a ship, unlikely to occur frequently, but likely to occur several times
High	3	Likely to occur once a year in the operation time of a ship

(2) C is severity index, the definition of which is in the following Table 2.3.3.3(2);

Severity Index **Table 2.3.3.3(2)**

Consequence	C	Definitions			
		Effects on human safety	Effects on equipment	Effects on ship	Effects on environment
Minor	1	Single or minor injuries	After malfunction, it can re-operates by itself or is repaired in time	Local equipment damage, however, the overall safety and environmental protection of the ship is not affected	The pollutant of the accidental leakage disappears naturally within a week

Medium	2	Multiple or severe injuries	It can not be repaired, however, the malfunction does not affect the ship's navigation	Severe damage, causing the ship unable to navigate, however, no pollutant leaks	The pollutant of the accidental leakage needs to be removed actively, and the environment restoration takes not more than a year
Severe	3	Single fatality or multiple severe injuries	Malfunction makes the ship unable to continue navigation	Total loss or the pollutant leaks seriously	The pollutant of the accidental leakage needs to be removed actively, and the environment restoration takes more than a year

2.3.4 Development of risk control measures

2.3.4.1 The appropriate risk control measures are to be taken for the accident scenario with a medium risk, which may include:

(1) developing the operational procedure for ship and equipment system;

(2) providing the crew with the training of operating in polar waters;

(3) providing protective measures.

2.3.4.2 For the accident scenario with a high risk, the following risk control measures are to be considered in addition to the above 2.3.4.1:

(1) developing operational limitations, for ensuring the ship is operated within the scope of the design operational capabilities;

(2) optimizing the design and arrangement of the system, improving the operational capabilities, eliminating the effect of human factors.

2.3.5 Report of operational assessment

2.3.5.1 After completion of the operational assessment of the ship, a clear and explicit report of assessment is to be prepared, the content of which includes:

(1) summary of implementation of the ship's operational assessment;

(2) a list of identified hazards and their associated accident scenarios;

(3) the risk level of each accident scenario;

(4) applied risk control measures required.

2.3.5.2 For the text of the report of operational assessment, see appendix 5 of the Guidelines (the report of operational assessment)

2.3.5.3 The results of operational assessment may vary with the change of the ship's navigating environment and operational conditions. The operational assessment is to be re-carried out when necessary, to avoid a new risk due to the change the navigational conditions.

(1) change of navigating area and navigating time;

(2) change of the ship management and operation, such as major adjustment of the crew, change of the ship purpose, major change of the loaded cargo etc.;

(3) major change of ship structure, navigational equipment and system.

Section 4 CERTIFICATES AND DOCUMENTS

2.4.1 Objective

2.4.1.1 This Section provides guidance on how to fill in Polar Ship Certificate, and how to approve and/or re-approve other relevant certificates and documents required by SOLAS and MARPOL.

2.4.2 Polar Ship Certificate

2.4.2.1 The operational capabilities and corresponding limitations of polar ship are required to be indicated on the Polar Ship Certificate , and the included categories are given in Table 2.4.2.1:

Table 2.4.2.1

Types	**Feature of operational capabilities**	**Operational limitations**
Operating in ice	Ice class, ship category	Ice condition in which operation is allowed
Operating in low air temperature	Polar Service Temperature (PST)	Lowest Mean Daily Low Temperature (LMDLT) in the area and season of operation in polar waters.
Operating at high latitudes	Latitude	The scope of latitude which the communication equipment is suitable for
Operating in remote areas	Max. expected rescue time	SAR position available (only included in PWOM)

2.4.2.2 Polar Ship certificate stipulates the standard text in relation to operational limitations as follows:

(1) Ice Conditions: Limited to operations in polar waters appropriate to the ice strengthening applied and the requirements of a method/system for determining operational limitations approved for use on the ship by the Administration:

① Name of method/system: such as (POLARIS) (see appendix 2);

② Reference document number: Chapter No. of PWOM;

③ Date issued.

A description of the method/system, ship-specific limitations and guidance on using the system, with example calculations, is/is not included in the Polar Water Operational Manual.

(2) Temperature: Limited to operations in polar waters where the expected lowest Mean Daily Lowest temperature for the area and season of operation is:

① Where the ship is intended to operate in low air temperatures: greater or equal to the PST assigned on the Certificate plus 10 degrees.

② Where the ship is not intended to operate in low air temperatures: greater or equal to the minus 10 degrees.

(3) High latitudes: Where the ship’s communication is limited with respect to coverage at high latitudes, limited to operations in polar waters within the detailed operational latitude range.

2.4.2.3 Operating in remote areas: Limited to operations in polar waters where access to appropriate Search and Rescue facilities is within the expected time to rescue, and included in PWOM.

2.4.3 International Oil Pollution Prevention Certificate (IOPP Certificate)

2.4.3.1 Categories A and B polar ships constructed on or after 1 January 2017 are to be in compliance with the additional structural requirements on tank protection, as set out in section 1.2 of Chapter 1 of Part II-A of IMO Polar Code. The IOPP Certificate (Forms A and B) amended by annex I of MARPOL is to be issued.

2.4.3.2 For ships built before 1 January 2017, if operating in polar waters, the IOPP Certificate amended by annex I of MARPOL is to be renewed at the expiry of the original IOPP Certificate.

2.4.3.3 A category A ship constructed before 1 January 2017 that cannot comply with paragraph 1.1.1, Chapter 1, Part II-A of IMO Polar Code for oil or oily mixtures from machinery spaces and is operating continuously in Arctic waters for more than 30 days is to comply with the requirement of such paragraph not later than the first intermediate or renewal survey, whichever comes first, one year after 1 January 2017. The approval could be achieved through a letter of approval issued by the Administration, instead of reflecting the approval on the IOPP certificate.

2.4.4 International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS certificate) or Certificate of Fitness and Procedures and Arrangements Manual

2.4.4.1 Categories A and B ships constructed on or after 1 January 2017, the carriage of noxious liquid substances (NLS) identified in chapter 17, column e, as ship type 3 or identified as NLS in chapter 18 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) in cargo tanks of type 3 ships, which is approved by the Administration, may be noted in the column "Conditions of carriage" or in the general remarks related to both the NLS Certificate and Certificate of Fitness.

2.4.4.2 For the existing ships engaged in operating in polar waters on or after 1 January 2017, the procedures and arrangements manual is to be amended in accordance with resolution MEPC.265(68), automatically approved and remains valid until the first scheduled survey related to the NLS Certificate or the Certificate of Fitness.

2.4.5 Garbage Record Book

2.4.5.1 No approval is needed for ships introducing modifications to the Form of Garbage Record Book, as set out in resolution MEPC.265(68).

2.4.6 PWOM

2.4.6.1 The owner is responsible for preparing PWOM, taking into consideration the results of the operational assessment.

2.4.6.2 PWOM is to be examined by the Society's surveyor who issues Polar Ship Certificate:

(1) the format and content of PWOM in compliance with Appendix 2 of IMO Polar Code;

(2) operational capabilities and limitations approved by the Society, and in compliance with the approved plans and documents.

(3) use of the method or system of assessment of limitations for operation in ice accepted by the Administration, where applicable;

(4) operational procedure in compliance with the requirements of Chapter 2 of Part I-A of the

Polar Code, the results of the operational assessment considered.

2.4.6.3 PWOM is to be incorporated in ship's Safety Management System, and verified for implementation at the ISM audit.

Section 5 ASSESSMENT OF AN EQUIVALENCY FOR ICE CLASS

2.5.1 General Provisions

2.5.1.1 If categories A and B polar ships are not designed in accordance with polar class (PC), the owner or the ship designer is to submit the request of an equivalency for ice class and provide supporting information required for approval by ISC.

2.5.1.2 The scope of assessment of an equivalency for ice class is expected to be limited at least as follows, see Table 2.5.1.2:

Table 2.5.1.2

Scope	New ship	Existing ship
Structural strength of the hull	X	X
Structural strength of the propulsion machinery	X	X
Materials selection	X	X
Damage stability	X	
Tank protection in structure	X	

2.5.2 Process of assessment:

2.5.2.1 The process includes the following stages of assessment:

(1) select the target Polar Class for equivalency;

(2) compare materials used in the design with minimum requirements for polar class (PC) materials; identify any shortfalls; and

(3) compare strength levels of hull and machinery components design with requirements for polar class (PC); quantify levels of compliance.

2.5.2.2 Where gaps in compliance with the selected target Polar Class are identified, additional steps should be necessary to demonstrate equivalency, as outlined below:

(1) identify any risk mitigation measures incorporated in the design of the ship (over and above the requirements of the Polar Code and polar class (PC));

(2) where applicable, provide documentation of service experience of existing ships, in conditions relevant to the target ice class for equivalency; and

(3) in accordance with the above information, undertake an assessment of safety and pollution risk, and determine the risk level for equivalency.

2.5.2.3 The principle of an equivalent level of risk is as follows:

(1) Based on the risk control principle that an increase in the probability of an event can be balanced by a reduction in its consequences, a local shortfall in strength level or material grade could be accepted if the internal compartment in a hull area is a void space, for which local

damage will not put the overall safety of the ship at risk or lead to any release of pollutants.

(2) For existing ships, service experience can assist in risk assessment. As an example, for an existing ship with a record of polar ice operations a shortfall in the extent of the ice belt (hull areas) may be acceptable if there is no record of damage to the deficient area; i.e. a ship that would generally meet PC 5 requirements but in limited areas is only PC 7 could still be considered as a category A, PC 5 ship. In all such cases, the ship's PWOM or other documentation should make clear the nature and scope of any deficiencies.

2.5.3 Documents of assessment

2.5.3.1 Documentation provided with an application for equivalency should identify each stage that has been undertaken in accordance with 2.5.2, and sufficient supporting information to validate assessments.

2.5.3.2 Where a ship in category A or B is provided with an equivalency for ice class by its flag State, this should be noted in its Polar Ship Certificate.

CHAPTER 3 HULL STRUCTURES AND EQUIPMENT

Section 1 MATERIAL AND COATING

3.1.1 General

3.1.1.1 One of the main consequences for ships navigating in polar waters is the effect on hull structures and components due to ice loads and/or low air temperature. The hull structure of polar ship is to select the adequate toughness material so as to avoid brittle fracture.

3.1.1.2 Although the design of polar ship depends on the anticipated operational conditions, the hull structural material is to be selected by giving due consideration to the match of polar class (ice class) with PST insofar as practicable:

(1) Category A polar ship is generally designed to operate in the coldest months of winter for a long period in polar waters, the PST of hull structural material is to be -40℃ and below.

(2) Category B polar ship is generally designed to seasonally operate in the continuous months of winter in polar waters, the PST of hull structural material is generally to be -15℃~-30℃.

3.1.1.3 Due to toughness of carbon steel reducing with the temperature drop, risk of brittle fracture is increased for the ships operating in low air temperature environments to use A class low carbon steel. A class steel is unsuitable to select for exposed structures at the temperature below -18℃.

3.1.2 Material selection

3.1.2.1 The materials of hull structures located in ice belt zone for Category A and B polar ships are to select proper steel grade in accordance with the polar class, grade of structural member material and plate thickness required in Sections 1 and 2, Chapter 13, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships. Materials of machinery installations are also to meet the requirements for impact toughness in Section 3, Chapter 13 of ISC Rules for Classification of Sea-going Steel Ships.

3.1.2.2 Applicable steel grade is to be selected for the materials of hull structures located in ice belt zone for Series B of Category C polar ship are to be in accordance with the relevant requirements of Chapter 4, PART TWO of ISC Rules for Classification of Sea-going Steel Ships.

3.1.2.3 For polar ship applying for the class notation of anti-cold climate (ACC), hull structural materials and machinery installations are to be in compliance with the requirements of Section 2, Chapter 23, PART EIGHT of ISC Rules for Classification of Sea-going Steel Ships, and the steel grade is to be selected in accordance with PST (DST), grade of structural member material and plate thickness.

3.1.2.4 For category C polar ship without ice class, if not applying for the class notation of ACC, the hull structural materials are to meet the relevant requirements of Section 3, Chapter 1, PART TWO of ISC Rules for Classification of Sea-going Steel Ships.

3.1.2.5 Polar ship materials are to satisfy the requirements of ISC Rules for Materials and Welding. In case of additional requirements from the shipowner, high strength steels for polar ship with suffix "ARC-M(X)" in Appendix 8 of the Guidelines may be selected.

3.1.3 Coating

3.1.3.1 Wear-resistant coating with the properties of high adhesion, peeling-resistance and low friction, such as polyurethane and epoxy, is recommended to use on shell plating located in ice belt zones for Category A and B polar ships, considering the increase of hull corrosion rate due to the higher concentration of dissolved oxygen in polar waters.

3.1.3.2 Stainless steel shell plating located in ice belt zones may not be coated, however, additional anodes or equivalent galvanic protection is to be provided to prevent electrochemical corrosion.

3.1.3.3 Low temperature performance coating may be applied to the external or internal surface of boundaries directly adjacent to exposed areas in low air temperature environments. Such coating is to maintain its original property in low air temperature so as to prevent the coating peeling off the protected surfaces in low air temperature.

3.1.3.4 Where the ship is intended to operate in a potential severe icing area or season for a long period, anti-ice/snow accumulation coatings are to be applied on the exposed surface, such as deck, both ends and side bulkheads of deckhouse and superstructure, rails, bulwarks and deck machinery, etc. in order to reduce the effects of ice and snow accumulation on hull structures and equipment.

Section 2 STRUCTURES AND ARRANGEMENT

3.2.1 General

3.2.1.1 For the structural type and arrangement of polar ship, due consideration is to be given to its intended purposes in polar waters so as to ensure the ship effectively adapts to the operational conditions of cold climate, remoteness, sea ice, etc.

3.2.1.2 The capability of ship navigating in ice zones depends on time quantum of operating in ice-covered waters corresponding to open water areas, ice condition on operational courses and availability and expense of escorting service provided by icebreaker. In general, polar ship mainly engaged in icebreaking operation is expected to meet the requirements for operational performance indicated in Table 3.2.1.2.

Table 3.2.1.2

Ice condition	Operational performance in ice zone
Normal ice condition	Reaching a normal speed of 10 ~ 12 knots
Severe ice condition	Reaching a lower speed of 6 knots
Under a given ice thickness condition	Maintaining the minimum continuous speed of 2 knots

3.2.1.3 The selection of ice class for merchant polar ship directly affects increase of structural scantlings and propulsive power and leads to raised construction costs and loss of cargo deadweight. The higher the ice class, the more substantial the influence will be.

3.2.1.4 For the general arrangement of polar ship, consideration is to be given to the following:

(1) Needs to provide cargo handling gear due to remoteness of ports in the Arctic and lack of port facilities in the Antarctic;

(2) Needs to provide tank capacities and storage for spares and provisions due to the strict environmental protection requirements in polar waters and appropriate ship's endurance ability;

(3) Needs to provide appropriate measures in interior access ways and equipment operating spaces and living facilities, i.e. heating, insulation, air conditioning, extra lighting, etc. due to cold climate and darkness;

(4) Needs to consider noise and vibration for design of accommodation spaces caused by icebreaking due to operation in ice zones;

(5) Needs to provide an accessible zone on aft deck, including towing notch at stern and helicopter deck due to escort and towing operation;

(6) Needs to arrange a clear vision in all directions for bridge.

3.2.2 Type of hull

3.2.2.1 The type of hull for polar ship is to be designed by considering the equilibrium between the performance in ice zones and open waters, including the following:

(1) performance in ice zones, including polar class, icebreaking ability, etc.;

(2) hydrostatic properties in open waters;

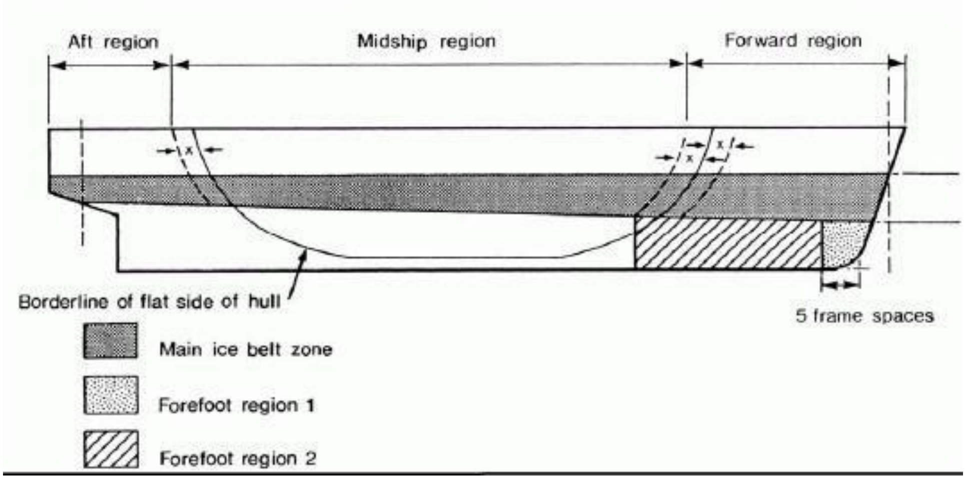
(3) maneuvering capability;

(4) selection of main scantlings;

(5) construction costs and maintenance;

(6) ship types.

3.2.2.2 The prediction of ice load for polar ship is an essential condition to carry out structural design. Ice loads depend on configuration of hull, displacement, power of main engine, speed, property and kind of ice, etc. In general, the forward region is under the maximum ice load while the bottom region is under the minimum ice load. The distribution trend of ice loads on conventional ship is shown in Figure 3.2.2.2.



(Source: Canadian Coast Guard《Ice Navigation in Canadian Waters》 Figure 78)

Figure 3.2.2.2 Diagram of Distribution Trend of Ice Loads

3.2.2.3 The bow form of polar ship is to be applicable to ice conditions in ice-covered waters. Icebreaking bow is to be used for Category A polar ship to avoid bulbous bow and blunt bow. Bulbous bow and blunt bow may be used for Category B polar ship, but any operation of ramming with ice blocks at stem is to be restricted.

3.2.2.4 The following design features (see Figure 3.2.2.4) are to be taken into consideration for icebreaking bow form. In order to obtain the best navigation capabilities and high deicing efficiency in ice zones, currently, the trends of design for icebreakers are to increase flare angle, reduce waterline angle, stem angle and buttock angle.

(1) Flare angle avails icebreaking and immersion efficiency;

(2) Waterline angle avails deicing efficiency;

(3) Stem angle and buttock angle avail icebreaking and immersion efficiency.

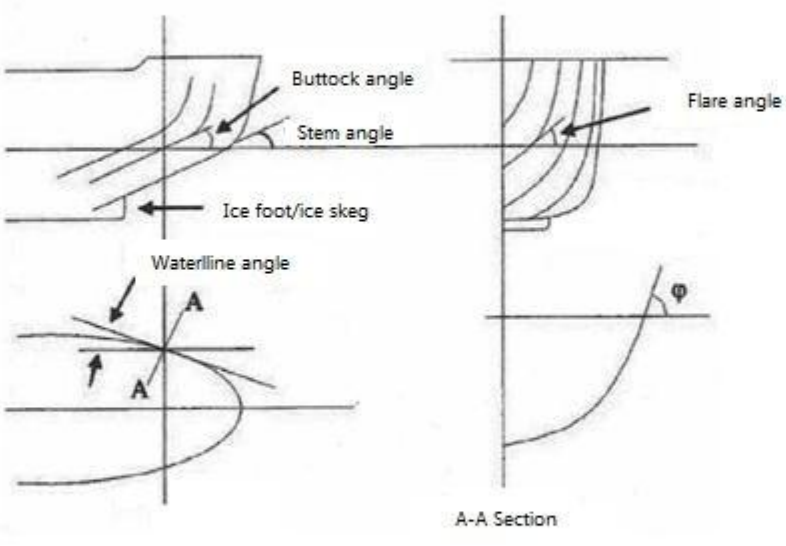


Figure 3.2.2.4 Bow Features of Polar Ship

3.2.2.5 Ice foot/ice skeg (see Figure 3.2.2.4) may be fitted to the bow to prevent the hull being damaged due to ramming with ice blocks and limit the extent to which the ship can ride up on the ice.
3.2.2.6 A gradual transition from the bow to the amidship for polar ship with icebreaking capability is to be employed so as to avoid excessive crushing at the shoulders.
3.2.2.7 The amidship form is to be selected by considering its effects on resistance, seaworthiness, construction cost and deadweight. Sloped side, generally taken 8^{o} from vertical availing bending type icebreaking, may be provided in admiship of polar ship having high class icebreaking capability, shown in Figure 3.2.2.7.

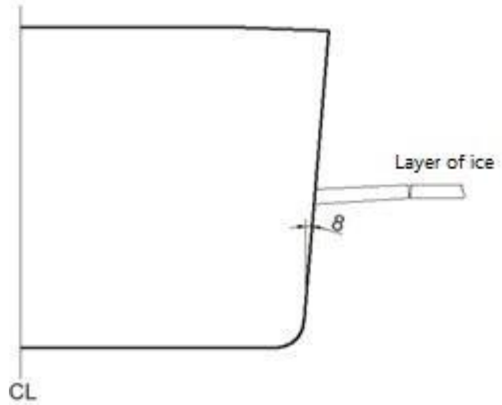


Figure 3.2.2.7 Diagram of Design for Midship Section of Ship with High Ice Class

3.2.2.8 The form of stern for polar ship is to be designed to facilitate protection of propelling unit of propulsion system (conventional shaft driving in Z direction, single, two, three propellers and open type or tube type propellers) when the ship is astern. For the ships with stern icebreaking capability, the stern is to be designed in accordance with the requirements for forward region and forward transition region, and ice knife is to be provided after the rudder so as to deflect and split the floating ice blocks and prevent the rudder and propeller excessively ramming with ice blocks.

3.2.3 Arrangement of pollutant tanks

3.2.3.1 All oil fuel tanks, residual oil (oil sludge) tanks and storage tanks containing oily bilge water with an individual capacity greater than 30 m^{3} onboard category A and B polar ships are to be separated from the outer shell by a distance of not less than 760 mm.
3.2.3.2 For category A and B ships other than oil tankers, all cargo tanks constructed and utilized to carry oil are to be separated from the outer shell by a distance of not less than 760 mm.
3.2.3.3 For category A and B polar oil tankers, irrespective of the deadweight, the entire cargo tank length is to be protected with:
(1) double bottom tanks complying with the applicable requirements of regulation 19.6.1 of MARPOL Annex I; and
(2) wing tanks arranged in accordance with regulation 19.3.1 of MARPOL Annex I and complying with the applicable requirements for distance referred to in regulation 19.6.2 of MARPOLAnnex I.

3.2.4 Scantlings of hull structural members

3.2.4.1 In addition to Category A and B polar ships in compliance with the requirements for structural strength and scantlings of structural members of applicable ship types in ISC Rules for Classification of Sea-going Steel Ships, the scantlings of hull in ice belt regions required by ice class are to comply with the applicable requirements of Chapter 13, PART EIGHT in ISC Rules for Classification of Sea-going Steel Ships.

3.2.4.2 Category C polar ship is to comply with the requirements for structural strength and scantlings of structural members of applicable ship types in ISC Rules for Classification of Sea-going Steel Ships. If ice class is used, series B ice class suitable for ice conditions in its operation areas may be selected and meeting the relevant requirements in Chapter 4, PART TWO of ISC Rules for Classification for Sea-going Steel Ships.

3.2.5 Anti-freezing protection for tanks

3.2.5.1 If ballast tanks and/or fresh water tanks of polar ship are partially or all located above light weight waterline or LIWL and adjacent to shell or exposed deck, in general 10% of void capacity is to be considered so as to reduce the effects of expansion of ballast water and fresh water due to freezing.

3.2.5.2 In general, ballast tanks all located below light weight waterline or LIWL (whichever is the less) is not to be heated, however, the piping serving these tanks (including venting pipes) are to be protected against blockage due to freezing.

3.2.5.3 For the ballast tanks and fresh water tanks mentioned in 3.2.5.1, suitable anti-freezing system and temperature monitoring system are to be provided so as to prevent structural damage by negative pressure when discharging due to freezing of ballast water and fresh water in tanks, if the polar ship is operated in low air temperature for a long period. Measures are to be taken for equipment and system in tanks to prevent surface damage due to ice dropping.

3.2.5.4 Anti-freezing system mainly includes heating, circulating and air bubbling systems, etc.

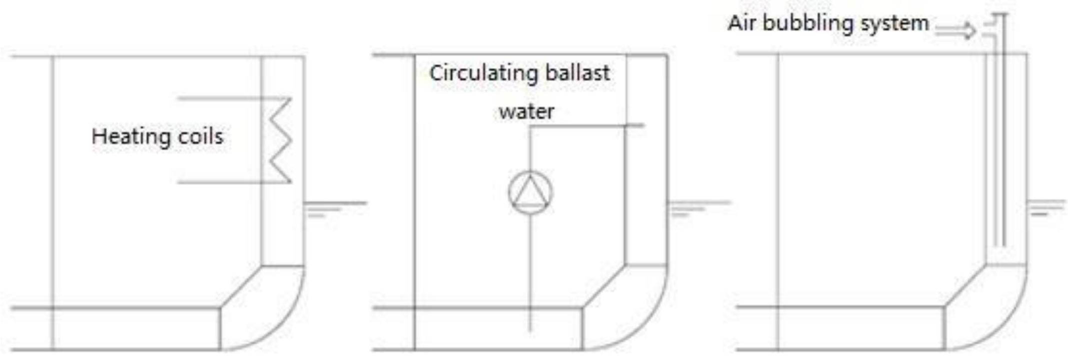


Figure 3.2.5.4 Anti-freezing System in Tanks

(1) The most effective and commonly used is steam heating coils. The heating coils are usually to

be fitted above the ballast waterline, adjacent to the ships side shell. When the heating exchange is calculated for determining the number of heating coils, the temperature of ballast water is to be maintained about 2℃. If the PST is less than -40℃, such anti-freezing system is to be provided.

(2) Steam heating system onboard oil tankers may be fitted to cargo and slop tanks, the condensate line located after steam heating ballast tank is to be independent from that of cargo system in order to prevent possible contamination through heating coil failure.

(3) Sufficient drainage is to be employed on both steam lines and condensate lines to prevent freezing of lines when not employed.

(4) Circulating the ballast water is considered as an efficient alternative in a short period of time because of the natural differences in temperatures between the bottom and surface of ballast tank.

(5) Air bubbling system achieves the anti-freezing effect through continuous turbulence of the ballast water to circulate internally. However, the low temperature in tank leads to freezing in local regions within tank, the piping may be damaged by ice falling down and coating and structural members in tanks were also damaged. It also has the disadvantage of possible under-cooling of the water and the formation of ice crystals by the cold air. Ballast water containing ice crystals makes the water have a consistence like porridge which is difficult to pump. Air-bubbling system is not fit to use in an extreme cold climate.

3.2.5.5 Vents (especially the vents facing the wind) are to be so arranged as to reduce the ice accumulation due to external spray to cause blockage and prevent the internal pressure changing when pumping and leading to the damage of tanks or hull structures.

3.2.6 Bridge wings and forward region and their arrangement

3.2.6.1 The bridge wings of category A and B polar ships are to be enclosed, unless the ships are restricted to operate above the ice point temperature.

3.2.6.2 Ships of the length below 150 m operating in low air temperature are to be provided with a forecastle in order to reduce the green seas and spray on main deck areas after the forward part. If it is impossible to provide, shell plating could be designed to flare so as to achieve the same effects. The forward part may also be enclosed or provided with a sheltering space to protect anchor equipment and operators. The sheltering space is generally to be designed to have a shelter in top and three directions and facing towards stern.

3.2.6.3 Vents are not to be provided in the exposed location of forward region of superstructure as practical as possible. If it is impossible, suitable protection is to be recommended, such as anti-exposure arrangement, protective shielding or heat tracing device is provided, etc.

3.2.7 Accommodation space

3.2.7.1 The accommodation space onboard polar ship operating in low air temperature is to be designed by considering that:

(1) The heating and ventilation systems are to be designed for satisfactory distribution of heating at the minimum anticipated temperature.

(2) Supplementary electric heaters may be used in cabins and other manned spaces provided they

are permanently installed. High amperage permanently installed heaters are not to be wired to the same circuit breakers as vital electronic equipment. Portable electric heaters are not permitted.

(3) The relative humidity is to be maintained in the range from 30% to 70%, and it is capable of regulating the humidity of accommodation compartments.

(4) Accommodation compartments are to be able to be heated to 18℃ at the minimum anticipated temperature, and continuously maintained.

(5) Recirculation of air in the accommodation spaces is to be in accordance with a recognized standard.

(6) Air ventilation ducting is to be insulated with non-combustible insulation.

(7) The closing apparatus for all ventilation inlets and outlets are to be provided with protective means or heat tracing device.

3.2.7.2 Doors or passageways extending to accommodation space are to be designed to meet the passing demand by a person wearing polar suit, and heat tracing device or other anti-icing measures are to be taken.

3.2.7.3 Bathrooms and toilets are not to be located adjacent to the external exposed boundaries as practical as possible to prevent icing, otherwise, the external exposed boundaries are to be provided with insulation and heating device, and drainage tray or drainage channel is to be provided to collect condensate water.

3.2.7.4 Protective vapour layer, i.e. aluminium foil or other equivalent measures is to be taken for external insulation on bulkheads and top deck of accommodation compartments, so as to reduce damage of moisture freeze to insulation on external exposed boundaries.

3.2.7.5 Ventilation system is easily to accumulate ice, and suitable heating device may be provided or the following alternative measures could be taken:

(1) Ventilation inlets are to be arranged in a space not affected by seawater spray, i.e. leeward or recessed position of superstructure;

(2) Each ventilation inlet is provided at both port and starboard, and arranged in opposite direction to effectively withstand the adverse effects of spray ice.

3.2.7.6 The internal units within air inlet channel (such as wind damper) is to be designed to be capable of draining accumulated ice or water after ice melting and condensate water caused by temperature change to prevent rust or bacterial growth in the pipes due to accumulated water of condensate water in air inlet channel.

3.2.7.7 For the ships operating in an extreme cold climate, the air inlet and outlet channels may be arranged crossly, so as to prevent excessive heat loss.

3.2.7.8 Sufficient dressing rooms are to be provided near the exits of accommodation compartments to facilitate changing of winter clothes, and the dressing room is to be capable of drying and storing the winter clothes.

3.2.8 Arrangement of heating areas

3.2.8.1 Critical areas to ship safety, including navigation, steering, propelling, anchoring, fire-protection, life-saving, etc., are to be heated or provided with shield to maintain an ice-free state. These areas are to include the followings as a minimum:

(1) gangway and stairway giving safe access to forward region, lifeboat, rescue boat, etc.;

(2) exit of escape route;

(3) lifeboat, davit, liferaft and launching area;

(4) storage facility of life-saving equipment;

(5) water supply distribution system of fire-protection system;

(6) navigational equipment (such as radar);

(7) windows of bridge room;

(8) anchoring area on deck, including windlass, chain and hawse pipe.

3.2.8.2 The heating area is to be provided according to ship type and intended operation demands, and manual tools may be provided in other areas, e.g. hose connector for steam blowing is to be required to provide in the following areas onboard tankers:

(1) upper deck (a certain quantity arranged with intervals along the deck);

(2) cargo manifold area (port and starboard);

(3) forward and afterward deck;

(4) adjacent to air inlet of air conditioning system;

(5) beneath of vent masts.

3.2.9 Anti-icing and anti-freezing arrangements

3.2.9.1 Deicing and anti-freezing measures depend on the intended operational requirements for ships. For the ships operating at a low air temperature (i.e. in the Arctic) for a long period, permanent deicing and anti-freezing measures are to be recommended to provide, but for ships occasionally operating in low air temperature, portable deicing and anti-freezing equipment may be employed.

3.2.9.2 For sheltering arrangement, hard mobile shield or canvas hood may be generally employed, or sheltering arrangement is to be provided. For the specific application onboard the ships, such as craft, winch or other exposed deck machinery are employed.

3.2.9.3 For electric heat tracing or vapour, heating cable or pipeline is to be fixed with proper intervals so as to transmit the heat to equipment and structure and prevent excessive heat stress. The related arrangement is generally to be based on heat balance calculation to ensure the effectiveness of heating measures at anticipated lowest ambient temperature. For the specific application board the ships, such as hydraulic control device for exposed deck machinery, piping easily icing, exposed accesses and stairways, etc. are employed.

3.2.9.4 For the manual deicing, special attentions are to be paid to the damage of equipment in the process of deicing. For the specific application onboard ships, such as steam blowing or pouring hot water, or swaying of sling/pillar/antenna are taken to prevent ice accumulation, and knocking off ice on shield by mallet, deicing by use of hammer/stick/scraper/similar tools, etc.

3.2.9.5 Low temperature grease protection is to be taken to prevent freezing of movable components of deck machinery, i.e. windlass, door hinge and fairlead, etc., but this may cause the components being inflexible or overloading, moisture beneath the coating is to be avoided.

3.2.9.6 Bubble generating device is to be provided, which may be supplied by dedicated compressed air device, or combined air system of which air bubbling amount has been calculated. Sufficient number of air nozzles is to be arranged in bilge and the air supply system is not to cause the pressure to exceed the design one of the tank. For the specific application board the ships, such as ballast tank, tank, etc. are employed.

Section 3 RUDDER EQUIPMENT AND APPENDAGES

3.3.1 General

3.3.1.1 Rudder equipment and outfitting of hull appendages for polar ship with ice class are to meet the relevant requirements of Chapters 3 and 4, PART TWO and Chapter 13, PART EIGHT in ISC Rules for Classification of Sea-going Steel Ships, so as to ensure that the ship has sufficient strength to withstand the effects of ice load.

3.3.2 Rudder equipment

3.3.2.1 The rudder is to be designed by considering lower speed of going ahead and the anticipated operational capabilities to improve maneuverability of navigating in ice areas. For rudders onboard ships with high ice class and icebreakers, more rudder pintles (and gudgeon) may be provided to evenly transmit the ice load on rudder blades to hull structures, see Figure 3.3.2.1.

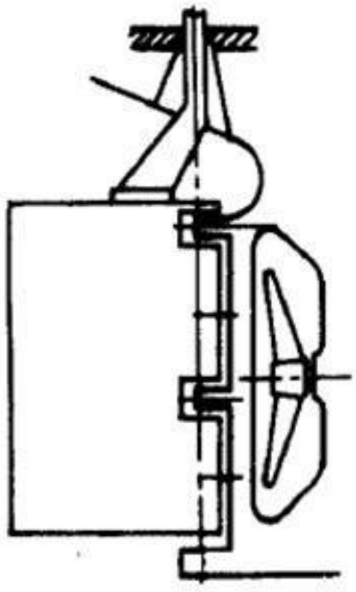


Figure 3.3.2.1 Diagram of Multi-pintle Rudder

3.3.2.2 Two working modes are considered for rudder onboard the ships with ice class, turning for going ahead mode and direct astern mode. In the turning for going ahead situation, the ice load acts on the side and due consideration is given to ice load acting on the rudder horn. In the direct astern mode, the ice load directly acts on the stern, and due consideration is given to ice load acting on the rudder blades.

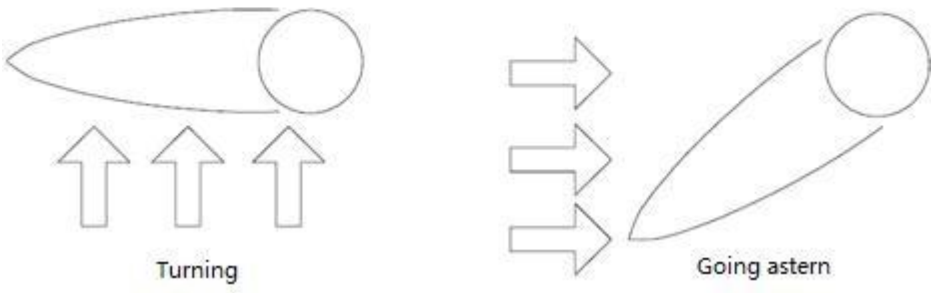
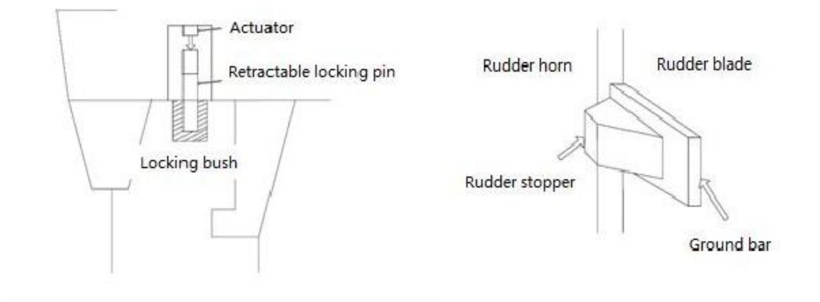


Figure 3.3.2.2 Ice Loads Acting on Rudder Structure

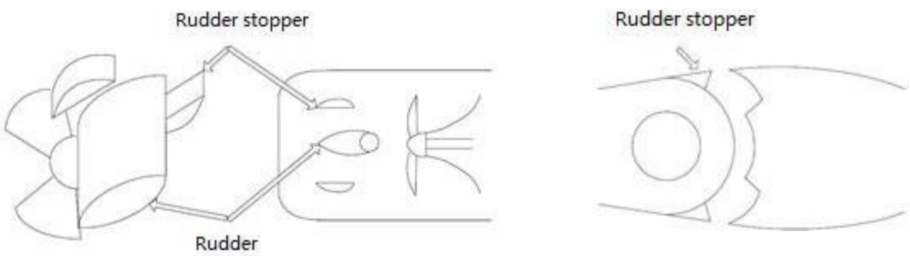
3.3.2.3 In low air temperature environments, ice may be accumulated on the exposed part of rudder to affect the connection zone between rudder stock and fixed ring or the zone between the surfaces of fixed rudder protector and rudder blade, so regular inspection is to be carried out to check if ice is accumulated on rudder, and deicing may be performed by rotating. The exposed sealings of rudder stock are to be designed by taking into consideration icing and low air temperature.

3.3.2.4 In order to reduce the damage on steering gears for the astern operation in ice areas, draught position of a ship is to be adjusted to make the easily damaged parts immerse in the water. When the rudder blades are deflecting from amidship due to effect of ice load, huge load will be generated in the whole rudder system. For ships with ice class, working pressure and setting value of safety valve will be higher due to greater steering gear power because of the greater service speed being selected for design calculation. In such a case, the setting values of safety valve are to be adjusted to prevent ineffective offloading when the effect of ice load exceeds the design torque of rudder stock.

3.3.2.5 Appropriate fixed device (such as rudder stopper/locking pin) is to be provided for rudder blades to ensure the blades are located in the amidship when the ship is going astern. The design torque of fixed device is to be taken as the design yield torque of the rudder stock in Chapter 3, PART TWO of ISC Rules for Classification of Sea-going Steel Ships, the criteria of stress is to be taken 95% yield stress of materials used. The diagram of rudder stopper and locking pin is shown in Figure 3.3.2.5.



(a) Locking pintle (b) Rudder stopper fitted to rudder blade



(c) Rudder stoppers fitted to hull structure (d) Integrated rudder stopper

Figure 3.3.2.5 Diagram of Rudder Stopper and Locking Pintle

3.3.3 Appendages

3.3.3.1 The appendages of polar ship are to be strengthened according to the anticipated ice loads.

3.3.3.2 In order to reduce the damage arising from a bilge keel being partly torn off, it is preferable that the bilge keels are cut into several shorter independent lengths and of box type construction. It is also recommended that bilge keels are not to be fitted within the 1/3 L (L is the length of ship) of forward part for category A polar ship.

3.3.3.3 During the operation in ice areas, the additional stabilizer of polar ship, i.e. bilge keel may be retracted and suitable strengthening is to be carried out for the structure around the stabilizer. For the additional stabilizer which could not be retracted during the operation in ice areas, strengthening is to be carried out in accordance with the requirements for rudders.

3.3.3.4 Ice knife made of steel plate or casting is to be provided to reduce the ice load acting on the top of rudder so as to prevent ice from wedging between the top of the rudder and the ship hull. The ice knife is to extend below the ballast waterline and be integrated into the hull.

3.3.3.5 If other appendage is provided, i.e. energy-saving device for propellers, sufficient strength is to be taken into consideration so as to prevent damage caused by ice load.

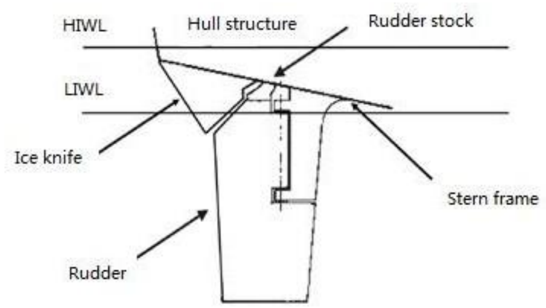


Figure 3.3.3.4 Provision of Ice Knife

CHAPTER 4 SHIP'S STABILITY

Section 1 INTACT STABILITY

4.1.1 General

4.1.1.1 In addition to the requirements of Section 9, Chapter 1, PART TWO in ISC Rules for Classification of Sea-going Steel Ships, the intact stability of polar ship is to have adequate intact stability when the ship is subject to ice accretion.

4.1.1.2 The polar water is an ice area defined by International Code on Intact Stability. If a polar ship has the intact stability required in 4.1.1, it is to be restricted to operate in warm seasons in polar waters.

4.1.2 Calculation of intact stability under icing condition and control of icing

4.1.2.1 The icing condition to be considered for the intact stability calculation for polar ship is not to be less than the following requirements:

(1) 30 kg/m^2 on exposed weather decks and gangways;

(2) 7.5 kg/m^2 for the projected lateral area of each side of the ship above the water plane; and

(3) the projected lateral area of discontinuous surfaces of rail, sundry booms, spars (except masts) and rigging of ships having no sails and the projected lateral area of other small objects are to be computed by increasing the total projected area of continuous surfaces by 5% and the static moments of this area by 10%.

4.1.2.2 Information on the icing allowance included in the stability calculations is to be given in the PWOM.

4.1.2.3 The polar ship is to be designed to minimize the accretion of ice, and equipped with such means for removing ice, e.g. electrical and pneumatic devices, and/or special tools such as axes or wooden clubs for removing ice from bulwarks, rails and erections.

4.1.2.4 During the ship's operation in ice areas, the ice accretion is to be monitored by crew in accordance with the procedures of PWOM, and appropriate measures is to be taken to ensure that the ice accretion does not exceed the values given in PWOM.

Section 2 DAMAGE STABILITY

4.2.1 General

4.2.1.1 In addition to the requirements for damage stability of conventional ships in Section 10, Chapter 1, PART TWO of ISC Rules for Classification of Sea-going Steel Ships, the category A and B polar ships are to have adequate residual stability under ice-related damage conditions.

4.2.2 Effects of floating ice on damage stability

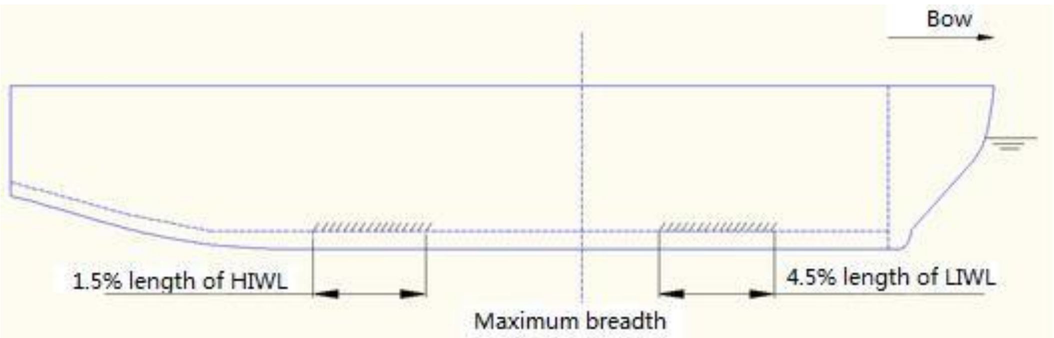
4.2.2.1 Categories A and B polar ships are to be able to withstand flooding resulting from hull penetration due to ice impact. The residual stability following ice damage is to be such that the factor s_i, as defined in SOLAS regulations II-1/7-2.2 and II-1/7-2.3, is equal to one for all loading conditions used to calculate the attained subdivision index in SOLAS regulation II-1/7. However, for cargo ships that comply with subdivision and damage stability regulations in another instrument with the deterministic approach in the damage stability calculation, the residual stability criteria of the corresponding instrument are to be met for each loading condition under ice-related damage.

4.2.2.2 In calculation of damage stability, the ice damage extents are to be assumed as following:

(1) The longitudinal extent is 4.5% of the upper ice waterline length if centred forward of the maximum breadth on the upper ice waterline, and 1.5% of upper ice waterline length otherwise, and is to be assumed at any longitudinal position along the ship's length;

(2) The transverse penetration extent is 760 mm, measured normal to the shell over the full extent of the damage; and

(3) The vertical extent is the lesser of 20% of the upper ice waterline draught or the longitudinal extent, and is to be assumed at any vertical position between the keel and 120% of the upper ice waterline draught.



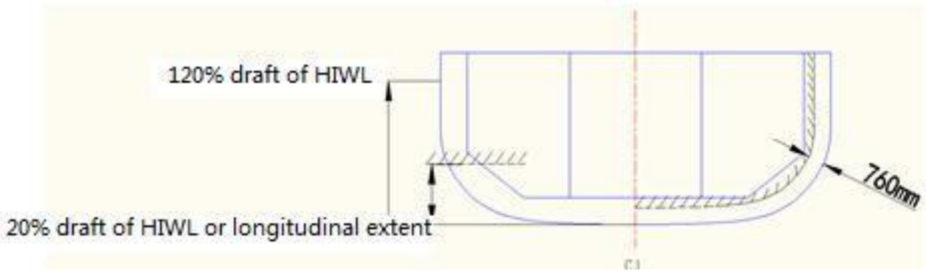


Figure 4.2.2.2 Diagram of Damage Extents

CHAPTER 5 MACHINERY AND ELECTRICAL INSTALLATIONS

Section 1 MAIN PROPULSION PLANT

5.1.1 General

5.1.1.1 Main propulsion plant is to be sufficient to ensure safe navigation of polar ship in ice-covered waters, and avoid ship being jammed or beset by ice due to system failure under severe conditions such as low temperature as far as possible, which will further lead to sea damage or pollution accident.

5.1.1.2 Main propulsion plant of category A and category B polar ship is to meet relevant requirements of Section 3, Chapter 13, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

5.1.1.3 Main propulsion plant of category C polar ship with ice class notation is to meet relevant requirements of Chapter 14, PART THREE of ISC Rules for Classification of Seagoing Steel Ships.

5.1.1.4 Main propulsion plant of polar ship with anti-cold climate class notation is to meet relevant requirements of Chapter 23, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

5.1.1.5 The propulsion system (including prime mover, gearing, shafting and propeller) of ships is to be designed so as to take into account the environmental characteristics of polar waters covered by sea ice all year round.

(1) System is to be designed based on load and vibration caused by the action of propeller and sea ice, and propeller damage is not to lead to shafting damage;

(2) As sea ice may lead to instantaneous jam of propeller, the design of relevant accessories is to consider prospective ice load and installation position on the hull. Propulsion machinery is to have sufficient strength, and effective measures are to be taken to prevent prime mover from over-speeding, excess torque, overloading and overheating;

(3) The propulsion system may improve operation efficiency in ice region by increasing or controlling the engine torque to a steady level during propeller ice interactions by the selection of appropriate engine type and engine control system;

(4) Increasing the moment of rotational mass inertia for the whole propulsion system can increase ice performance and can be achieved by increasing the diameter and mass of the rotor or shafting, and/or adding a flywheel.

5.1.2 Determination of propulsion power

5.1.2.1 When determining propulsion power of ship, following factors are to be taken into account:

(1) The determination of ice going capability is largely dependent on the vessel’s ability to produce sufficient force to break the ice. This comes from the engine power. Icebreaking ships

(especially exclusive icebreakers) have a large power to displacement ratio, required to overcome the friction resistance of the ice. There is usually an overlap in the engine power for ships, between the power for ice navigation and the power for open water speed. Usually, the former may have a higher requirement, but for ships with higher open water speed, the later may have dominant requirement.

(2) The demand for ship propulsion power is dependent on ice operation mode. Different from North Baltic Sea, polar waters usually cannot ensure icebreaker to assist navigation, and independent ice navigation may have higher power demand for ship. Higher power configuration may provide ship with higher icebreaking capability, and ship may encounter sea ice with higher strength. Therefore, certain balance between hull strength and propulsion power must be achieved, insufficient propulsion power may cause ship unable to break ice and thus being jammed by sea ice, but higher propulsion power may cause hull structure to suffer excessive ice load.

5.1.2.2 For category A and category B polar ship and category C polar ship with ice class notation, required propulsion power may be obtained based on numerical calculation or ice basin model test.

5.1.3 Selection of propulsion type

5.1.3.1 For ships navigating in ice region, sufficient thrust force is usually required under lower speed to support ice breaking, therefore, propulsion system with low revolution speed and big torque is to be selected.

5.1.3.2 In addition to higher output torque than that of diesel engine, AC propulsion motor under low revolution speed has other advantages, e.g. constant power over a wide range of speeds, constant power mode, rapidly rising torque, high inertia moment (providing instant resistance to falls in propeller speed) and prompt power reversing.

5.1.3.3 If propeller is driven directly by diesel engine through shafting, controllable pitch propeller is to be adopted as far as possible and pitch change is required to be as quick as possible.

5.1.3.4 Adopting ducted propeller can increase ship’s thrust force under bollard and low speed as well as contribute to blade protection. However, ducted propeller is liable to be blocked by sea ice, and therefore capability of prompt power reversing is required to remove blocked sea ice.

5.1.4 Propulsion propeller

5.1.4.1 Usually, plastic deformation of propellers of ships navigating in polar waters will not cause damage to propulsion shaft. Taking into account action of ice impacting blade, necessary strengthening is required for propeller, and size determination is to ensure its integrity.

5.1.4.2 Ice load of propeller comes from reaction of cutting and grinding ice during navigation, and ice load can be calculated by numerical simulation.

5.1.4.3 Suitable propulsion propeller is to be selected according to ice operation characteristics of ships navigating in polar waters. Propellers of polar ship generally adopt blades of detachable type rather than integral type to facilitate maintenance or replacement.

5.1.4.4 Fix pitch propellers (FPP) have the advantage of being simple and strong, but high skew propellers are more liable to be damaged at blade tip and not suitable in ice.

5.1.4.5 Controllable pitch propellers (CPP) have the advantage of being able to maintain a constant engine load, the disadvantage being a reduced pitch at slow speeds and hence, a reduced recovery speed when speeding up is needed.

5.1.4.6 Azimuths and Azipods improve manoeuvrability and can offer both low weight and size to reduce energy consumption.

5.1.4.7 All propellers must work below the ice in ballast condition. It is recommended that this minimum propeller immersion in all operating conditions is from the upper propeller tip to the waterline, with a minimum of trim aft and sufficient forward draft for efficient icebreaking. However, this may limit the size of propeller and result in twin screw arrangements.

5.1.5 Performance of main engine in low temperature environment

5.1.5.1 Polar ship is to ensure normal and adequate supply of cooling water and combustion air so as to improve performance of main engine.

5.1.5.2 Many ships stop when the engine is too hot because of lack of cooling as the sea chest is full of ice. Therefore, for ships navigating in ice region, the best way to exploit the performance of the main engine is to provide sufficient cooling water supply. For details of cooling water system, see 5.1.7.

5.1.5.3 Ships that cannot maintain the engine room temperature may well be subject to the combustion air coming in at -30℃. At that time, heating elements may be required in the engine room. In addition, one efficient way of controlling the engine room temperature is to modify the funnel vent fire damper, e.g. installing closable and adjustable fire damper. The damper can be gradually closed to a small circulation area in order to prevent excessive loss of hot air in tank when the temperature difference between the engine room and outside is up to 60 ℃ (e.g. temperature inside engine room is 25℃ but temperature outside engine room is -35℃). For ships operating in polar waters for a long time, main engine inlet is to avoid direct facing main engine turbine inlet as far as possible, but sufficient air is necessary.

5.1.5.4 Temperature drop of engine combustion air will help to reduce oil consumption, but if air inlet temperature is too low, engine may suffer overload. Usually, main engine intakes combustion air from engine room and inlet temperature will not be too low. But if ambient temperature is lowered to -30 ℃ or below, lower inlet temperature of combustion air in internal combustion engine may lead to failure of self-ignition of compressed mixed gas and thus failing to start engine. Higher specific gravity of low temperature air may cause surging of turbocharger, and excessive combustion air may cause overpressure of cylinder and overload of engine.

Preventive measures include:

(1) preheating intake air (more expensive);

(2) inhaling heated air in engine room;

(3) scavenge air bypass (controlling scavenge pressure, bypass is not necessary if reducing main engine load is allowed);

(4) exhaust turbine bypass (controlling combustion and air intake effectively).

5.1.5.5 For ships operating in polar waters for a long time, matching of the turbochargers to the cold temperatures may be taken into account.

5.1.6 Compressed air system

5.1.6.1 For ships navigating in ice region, increasing storage of starting compressed air may help to improve reliability and maneuverability of propulsion engine, thus avoiding ship accident due to power loss caused by insufficient air.

5.1.6.2 For ships operating under severe cold condition, not only control compressed air is to be dry enough, but also utility air in exposed and low-temperature spaces is to be dry enough to prevent air pipe from freezing due to condensate water.

5.1.7 Cooling water system

5.1.7.1 Ships operating in ice conditions are prone to blockage of sea water cooling intakes unless special arrangements are made. There have been many reported incidents such as ship grounding due to the loss of cooling water to the ship's main engine and/or generators owing to the blockage of sea inlets by ice.

5.1.7.2 Measures to prevent seawater from blocking may be considered from three aspects, i.e. arrangement, construction and heating.

(1) Sea chest (or sea box or ice box) and sea bay are to be arranged at lower part of ship and far away from ice belt waterline. Water is to be separated from ice by baffle, weir, filter and other measures. Hot water circuit of cooling system is injected for heating;

(2) The volume of the sea chest is to be determined according to the total power of engines which may operate simultaneously and require sea water cooling;

(3) The most effective sea water intake plan is to be designed according to ship type and service characteristics, and the arrangement of sea chest is to consider hull line and ship size. For example, for large tanker and bulk carrier with traditional ice-breaking line type, ice is rarely found below stern bilge, and if sea chest is arranged at these spaces, the possibility of significant problem due to ice in sea chest during navigation is small, and for small ships, sea chest is to be arranged at bottom of midship as far as possible. In addition, for ships navigating in cold area, the effect of sea ice is to be considered, and anti-icing and deicing may be achieved by heating or circulating cooling water;

(4) Sea chest top is to be high enough and pipe inlet leading to sea chest is to be arranged low as far as possible. Manual deicing measures are to be provided, e.g. opening filter or entering sea chest from opening above waterline to deice. Sea bay is to be filled at least from two independent sea chests. The flow area of filling pipe from sea chest to sea bay is to consider 4 to 6 times sum of sectional area of sea pumps which may be used simultaneously according to different ice class. The flow area of openings such as side gratings, holes or slots of sea chest are not to be less than that of filling pipe;

(5) Sea chest and sea bay are to be provided with air pipes with shutoff valves, and the sectional area of air pipe is to be equivalent with that of cooling water suction pipe. Block due to ice is to be avoided for air pipe head in severe cold area;

(6) For high ice class ship, consideration is to be given to installing integrated emergency sea bay or take ballast tank as emergency source of sea water. Cooling sea water may be returned to sea bay or ballast tank. It is to avoid structural corrosion within tank due to excessive sea water temperature.

(7) Deicing measures are to be taken into account for sea chest and cooling water suction inlet. Steam deicing system may be adopted, and steam system is to be provided with effective isolating valve, filter and pressure gauge to ensure sufficient steam supply. Deicing by hot water is also effective. As an alternative, thermal oil heating coil may be arranged in sea chest and sea bay, but it is to be noted that:

① heating coils are to be thickened pipes of which wall thickness is to be at least meet equivalent requirements for steam heating coils in tank in Table 2.2.2.6(1), Chapter 2, PART

THREE of ISC Rules for Classification of Seagoing Steel Ships;

② heating coils are to be connected by welded joints;

③ heating coils are to be arranged to absorb expansion and contraction due to temperature difference change;

④ inlet and outlet of heating coils are to be provided with isolating valves which are readily accessible.

5.1.7.3 Following three figures are provided for reference during design.

(1) Schematic diagram required by IMO MSC Circ.504 and IACS UR I3 is shown in Figure 5.1.7.3(1):

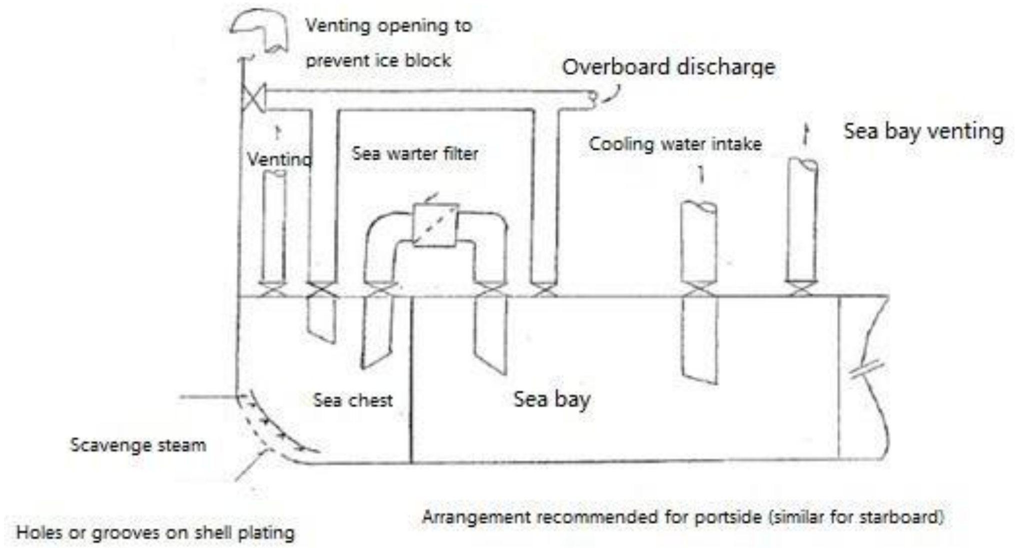


Figure 5.1.7.3(1)

Some details are as follows:

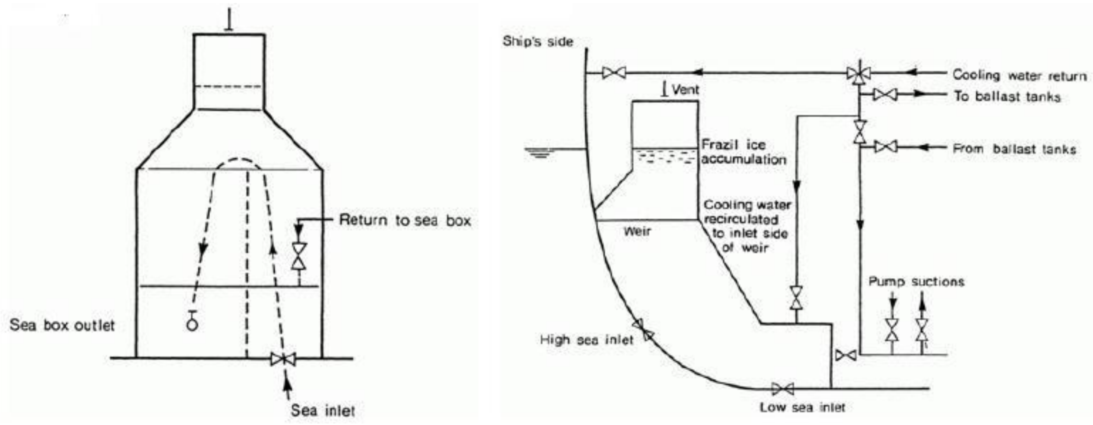
① If a strainer plate is provided in sea chest, it is to be higher than waterline and having perforations approximately 20 mm in diameter;

② If a weir is provided in sea chest, it is usually lower than waterline;

③ Heating coils may be arranged on the strainer plate in sea chest, and watertight manhole cover or small hatch cover may be provided at top of sea chest to facilitate manual deicing;

④ Frazil ice can be removed by steam blowing, steam coil and tracing pipe.

(2) Schematic diagram required by navigation in Canadian Arctic Waters is shown in Figure 5.1.7.3(2):



Elevation Section

Figure 5.1.7.3(2)

The design characteristics are as follows:

① High and low inlet gratings can be provided as far apart as possible;

② Weir-type sea inlet boxes will overcome the problem of suction pipe clogging. The suction is separated from the sea inlet gratings by a vertical plate weir. Any ice entering the box can float to the top and is unlikely to be drawn back down to the suction level;

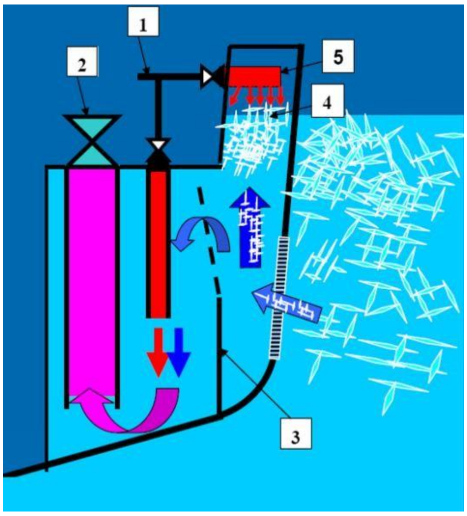
③ De-icing return(s) can be arranged to feed steam or hot water to the sea inlet box top, where frazil ice may have accumulated, or directly to the cooling system suction where a blockage may have occur;

④ Ballast water recirculation through the cooling water system allows ballast tanks to be used as coolers, alleviating any need to use blocked sea inlet boxes. It is to be noted that, while this solution is effective, it is usually a short-term solution unless vast quantities of ballast water are available or if the ship is fitted with shell circulation coolers because the recirculated ballast water will quickly become too warm for effective cooling;

⑤ Means are to be provided to clear the systems manually of blockage by ice;

⑥ The navigators and engineers are to be aware of these potential problems and the solutions available to them on their ship.

(3) Schematic diagram required by navigation in Russian Arctic Waters is shown in Figure 5.1.7.3(3):



Notes: 1—supply of recirculating hot water

2—cooling water intake

3—dash plate deflecting a flow

4—trunk-ice collector

5—perforated pipe for hot water supply

Figure 5.1.7.3(3)

To ensure the reliable operation of the ice box, its design is to provide for:

① an inlet screen at intake (holes and slots are allowed in shell plating, a diameter of holes and a width of slots in screens or shell plating is to be about 20 mm);

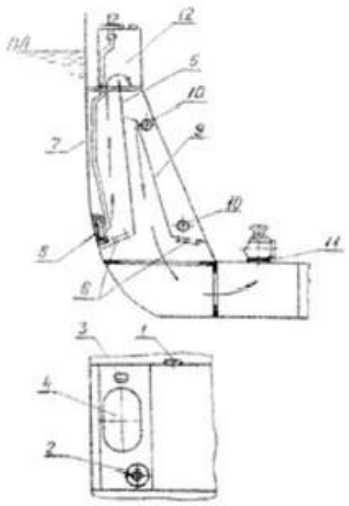
② Recirculation of cooling system water;

③ a manhole located above a waterline which provides an access to the ice box during operation;

④ air pipe with shutoff valve;

⑤ air or steam pipe for purging.

Requirements for ice box arrangement in Russian Industrial Standard are shown in Figure 5.1.7.3(4).



1 welded flange for recirculation cooling water valve
2 welded flange for air pipe valve
3 welded flange for purging valve
4 manhole
5 barrier
6 cover
7 purging pipe
8 suction grating
9 grating
10 recirculation cooling water pipe
11 welded flange for suction valve
12 ice main

Figure 5.1.7.3(4)

5.1.7.4 In recent years, overboard cooling such as box cooler has been applied as an alternative to ship's cooling system , and forced circulation of cooling water is by means of a bunch of U pipes arranged in sea chest with flowing sea water. During navigation, cooling water is cooled by free overboard sea water when passing through U pipe. However, under cold conditions, sea chest is also possible to be blocked due to ice accumulation, it is recommended that at the beginning of starting cooling system, heat medium circulating for ice melting are used in combination with steam/hot water/air to purge accumulated frazil ice.

5.1.7.5 In addition, water depth of many areas in Arctic Ocean is relatively shallow, approximately 10 m, for ships navigating in shallow water areas, preventing sand accumulation is also to be taken into account for construction and arrangement of sea chest.

5.1.8 Engine lubricating oil type

5.1.8.1 For engines that may be required to work in low temperature environment, it is to be noted that lubricating oil is to be kept at suitable temperature for normal starting of machinery according to manufacturer's recommendation.

5.1.8.2 It is not suitable to fit steam heating coils in oil sump of engine itself, when necessary, external pipes may be used for heat cycling to ensure suitable lubricating oil temperature, or as an alternative, synthetic lubricating oil with appropriate viscosity in low air temperature may be adopted case by case. For lubricating oil type, refer to Table 5.1.8.2.

Table 5.1.8.2

Engine lubricating oil type	Environmental temperature（℃）	
	Minimum	Maximum
SAE 0W-20	-40	10
SAE 0W-30	-40	30
SAE 0W-40	-40	40
SAE 5W-30	-30	30
SAE 5W-40	-30	50
SAE 10W-30	-18	40
SAE 10W-40	-18	50
SAE 15W-40	-9.5	50

Section 2 STEERING GEAR

5.2.1 General provisions

5.2.1.1 Steering gear of category A and category B polar ship is to meet relevant requirements of Section 3, Chapter 13, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

5.2.1.2 Steering gear of category C polar ship with ice class notation is to meet relevant requirements of Section 2, Chapter 4, PART TWO of ISC Rules for Classification of Seagoing Steel Ships.

5.2.1.3 In order to ensure fluidity of oil in steering gear of polar ship in low temperature condition, a permanent electric heater is to be fitted adjacent to each power unit.

5.2.2 Additional requirements for steering gear of PC class ship

5.2.2.1 For effective torque of steering gear, product of design speed in open waters (maximum 18 kn) by amplification coefficient required by Table 5.2.2.1 is to be taken into account.

Table 5.2.2.1

Ice class	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Amplification coefficient	5	5	3	3	3	1.5	1.5

5.2.2.2 Torque release measures are to be provided to protect steering gear. When steering gear is operated at speed listed in Table 5.2.2.2, excessive pressurization is not to occur for hydraulic system.

Table 5.2.2.2

Ice class	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Speed（°/s）	10	10	7.5	7.5	7.5	6	6

Section 3 DECK EQUIPMENT

5.3.1 General

5.3.1.1 For arrangement and function of deck equipment of polar ship, adverse effects of low temperature and icing in polar waters are to be taken into account.

5.3.1.2 Good function of exposed deck equipment (including rail, bow passageway, anchoring and mooring equipment, lifting equipment, emergency towing plant, gangway, etc.) under polar service temperature are to be ensured by selecting material and taking suitable winterization measures.

5.3.1.3 For ships with anti-cold climate class notation, deck equipment is to meet applicable requirements of Chapter 23, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

5.3.2 Deck equipment

5.3.2.1 Windlass arranged on deck may be frozen due to sea water spray, therefore, heating or sheltering measures are to be taken or windlass is to be arranged within forecastle or below deck. If windlass is arranged on the deck, emergency release device is to be provided at navigation bridge as far as possible. During design, prospective minimum environmental temperature is to be taken into account for parts with larger stress, and moving parts (e.g. reduction gear and brake) are not to be frozen.

5.3.2.2 Available thrust for ship is to be taken into account during design of towing winches. At present, traditional equipment for towing in ice is the use of a traction winch. Brake traction of Russian Ice Breaker can reach 80% of available thrust, and other types of ice breakers usually operate within the range of 20% to 50%.

5.3.2.3 All ships navigating in polar waters are to be provided with equipment which can throw emergency towing ropes to tug, e.g. rope-throwing appliance. Under emergency conditions, towing cable ropes are to be disconnected.

5.3.2.4 Rails acting as handrails (e.g. in way of stairway or escape route) are to be protected from icing, e.g. using heating equipment or ice proof coating. Rails only acting as guardrail may only be provided with deicing measures.

5.3.3 Deck piping system

5.3.3.1 For ship deck piping system suffering low air temperature, including piping system on tanker deck, the following problems are to be taken into account during design and arrangement and relevant measures are to be taken:

(1) Reduction of air temperature will lead to increase of temperature difference between air and cargo as well as thermal expansion of piping during cargo handling. Usually, the amount of expansion/extraction due to temperature difference are less than the amount of variation due to hogging/sagging of the ship, therefore, further consideration are not necessary for pipes arranged longitudinally along ship length, and above-mentioned expansion amount is to be considered additionally for pipes arranged transversely along ship breadth during fixing;

(2) In order to prevent any inadequate thermal stress, deck cargo and stripping pipelines may be provided with trace heating. It is also necessary for bunker pipeline and sludge out-transfer pipeline. If heating is not provided, pumping may be impossible or damage may occur. Deck cargo pipeline and cargo hold venting pipeline are generally to be provided with sliding expansion joints and resilient seals which are suitable for temperature condition;

(3) Adequate arrangements are to be provided to prevent actuating mechanism of deck valve from being frozen;

(4) Cargo venting arrangements are to be suitable for intended operation condition. High-velocity vent valve may suffer freezing and/or snow blockage, so trace heating is also necessary. Venting mast with fire screen rather than high-velocity venting valve in each tank is preferred;
(5) Heat tracing system includes electric cable, hot water, steam and heated ethylene glycol, and water-based heating system itself also needs freezing prevention.

Section 4 ELECTRICAL EQUIPMENT

5.4.1 General

5.4.1.1 Electrical installations of ships navigating in polar waters are to meet the requirements of PART FOUR of ISC Rules for Classification of Seagoing Steel Ships.

5.4.1.2 Electrical installations of ships navigating in polar waters are to meet relevant requirements of Chapter 6 of IMO MSC.385(94).

5.4.1.3 For ships applying for anti-cold climate class notation, electrical installations are also to meet the requirements of Section 6, Chapter 23, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

5.4.2 Rotating motor

5.4.2.1 Generators and motors installed on open deck and in low temperature space are to be provided with anti-condensation equipment. If compulsory lubrication or prelubrication is required for bearing, lubricating oil suitable for work under design service temperature is to be provided. For generators and motors, additional heating elements can be installed to maintain winding protection from extremes of low temperature and condensation, either by a heating element separate from the generator, or by phase injection whereby a low voltage is supplied into the windings.

5.4.2.2 Emergency generator is to be readily available in low temperature condition. In emergency generators, the jackets can be provided with thermostatically controlled electric heaters to ensure that the engine can deliver load immediately. Additional space heating is also to be provided within the emergency generator compartment as a result of cold air coming from the ventilating system.

5.4.3 Power distribution and control equipment

5.4.3.1 Electric distribution box, switchboard and control equipment installed on open deck and in low temperature space are to be provided with anti-condensation equipment, and this can be achieved by providing heating elements.

5.4.4 Accumulator

5.4.4.1 For ships expected to navigate in ice region, accumulators need to be secured in a position where excessive movement is prevented during ice transiting operations.

5.4.4.2 Accumulation of ice or snow is not to hinder ventilation pipe in battery room so as to ensure dispersion of explosive gas released by accumulator.

5.4.4.3 If the battery room is heated by electrical equipment, it is to be noted that the explosion group and temperature class for electrical equipment are not to be lower than IIC T1. Battery room can also be heated by mechanical ventilation with heated air, steam-heated equipment or heating adjacent room.

5.4.5 Electric cables

5.4.5.1 Cables located on open deck, where the ambient temperature is likely to be low, are to be checked they are made of suitable materials to endure without damage. If it is not specially indicated, sheath and insulation of marine cable is suitable for the environment with lowest temperature -25℃, therefore, it is expected that cable used under lower temperature environment may require sheath and/or insulation made of special material.

5.4.5.2 Electric cables on the open deck are to be protected by metal pipes, conduits or trunking with draining facilities.

Section 5 OTHER AUXILIARY EQUIPMENT

5.5.1 Bow thrust

5.5.1.1 Because such conditions as gratings covered by ice preventing sea water entering pipe tunnel and ice retaining in pipe tunnel occur, using bow thrust in ice region is to be avoided. If bow thrust is needed in ice region, it is recommended that effective measures are to be taken to avoid failure of bow thrust.

5.5.1.2 Bow thrust may adopt 360^{o} azimuth recoverable thruster. When thruster is recovered, shell plating is to be parallel with hull to decrease hull resistance.

5.5.2 Auxiliary ice-breaking system

5.5.2.1 For polar ship with ice-breaking capability, provision of ice-breaking auxiliary system may be taken into account to decrease resistance, or improvement of propulsion performance may be taken into account. Auxiliary system includes:

(1) low friction coating used by hull;

(2) bubble system pumping compressed air at bow and amidship;

(3) heeling tank.

5.5.2.2 Auxiliary ice-breaking system is included in main propulsion power.

CHAPTER 6   SAFETY EQUIPMENT

Section 1   FIRE SAFETY SYSTEM

6.1.1   General

6.1.1.1   The performance of fixed and portable fire systems is liable to be affected by low temperature or snow accumulation within the range from sea suction to fire hydrant. For type and configuration of fire system of polar ship operating in low temperature environment, due consideration is to be given to applicability under extreme operation condition.

6.1.1.2   Fire equipment and appliance, fire-extinguishing agent and system are to be readily under protection against freezing.

6.1.2   Fire pipe and fire pump

6.1.2.1   If fire piping system (including fire main and bubble pipe) is located on open deck, drain plug or valve may be installed at lower position to drain pipe.

6.1.2.2   Under empty condition of fire pipes, if low temperature protection is not provided for fire hydrant, it is to be installed in protected position, or heating covers are to be provided to prevent ice snow accumulation and freezing.

6.1.2.3   For isolating valve and vacuum valve on open deck, cover or heating cover may be adopted for effective prevention of failure due to ice snow freezing.

6.1.2.4   Fire pumps (including emergency fire pump, water spray pump and injection pump) are to be installed in space with positive temperature. For any independent sea suction (including main fire pump, fixed water-based fire-fighting system), measures are to be taken to prevent ice snow intake.

6.1.3   Fixed deck foam fire-fighting system

6.1.3.1   Deck foam fire-fighting system is to use foaming agent complying with design service temperature.

6.1.4   Water spray system

6.1.4.1   For water spray system, attention is to be paid that the spray nozzle is to be fully drained after use to ensure normal operation of water spray system.

6.1.5   Fire appliance

6.1.5.1   Portable fire extinguishers are to be provided in protected position. If it must be exposed to low temperature environment, approved fire extinguishers suitable for polar service temperature are to be provided.

6.1.5.2   Dry powder fire extinguishers are to be capable of preventing nozzle from blockage under polar service temperature and releasing fire-extinguishing agent effectively.

6.1.5.3   Two-way portable radio communication equipment for fire purpose on board ship is to be approved for fitting polar service temperature.

6.1.5.4   Fireman’s outfits may be placed in navigation bridge, fire control station or other spaces with positive temperature.

6.1.6 Passageway

6.1.6.1 The size of means of escape is to satisfy the requirements for passage of personnel wearing polar clothes. Passageway breadth may be increased to 1.25 times breadth of means of escape required by SOLAS Chapter II-2.

6.1.6.2 Safe access to tanker bow is usually to be provided with heating and anti-icing protection measures, but for overhead passageway only facing the threat of frazil ice due to sea water splash, gratings with non-slip bulge may be adopted.

6.1.7 Helicopter deck

6.1.7.1 Helicopter deck may be provided with measures meeting the requirements for quick deicing, e.g. low pressure steam connector, hot water connector and heating measures.

6.1.8 Material

6.1.8.1 For polar ship operating in low temperature, low-temperature resistant brittle material is to be selected for fire system exposed to low temperature environment according to Chapter 23, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships and polar service temperature.

Section 2 LIFE-SAVING APPLIANCES

6.2.1 General

6.2.1.1 For provision, arrangement and evacuation of life-saving appliances for polar ship, in addition to meeting the requirements of SOLAS III and International Code for Ships Operating in Polar Waters (Polar Code), adequate personal and group survival equipment are to be provided based on operation evaluation, considering the effects of shore-based emergency response capability in expected operation area and season, ice condition, air temperature and climate condition as well as survival needs of personnel on board who may evacuate to ice or land after abandonment within maximum expected time of rescue (MaxETR).

6.2.1.2 Life-saving appliances provided for polar ship are to have all functions under polar service temperature (PST).

6.2.1.3 For life-saving appliances and arrangements, adequate anti-icing and deicing measures are to be taken according to applicable requirements of Chapter 23, PART EIGHT of ISC Rules for Classification of Seagoing Steel Ships.

6.2.2 Maximum expected time of rescue (MaxETR)

6.2.2.1 For each polar ship, maximum expected time of rescue is to be determined according to the range of expected operation area in polar waters, taking into account following factors (not limited to these factors), but at least 5 days:

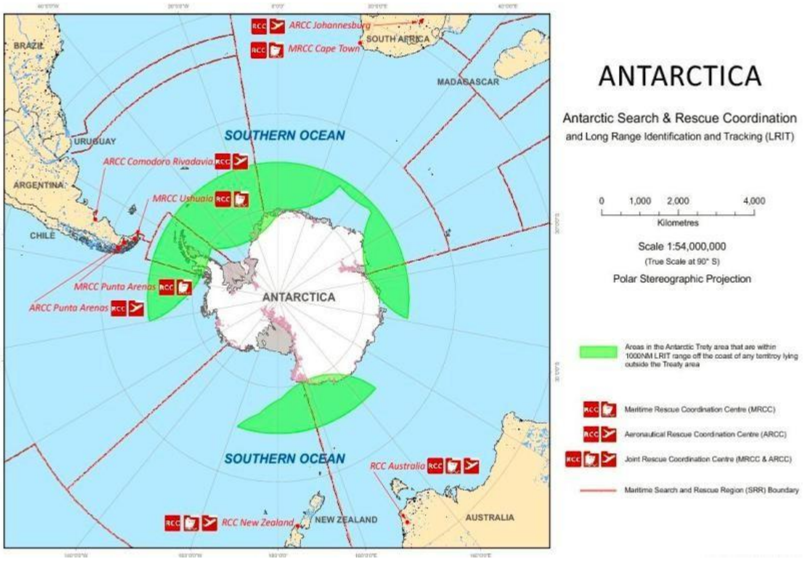
(1) distance to Rescue Coordination Center (RCC) that may be contacted;

(2) capacity of rescue facilities of rescue center;

(3) providing ice breaker escort service;

(4) providing ice region pilot service.

6.2.2.2 Rescue Coordination Centers in Antarctic waters are located in such countries as Argentina, Chile, Australia, New Zealand and South Africa. For details, see Table 6.2.2.2.



Antarctic area	Rescue Coordination Center（RCC）distance（nm）				
	Argentina MRCC	Chile ARCC	New Zealand RCC	Australia RCC	South Africa MRCC
North West Antarctic Peninsula	590	720			
South West Antarctic Peninsula	710	820			
Ross Sea			2300	2800	
South Pacific	770	860		3100	2800
Wedel Sea	1100	1200			

(Source: CLIA, DE 54/INF.2)

Table 6.2.2.2 Arrangement of search and rescue (SAR) facilities in Antarctic Area

6.2.2.3 Rescue coordination centers along northeast course of Arctic and their emergency SAR facilities are shown in Table 6.2.2.3.

Table 6.2.2.3

RCC location	SAR facility category
MRCC Dikson	Rescue boat, rescue ship, long-range aircraft
MRSC Pevek	Rescue boat, rescue ship, long-range aircraft, light helicopter
MRSC Tiksi	Rescue boat, rescue ship, long-range aircraft, medium helicopter

6.2.2.4 Canadian RCC along northwest course of Arctic covers all waters under the jurisdiction of Canada, and Canadian army and coast guard work 24 hours every day. Canadian RCC is located in Victoria, British Columbia, Trenton, Ontario and Halifax, Nova Scotia. Joint Rescue Coordination Center (JRCC) in Trenton provides emergency response and SAR alarm system for Arctic area (http://www.jrcchalifax.forces.gc.ca/JRCC_home_E.htm for more information).

6.2.3 Escape arrangements

6.2.3.1 Deicing and anti-slip measures are to be taken for all escape arrangements for polar ship, including escape route, muster station and embarkation station, unless the ship is limited to operation in areas and/or seasons without ice accretion. For polar ship constructed on or after 1 January 2017, the exposed escape routes are to be arranged so as not to hinder passage by persons wearing suitable polar clothing/heat-insulated immersion suit or cold protective clothing.

6.2.3.2 For polar ship operating in low air temperature, escape routes are to be clearly marked. For external escape route, heating measures are recommended. Escape routes passing dangerous area are to be clearly marked and displayed. Nonslip coating may be considered.

6.2.3.3 For polar ship operating in low air temperature, adequacy of embarkation arrangements are to be assessed, having full regard to any effect of persons wearing additional polar clothing/heat-insulated immersion suit or cold protective clothing. For polar ship operating all year round, indoor arrangements of embarkation station are to be considered to prevent personnel from catching cold during evacuation and embarkation under severe cold climate.

6.2.3.4 For polar ship operating in low air temperature, deicing measures are to be taken for all life boats, life rafts, launching appliances and passageway entering survival crafts, including that steam or hot water heating arrangements or such tools as mallet can be used in the vicinity of life-saving appliances.

6.2.4 Evacuation measures

6.2.4.1 Polar ship is to be provided with partially or totally enclosed life boats. For life boats provided on polar ship of category A and operating in low air temperature, in addition to complying with requirements of LSA Code, following aspects are to be taken into account:

(1) For the volume and access size of survival crafts, embarkation of personnel wearing swollen polar clothing/ heat-insulated immersion suit or cold protective clothing is to be taken into account. The size of immersion suit or cold protective clothing can be considered as 1.25 times immersion suit;

(2) The engine of lifeboat is to be capable of cold start and continuous operation under polar service temperature. Cooling water, fuel oil and lubricating oil are to suit boat engine to operate under polar service temperature;

(3) For polar ship with ice class, it is to be considered that boat engine power is to be sufficient to pass through thin ice with lower ice intensity. Protective measures are to be taken for propellers and keels to prevent damage due to ice contact. The boat strength is to be sufficient to withstand ice and snow accumulation;

(4) The life boats are to provide radio equipment and batteries suitable for operating under maximum expected temperature;

(5) Life boat releasing appliances are to be protected by anti-icing measures so as to be readily accessible;

(6) For category A polar ship, life boat hatchcover and door are to be provided with heating lines to prevent freezing;

(7) For category A polar ship, measures are to be taken to release the life boat or draw the life boat to the ice;

(8) Measures are to be taken for the observation window of lifeboat maneuvering position so that it can have clear vision under design service temperature, e.g. providing windscreen

wiper and electric heating for glass.

6.2.4.2 The power supply of any survival craft releasing gear is to be capable of being dependent of main power supply of the ship.

6.2.4.3 For the design of launching devices for life boat, rescue boat and life raft provided for category A and category B polar ship, special consideration is to be given to following aspects:

(1) Free launching life boat cannot be released to ice-covered waters to avoid ice impact;

(2) The arrangement of launching station is to be suitable for abandoned ships during navigating in ice-covered waters;

(3) The life raft is to be stored in an operable position and arranged to be launched on the ice;

(4) Motor, winch and automatic releasing hook are to be provided with movable protection cover;

(5) Hydraulic oil and lubricating oil for launching and embarkation devices are to be suitable for application under polar service temperature.

6.2.5 Survival equipment

6.2.5.1 For polar passenger ship, a proper sized immersion suit or a thermal protective aid is to be provided for each person on board. Where immersion suits are required by polar ship, they are to be of the insulated type.

6.2.5.2 For polar ship intended to operate in extended periods of darkness, searchlights suitable for continuous use to facilitate identification of ice are to be provided for each life boat.

6.2.5.3 For all polar ships, provision of suitable personal survival equipment listed in Table 6.2.5.3 is to be considered based on operation evaluation and in combination with life-saving appliances and group survival group to effectively protect all personnel on board ship from cold wind and frostbite of all extremities.

Applicable personal survival equipment Table 6.2.5.3

Protective clothing (hat, gloves, socks, face and neck protection, etc.)
Skin protection cream
Thermal protective aid
Sunglasses
Whistle
Drinking mug
Penknife
Polar survival guidance
Emergency food
Carrying bag

6.2.5.4 If operation evaluation identifies a potential of abandonment onto ice or land, following requirements apply:

(1) Following applicable group survival equipment are to be carried, unless an equivalent level of functionality for survival is provided by the ship's normal life-saving appliances:

Applicable group survival equipment Table 6.2.5.4

Shelter-tents or storm shelters or equivalent—sufficient for maximum number of persons
Thermal protective aids or similar—sufficient for maximum number of persons
Sleeping bags—sufficient for at least one between two persons
Foaming sleeping mats or similar—sufficient for at least one between two persons
Shovels—at least 2
Sanitation (e.g. toilet paper)
Stove and fuel—sufficient for maximum number of persons ashore and maximum anticipated time or rescue
Emergency food—sufficient for maximum number of persons ashore and maximum anticipated time of rescue
Flashlights—one per shelter

Waterproof and windproof matches—two boxes per shelter
Whistle
Signal mirror
Water containers & water purification tablets
Spare set of personal survival equipment
Group survival equipment container (waterproof and floatable

(2) When required, personal and group survival equipment sufficient for 110% of the persons on board are to be stowed in easily accessible locations, as close as practical to the muster or embarkation stations;

(3) Containers for group survival equipment are to be designed to be easily movable over the ice and be flotable;

(4) Whenever the assessment identifies the need to carry personal and group survival equipment, means are to be identified of ensuring that this equipment is accessible following abandonment;

(5) If carried in addition to persons, in the survival craft, the survival craft and launching appliances are to have sufficient capacity to accommodate the additional equipment;

(6) Passengers are to be instructed in the use of the personal survival equipment and the action to take in an emergency;

(7) The crew is to be trained in the use of the personal survival equipment and group survival equipment.

6.2.5.5 Survival crafts are to provide adequate emergency rations and fresh water for the maximum expected time of rescue. Measures are to be taken to ensure non-freezing fresh water and storage of equivalent edible fresh water ice chips.

Section 3 NAVIGATIONAL EQUIPMENT

6.3.1 General

6.3.1.1 Navigational equipment for ships operating in polar waters is to comply with the requirements of not only Chapters V and XIV of SOLAS Convention but also this Section, and be suitable for its operating conditions such as expected ice condition, high latitude, remoteness, low temperature and icing (if relevant) to ensure safe navigation.

6.3.1.2 The navigational equipment and systems are to be designed, constructed and installed to retain their functionality under the expected environmental conditions in the area of operation.

6.3.1.3 All polar ships are to comply with the requirements of Reg. V/22.1.9.4 of SOLAS Convention, at the same time, provide unimpaired forward and astern vision according to the form of navigation bridge, and be fitted with:

(1) a suitable means to de-ice sufficient conning position windows to provide unimpaired forward and astern vision from conning positions; and

(2) an efficient means of clearing melted ice, freezing rain, snow, mist and spray from outside and accumulated condensation from inside. A mechanical means to clear moisture from the outside face of a window is to have operating mechanisms protected from freezing or the accumulation of ice that would impair effective operation.

6.3.2 Nautical information

6.3.2.1 Ships are to have means of receiving and displaying current inforamtion on ice

conditions in the area of operation, which can be realized by following means:
(1) meteorological fax receiver capable of receiving ice regime or equivalent equipment;
(2) radar system capable of identifying ice target.

6.3.3 Navigational equipment

6.3.3.1 All polar ships with ice category Are to have either two independent echo-sounding devices or one echo-sounding device with two separate independent transducers.

6.3.3.2 For ships operating in areas, and during periods, where ice accretion is likely to occur, means to prevent the accumulation of ice on antennas required for navigation and communication are to be provided. For motor/gear of radar antennas, suitable heating measures are to be considered.

6.3.3.3 For all polar ships with ice class, where equipment required by SOLAS Chapter V or this Chapter have sensors that project below the hull, such sensors are to be protected against ice.

6.3.3.4 All polar ships are to have two non-magnetic means to determine and display their heading, e.g. GNSS (global navigational satellite system) compass, fiber optic gyrocompass and electric gyrocompass. Both means are to be independent and connected to the ship's main and emergency source of power.

6.3.3.5 Polar ship proceeding to latitudes over 80 degrees is to be fitted with at least one GNSS compass or equivalent, which is to be connected to the ship's main and emergency source of power.

6.3.3.6 For category A and B polar ship, the bridge wings are to be enclosed or designed to protect navigational equipment and operating personnel.

6.3.4 Additional navigational equipment

6.3.4.1 Ships, with the exception of those solely operating in areas with 24 hours daylight, are to be equipped with two remotely reotatable , narrow-beam search lights controllable form the bridge to provide lighting over an arc of 360 degress, or other means to visually detect ice.

6.3.4.2 Ships involved in operations with an icebreaker escort are to be equipped with a manually initiated flashing red light visible from astern to indicate when the ship is stopped. This light is to have a range of visibility of at least two nautical miles, and the horizontal and vertical arcs of visibility are to conform to the stern light specifications requried by the International Regulations for Preventing Collisions at Sea.

6.3.5 Ice region navigation monitoring equipment

6.3.5.1 For category A polar ship, sea ice effect monitoring system may be installed for the shipmaster to carry out real-time monitoring of the effect of ice load. The system may be connected directly with bridge computer to display ice impact load and provide allowable load percentage to determine safe speed. The system may have such function as data record, alarm and trend prediction.

Section 4 COMMUNICATION EQUIPMENT

6.4.1 General

6.4.1.1 For the provision of communication equipment for polar ship, limits of communication system under high latitude and expected low temperature condition are to be considered, and in addition to the requirements of SOLAS Chapter IV, the requirements of this Section are to be met to suit its operating conditions such as expected high latitude, low temperature and icing, and have ship-to-ship, ship-to-shore and emergency operation communication capability.

6.4.2 Ship communication

6.4.2.1 Ships intended to provide icebreaking escort are to be equipped with a sound signaling system mounted to face astern to indicate escort and emergency manoeuvers to following ships as described in the International Code of Signals.

6.4.2.2 All polar ships are to be provided with following communication equipment:

(1) voice and/or data communications with relevant rescue coordination centers;

(2) equipment for voice communications with aircraft on 121.5 and 123.1 MHz; and

(3) communication equipment providing a Technical Assistance Service (TMAS).

6.4.3 Survival craft and rescue boat communiation capabilities

6.4.3.1 For polar ship intended to operate in low air temperature, all rescue boats and lifeboats, whenever released for evacuation, are to carry:

(1) one device for transmitting ship to shore alerts;

(2) one device for transmitting signals for location; and

(3) one device for transmitting and receiving on-scene communications.

6.4.3.2 For polar ship intended to operate in low air temperature, all other survival crafts are to carry:

(1) one device for transmitting signals for location; and

(2) one device for transmitting and receiving on-scene communications.

CHAPTER 7　POLAR WATER OPERATION

Section 1　BASIC REQUIREMENTS

7.1.1　General

7.1.1.1　Polar ship is to be provided with a set of Polar Water Operational Manual (PWOM) on board to provide the owner, operator, master and crew with training and decision guidance on safe operation in polar waters so as to ensure that ship operation is controlled within its design operational capability and limitation.

7.1.1.2　The contents of PWOM at least include:

(1) the ship's operational capability and limitation determined based on operation assessment and approved by Administration or its recognized organization, and methods determined during actual operation in ice region;

(2) risk-based normal, abnormal and emergency operation procedures, as well as pilot or icebreaker assistance operation procedures.

7.1.1.3　Normal operation procedures are to be able to prevent ship from encountering conditions that exceed the ship's capabilities, and include at least:

(1) voyage planning to avoid ice and/or temperatures that exceed the ship's design capabilities or limitations;

(2) arrangements for receiving forecasts of the environmental conditions;

(3) means of addressing any limitations of the hydrographic, meteorological and navigational information available;

(4) operation of equipment required under Polar Code;

(5) implementation of special measures to maintain equipment and system functionality in low temperatures, topside icing and the presence of sea ice, as applicable.

7.1.1.4　Emergency operation procedures are to be able to provide the ship with shore-based response in time under emergency conditions and ensure safety of ship and person on board, and include at least:

(1) methods and procedures for contacting emergency response providers for salvage, search and rescue (SAR), spill response, etc., as applicable; and

(2) in the case of ice strengthened ships, procedures for maintaining life support and ship integrity in the event of prolonged entrapment by ice.

7.1.1.5　Abnormal operation procedures are to be able to take proper measures against ice and/or temperatures that exceed the ship's design capabilities or limitations.

7.1.1.6　Escort or icebreaker assistance operation procedures are to be able to monitor and maintain safety during operations in ice, including different operational limitations for ship's independent operation and icebreaker escort.

7.1.1.7　Appendix 2 of Polar Code provides integral model manual. For each polar ship, applicable parts in model manual are to be determined according to the result of operation assessment, and proper information, procedure or plan is to be prepared, or directing to other ship document. Other parts which are not applicable are to be marked with "not applicable", indicating that they have been considered and not omitted.

7.1.1.8 Category C ships that undertake occasional or limit polar voyages will not need to have procedures for situations with a very low probability of occurrence.

Section 2 OPERATIONAL CAPABILITY AND LIMITATION

7.2.1 Operation in ice region

7.2.1.1 Safe operation assessment method

(1) The manual is to establish method for assessing whether ice conditions exceed ship design limits during operation in ice region, and consider operational limitation in Polar Ship Certificate to make decisions on safe operation in ice region;

(2) According to ship's intended navigation area in polar waters and paying attention to the requirements of coastal state, either of following ice region decision-making support system may be selected as assessment method.

Table 7.2.1.1(2)

System name	Issued by	Applicable area	System summary	Remarks
Polar Operational Limit Assessment Risk Indexing System（POLARIS）	IMO	All polar waters	Based on method of sailing control under actual ice condition of the area, granting risk index value (RIV) of ice class corresponding to ice type, calculating a risk index overall value (RIO) for each ice body suffered, and providing decision-making basis for preparing route plan and/or real-time operation or limited operation	
Arctic ice region shipping system（AIRSS）	Canada	Arctic northwest route	Based on method of sailing control under actual ice condition of the area, granting risk coefficient (IM) of ice class corresponding to ice type, calculating an ice number (IN) for each ice body suffered, zero and positive value are applicable, negative value is not applicable, providing decision-making for operation in ice region	Appendix 6
Arctic zone/time system（Z/DS）	Canada	Arctic northwest route	Arctic northwest route (zone) is divided into 16 zones, the severest ice condition is in zone 1, and the weakest ice condition is in zone 16, zone/time is established to indicate time that ships of each ice class may pass through each zone	Shipping Safety Control Area Code
Ice Passport	Russia	Arctic northeast route（NSR）	According to ship ice class, structure and power capacity, establishing ice thickness—safe speed curve, safe escort speed and instructions to speed curve	To be approved by RS

Note：RS——Russia Classification Society.

(3) The manual is to establish training procedure or provide application examples of ice region decision-making supporting system so that personnel at navigation bridge can use the system correctly;

(4) The application examples of Polar Operational Limit Assessment Risk Indexing System（POLARIS） are as follows, in which P indicates that passage is allowed, S indicates that passage is limited and N indicates that passage is not allowed.

Table 7.2.1.1(4)①

Ice condition	Ship type	Ice class	RIO	Result
 4/10 thick first year ice, 1/10 medium thick first year ice, 5/10 open waters	A	PC1	25	P
		PC2	25	P
		PC3	25	P
		PC4	21	P
		PC5	16	P
	B	PC6	11	P
		PC7	6	P
	C	B1*/IAS	6	P
		B1/1A	1	P
		B2/IB	1	P
		B3/IC	-4	N
		Without ice class	-4	N

Table 7.2.1.1(4)②

Ice condition	Ship type	Ice class	RIO	Result
 2/10 medium thick first year ice, 7/10 thick first year ice, 1/10 open waters	A	PC1	19	P
		PC2	19	P
		PC3	17	P
		PC4	8	P
		PC5	-1	S
	B	PC6	-10	S
		PC7	-17	N
	C	B1*/IAS	-19	N
		B1/1A	-26	N
		B2/IB	-28	N
		B3/IC	-35	N
		Without ice class	-37	N

Table 7.2.1.1（4）③

Ice condition	Ship type	Ice class	RIO	Result
	A	PC1	27	P
		PC2	27	P
		PC3	27	P
		PC4	27	P
		PC5	24	P
	B	PC6	21	P
		PC7	18	P
	C	B1*/IAS	18	P
		B1/1A	15	P
		B2/IB	15	P
		B3/IC	12	P
3/10 medium thick first year ice, 7/10 open waters		Without ice class	12	P

Table 7.2.1.1（4）④

Ice condition	Ship type	Ice class	RIO	Result
	A	PC1	24	P
		PC2	24	P
		PC3	24	P
		PC4	24	P
		PC5	24	P
	B	PC6	20	P
		PC7	14	P
	C	B1*/IAS	20	P
		B1/1A	14	P
		B2/IB	8	P
		B3/IC	2	P
6/10 thick first year ice, 4/10 new ice		Without ice class	-18	N

Table 7.2.1.1（4）⑤

Ice condition	Ship type	Ice class	RIO	Result
 6/10 medium thick first year ice, 4/10 open waters	A	PC1	24	P
		PC2	24	P
		PC3	24	P
		PC4	24	P
		PC5	18	P
	B	PC6	12	P
		PC7	6	P
	C	B1*/IAS	6	P
		B1/1A	0	P
		B2/IB	0	P
		B3/IC	-6	N
		Without ice class	-6	N

Table 7.2.1.1（4）⑥

Ice condition	Ship type	Ice class	RIO	Result
 1/10 multi-year ice, 8/10 thick first year ice, 1/10 open waters	A	PC1	20	P
		PC2	20	P
		PC3	19	P
		PC4	10	P
		PC5	1	P
	B	PC6	-8	S
		PC7	-16	N
	C	B1*/IAS	-17	N
		B1/1A	-25	N
		B2/IB	-26	N
		B3/IC	-34	N
		无冰级	-35	N

Table 7.2.1.1（4）⑦

Ice condition	Ship type	Ice class	RIO	Result
 9/10 medium thick first year ice (melted), 1/10 open waters	A	PC1	21	P
		PC2	21	P
		PC3	21	P
		PC4	21	P
		PC5	21	P
	B	PC6	12	P
		PC7	3	P
	C	B1*/IAS	3	P
		B1/1A	-6	N
		B2/IB	-6	N
		B3/IC	-15	N
		Without ice class	-15	N

Table 7.2.1.1（4）⑧

Ice condition	Ship type	Ice class	RIO	Result
 6/10 second year ice, 3/10 thick first year ice (melted), 1/10 open waters	A	PC1	21	P
		PC2	15	P
		PC3	15	P
		PC4	6	P
		PC5	0	P
	B	PC6	-9	S
		PC7	-18	N
	C	B1*/IAS	-18	N
		B1/1A	-27	N
		B2/IB	-27	N
		B3/IC	-30	N
		Without ice class	-36	N

(5) Z/DS application example

A category A ice strengthened ship intends to pass through 6 ice regions, referring to Z/C table in Code for Pollution Prevention in Canadian Arctic Waters, passage is only allowed between 15 August and 15 October, and ship of such ice class are not allowed to pass through such area beyond this time window.

(6) For ships without ice class and operating in polar waters, the manual may describe ice-avoiding operation measures to substitute ice region decision-making supporting system.

7.2.1.2 Icebreaking capability

(1) Icebreaking capability usually means maximum thickness (Hi) of 100% covered ice of certain type at speed V of continuous sailing, which may be described by adding snow covered thickness. For example, for one polar scientific investigation icebreaker, two-way icebreaking capability means operation in second year ice mixed with old ice, at bow, horizontal ice breaking thickness is not lower than 1.5 m plus 0.2 m snow, with continuous icebreaking speed of 3 knot. At stern, icebreaking capability includes capability of breaking horizontal ice and ridge ice.

(2) The manual is to provide ship's icebreaking capability, and provide the master with information on ice conditions in which the ship can be expected to make continuous progress and safe operation. According to the design purpose of polar ship, there are bow icebreaking capability, stern icebreaking capability and without icebreaking capability. Icebreaking capability data may be obtained from such result as numerical analysis or ice basin model test or ice trails.

7.2.1.3 Ice maneuvering characteristics

(1) The manual is to describe ice maneuvering characteristics of polar ship, and provide relevant ice maneuvering guidelines;

(2) For ice maneuvering characteristics, hull structure, propeller strengthening and propulsion power capability are to be taken into account, and unsafe operation which is to be avoided is to be provided, including:

① if strengthening of structure at stern area is weak, a sharp turn at multi-year ice is to be avoided;

② if there is no ice strengthening at ship stern, back operation in ice region is to be avoided;

③ it is to provide ice turning radius as well as maximum stop distance (from giving stop order to ship's full stop) data and information.

7.2.1.4 Special performance

(1) When applicable, the manual is to include determination of polar ship category or difference identified according to Section 5 "Equivalent Ice Class Evaluation", Chapter 2 of the Guidelines;

(2) The manual is also to provide information on using special system assisting ship to operate in ice region (if fitted, see paragraph 5.5.2 of the Guidelines).

7.2.2 Operation in low air temperature

7.2.2.1 If the ship is designed to operate in air temperature environment whose lowest mean daily low temperature (LMDLT) is below -10 ℃ , the manual is to describe polar service temperature (PST) consistent with Polar Ship Certificate. Polar service temperature is set by the shipowner according to ship operation demands, as ship and equipment /system design parameter and/or input information of operation evaluation.

7.2.2.2 The manual is to list shipboard equipment and system liable to damage or failure in low air temperature as well as measures to avoid failure.

7.2.2.3 For shipboard equipment and system exposed to low air temperature environment and liable to being affected, following category may be taken into account:

(1) low-temperature-resistant material is not applied or not determined;

(2) with grease lubricating, hydraulic liquid equipment;

(3) using such liquid as oil, sea water and fresh water.

7.2.2.4 For the following (but not limited to) shipboard equipment and system and depending on ship (service) type, measures against low-air-temperature failure are to be taken into account:

(1) Navigation and communication equipment

① applicable search light;

② radar;

③ whistle installation heating system;

④ bridge window deicing and windscreen wiper window deicing equipment.

(2) Fresh water tank and ballast tank

① discharge to less than 90% to allow freezing expansion;

② providing heating equipment.

(3) Exposed deck piping system (including service, washing and cooling pipes)

① providing drain plug;

② isolating, draining and opening valve.

(4) Deck equipment and system

① using anti-freezing parts, low-temperature lubrication oil and hydraulic liquid;

② providing heat tracing (electricity or steam);

③ providing protective cover;

④ thermal insulation layer.

(5) Indoor machinery equipment and system

① machinery space heating;

② closing external ventilation.

7.2.3 Communication and navigation capabilities at high latitudes

7.2.3.1 Restrictions to communication system at high latitudes include:

(1) Current maritime digital communication systems cover polar waters. Limitations for conventional marine communication system in polar waters are as follows:

① VHF is still largely used for communication at sea, but only over short distances (line of sight) and normally only for voice communication;

② HF and MF are also used for emergency situations. Digital VHF, mobile phone systems and other types of wireless technology offer enough digital capacity for many maritime applications, but with restriction to part waters at polar high latitudes;

③ AIS can also be used for low data-rate communication, but there are very few base stations, and the satellite-based AIS system is designed for data reception only;

④ The theoretical limit of coverage for GEO system is 81.3^{o} north or south, but instability and signal dropouts can occur at latitudes as low as 70^{o} north or south under certain conditions. Many factors influence the quality of service offered by GEO systems, and they have different effects depending on the system design.

(2) Non-GMDSS systems may be available and may be effective for communication in polar waters.

7.2.3.2 Function limitations for high latitude navigation equipment include:

(1) Course and locating equipment:

① Gyrocompass is to be adjusted for accuracy according to navigation demands and latitude, usually error begins to occur for spinning compass at latitude 70^{o}, and the decrease range of accuracy widens following latitude increases, long time is needed for being stable. In general, error of gyrocompass within the scope of 2^{o}-5^{o} occurs between latitude 75.5^{o} and 77.9^{o};

② The horizontal component of magnetic field in polar waters is very small, and the directing force of magnetic compass is very weak. With the effect of local magnetic difference and magnetic storm and/or aurora magnetic interference, the error for magnetic compass is very big above latitude 80^{o}, which is not applicable;

③ In area of high latitude, it is difficult to identify celestial body, and there is little chance to observe celestial body.

7.2.3.3 The manual is to list function limitations for shipboard communication and navigation equipment at high latitude and countermeasures, including using non-magnetic course appliances:

(1) equipment is applicable to A4 sea area DSC;

(2) providing satellite telephone applying above latitude 75^{o};

(3) providing 121.5 and 123.1 MHz aeronautical communication;

(4) providing GNSS compass connecting main/emergency source of power;

(5) observing change of gyro compass and checking error of gyro compass to avoid application of magnetic compass for direction and location.

7.2.4 Voyage endurance

7.2.4.1 The manual is to provide or quote information on normal voyage endurance limitation, including maximum fuel tankage, fresh water capacity, provision stores, etc.

7.2.4.2 This will normally only be a significant consideration for smaller ships, or for ships planning to spend extended periods in ice.

Section 3 OPERATION OF POLAR SHIP

7.3.1 Voyage planning

7.3.1.1 In order to avoid ice condition and/or temperature exceeding operational capability and/or limitation for ships navigating in polar waters, when preparing manual, the shipowner and master are to plan based on acceptable standard navigation practice, taking expected ice condition, ship maneuvering capability as well as shipboard equipment and system into account, including limitation for navigation and communication equipment, and the flow is as follows:

(1) Evaluating information, considering:

① historical information on current, ice and weather;

② information on the extent and type of ice and icebergs in the vicinity of the intended route, as well as weather forecast and prediction information;

③ ice service organization;

④ navigation data, chart, route and pilot guidelines as well as limitations of hydrographic information and aids to navigation;

⑤ communication resources.

(2) Planning and evaluating route, considering:

① ice condition, taking special consideration to the condition of close pack (7/10-8/10), consolidated ice (10/10), open drift (4/10-6/10), route, polynya, old ice or multi-year ice and iceberg;

② historical state, limitation and ice amount, and the condition of floating ice, multi-year ice and iceberg;

③ information on weather and temperature from former years;

④ availability of ice supported icebreaker;

⑤ place of refuge;

⑥ current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas;

⑦ current information on relevant ship's routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas;

⑧ national and international designated protected areas along the route; and

⑨ operation in areas remote from search and rescue (SAR) capabilities.

(3) Route establishment, selecting safe operation areas to avoid sea ice; selecting area with minimum ice amount to avoid area with ice pressure or potential ice pressure; avoiding social and ecological sensitive area.

(4) Plan implementation, including:

① preparation before ship enters polar waters;

② adjusting ship's floating condition to ice draught;

③ using sounding equipment;

④ strengthening watch;

⑤ icebreakers supporting ship requirements;

⑥ using search light;

⑦ requiring to update information on ice regime and weather;

⑧ in the event that marine mammals are encountered, any existing best practices is to be considered to minimize unnecessary disturbance; and

⑨ Planning to minimize the impact of the ship's voyage where ships are navigating near areas of cultural heritage and cultural significance.

(5) monitoring, accepting updated ice regime and meteorological information in time to ensure that ships always navigate in safe waters.

7.3.1.2 For ships often operate in polar waters, the manual is to identify historical ice condition of intended operation area in polar waters according to voyage planning and provide information on ice condition to avoid damage ice affecting ice operational capability, including:

(1) information on ice condition of intended polar waters in each stage;

(2) potential safe operation issues, and reminding master of areas to which special attention is to be paid during route establishment or adjustment and their ice conditions, for example:

① location of ice chokepoint ;

② location of ice ridging;

③ area with worst recorded ice conditions.

(3) During voyage planning, the master is to be reminded that areas with limited information or uncertain ice condition are to be treated as risk and avoided for route establishment and adjustment.

7.3.1.3 For ships operating frequently in polar waters, the manual is to identify historical meteorological information of intended operation area in polar waters according to voyage planning and provide information on air temperature to avoid dangerous temperature exceeding design polar service temperature, including:

(1) mean daily low temperature of intended waters where ships are capable of operating;

(2) area with minimum recorded temperature during operation;

(3) During voyage planning, the master is to be reminded that areas with limited information or uncertain air temperature condition are to be treated as risk and avoided for route establishment and adjustment.

7.3.1.4 Section 2 of Chapter 1 provides temperature limitation of summer and winter in Antarctic and Arctic waters for reference. Detailed historical and real-time temperature information of different area and season of polar waters can be obtained from relevant national climate date center, such as National Climate Data Center of National Ocean and Atmosphere Administration Bureau of USA—http://gis.ncdc,noaa.gov.

7.3.1.5 The manual is to identify ice condition of intended polar waters and planned operation mode according to voyage planning, including independent navigation and icebreaker pilot, and establish procedure required by ship supply to ensure safe margin of voyage endurance, taking following factors into account:

(1) slower than expected speed;

(2) course alterations due to adverse climate and ice condition, and finding places of refuge;

(3) difficult refueling during navigation.

7.3.1.6 The manual is to identify ice condition of intended polar waters and planned operation mode according to voyage planning, including independent navigation and icebreaker pilot, provide following guidance on human resource management, consider expected ice condition and ice navigation requirements, improve watch level, rest time and fatigue, and ensure compliance with these procedures:

(1) Masters, chief mates and officers in charge of a navigational watch are to be qualified in accordance with Chapter V of the STCW Convention and the STCW Code, as follows:

Table 7.3.1.6

Ice conditions	Tankers	Passenger ships	Other
Ice free	Not applicable	Not applicable	Not applicable
Open waters	Basic training for master, chief mate and officers in charge of a navigational watch	Basic training for master, chief mate and officers in charge of a navigational watch	Not applicable
Other waters	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch	Advanced training for master and chief mate. Basic training for officers in charge of a navigational watch

(2) Use of person other than the master, chief mate or officers in charge of a navigational watch may be allowed during ice operation of ship, provided that:

① the person is qualified and certified in accordance with regulation II/2 of the STCW Convention and section A-II/2 of the STCW Code, and meets the advance training requirements noted in the above table;

② the ship has sufficient number of persons meeting the appropriate training requirements to cover all watches;

③ this person is subject to the minimum hours of rest requirements;

④ this does not relieve the master or officer of the navigational watch from their duties and obligations for the safety of the ship.

(3) For operation in proximity to ice region, most experienced steersman and two-person watch are to be arranged;

(4) In waters with large ice concentration, arrangement of ice watch at bow and stern is to be considered.

7.3.2 Receiving forecasts of environmental conditions

7.3.2.1 The manual is to establish procedures for receiving forecasts of environmental conditions, including:

(1) setting out the method and frequency for provision of ice and weather information. Where a ship is intended to operate in or in the presence of ice, the manual is also to set out when weather and ice information is required and the format for the information;

(2) providing forecasts that will identify weather and ice patterns/regimes that could expose the ship to adverse conditions in the whole polar waters and real-time navigation area;

(3) the frequency of updates is to provide enough advance notice that the ship can take refuge or use other methods of avoiding the hazard if the conditions are forecast to its capabilities;

(4) using a land-based meteorological pilot and ice service organization information to provide the ship with information that is relevant, reducing demands on the ship's communication systems;

(5) providing means to obtain and analyze additional ice images.

7.3.2.2 The manual is to establish methods for receiving and using ice information during ship's ice operation, including:

(1) how radar is used to identify ice floes, how to tune the radar to be most effective, instructions on how to interpret radar images;

(2) other technologies are used to provide ice information.

7.3.2.3 When establishing method for ice information collection and observation, following (but not limited to) information may be used for reference:

(1) Guidelines for Arctic Navigation (northeast course) (2014);

(2) Canada Manual on Ice Observation and Report Standard Procedures (MANICE) (www.ec.gc.ca/glace-ice).

7.3.2.4 The manual is to establish procedure for collecting and analyzing meteorological information, including:

(1) receiving meteorological equipment on board ship;

(2) ship company's shore-based supply;

(3) providing shore-based information support service provider.

7.3.2.5 The manual is to provide guidelines on using hydrographic, meteorological and navigation information in operation area, including:

(1) category and channel of information available;

(2) limitations of information; and

(3) matters needing attention.

7.3.2.6 The manual is to include following instructions on operating special equipment.

(1) Instructions on operating special navigation equipment/system in polar waters that is required by Polar Code, for example:

① equipment receiving and displaying ice regime;

② non-magnetic course equipment, including gyrocompass adjusted by high latitude and

GNSS compass;

③ remote control 360^{o} rotating narrow-beam search light;

④ sounder.

(2) Instructions on operating special communication equipment/system in polar waters that is required by Polar Code, for example:

① special sound signal system for icebreaker escort operation;

② voice and data communication system for contacting rescue coordination center;

③ 121.5 and 123.1 MHz aeronautical frequency;

④ telemedical assistance service (TMAS) communication system;

⑤ survival craft communication system, including device for transmitting ship to shore distress alert, device for transmitting location signal and device for transmitting and receiving on-scene communications.

7.3.2.7 The manual is to establish procedures for keeping equipment and system function, including:

(1) Providing guidelines on operational measures against icing, icing monitoring and evaluation, using tools on board ship to melt ice and keeping measures for the safety of ship and crew to eliminate the effect of ship icing. Following practices may be taken into account:

① When the air temperature drops below the freezing point of sea water and sea water temperature is below 6 ℃, splashing sea water has the risk of freezing. In addition to air and water temperature, wind speed, ship course and speed as well as wave height further affect ice accumulation on exposed surface. Although the risk of splashing sea water icing is small during ice operation, attention is also to be given to ice accumulation due to rain or frost freezing. The icing level is related to water temperature, air temperature and wind speed, refer to Section 2 of Chapter 1;

② When the ship begins icing, it is to change course and speed to reduce sea water splashing or relative wind speed;

③ Using shipboard ice-melting equipment system, tool and object , including electric and steam heating system, deicing stick, sand and salt, and removing ice in time to reduce adverse effect to ship stability.

(2) Providing guidelines on monitoring, preventing and alleviating ice intake of sea water system during operation in ice region in low temperature, including:

① using recycling system;

② using low suction.

(3) For ships operating in low temperature, the manual is to provide guidelines on keeping and monitoring operation of equipment and system listed in section 7.1, including cyclic heating or continuous cycle of work media, and other anti-freezing measures.

7.3.2.8 Polar Water Operational Manual is to establish and implement following procedures so that mandatory communication equipment for use in survival crafts and rescue boats is capable of operation during the maximum expected time of rescue, and battery time is to be extended as far as possible:

(1) When survival crafts are in close proximity, not more than two alerting or locating devices are activated to preserve battery life, enable extended periods of time for the transmission of alerting or locating signal and avoid potential interference;

(2) It is not to activate multiple satellite distress beacons, unless the survival craft operating the

beacons are widely dispersed, as this can cause interference on direction-finding equipment;
(3) In determining the equipment to be carried for transmitting signals for location, the capabilities of the search and rescue resources likely to respond are to be borne in mind. Responding ships and aircraft may not be able to home to 406/121.5 MHz, in which case other locating devices (e.g. AIS-SART) are to be considered.

Section 4 RISK MANAGEMENT

7.4.1 General

7.4.1.1 For ships operating in polar waters, at any time and only when necessary, routes in open waters are to be selected as far as possible to enter ice region. Ships operating in polar waters are to observe following safe practices:
(1) keeping ship movement, even though speed is low;
(2) sailing downstream as far as possible;
(3) controlling to safe speed and reducing ice damage;
(4) keeping sailing vertical to ice edge in the vicinity of floating ice;
(5) keeping amidship when being astern.

7.4.1.2 Masters and officers in charge of a navigational watch are to apply ice region decision-making support system to evaluate navigational environment condition and reduce risk of dangerous ice condition, considering:
(1) route accessibility under former and expected ice and climate condition;
(2) position of ice edge;
(3) visibility;
(4) ship's ice class and capability;
(5) accessibility of icebreaker assistance;
(6) navigation danger level.

7.4.1.3 Appropriate measures are to be taken when the environment conditions exceeding ship's operational capability are encountered or will be encountered.

7.4.2 Risk mitigation in limiting environmental condition

7.4.2.1 The manual is to provide the master and officer in charge of a navigational watch with measures to be considered and taken under adverse ice condition according to operation evaluation result:
(1) For ice conditions with increased operational risk and/or special consideration as well as glacier ice and iceberg:
 ① At the stage of voyage planning, voyage plan is to be identified and planned route is to be avoided;
 ② At the stage of real-time navigation, ships are to take such measures as reducing speed, reducing maneuver, increasing watch, icebreaker support and changing route.
(2) The manual is to provide relevant operation measures and/or establish procedures, including:
 ① Operation with reduced speed: when ice regimes with rising operational risk occur, operation with reduced speed can be carried out. Limited speed may be obtained and

approved according to ship's ice trial or by providing ice load measuring and monitoring system. Based on hull structure capability of ice class, recommended speed limitation is shown in Table 7.4.2.1(2)①.

Recommended speed limitation for risk-reducing operation Table 7.4.2.1(2)①

Ice class	Recommended speed limitation
PC1	11 knot
PC2	8 knot
PC3-PC5	5 knot
Below PC5	3 knot

② Reducing maneuver: when ice regimes with rising operational risk occur, it is to arrange experienced helmsman and observe following operation principles:

(a) Amidship when being astern, and keeping to next steering command;

(b) If it is unavoidable to encounter floating ice impact, slowing down and ensuring vertical impact of bow stem post with ice edge;

(c) Avoiding approaching thick floating ice to decrease shell plating impacting ice;

(d) Avoiding sudden turning in thick ice, using small rudder angle (less than 10^{o}) in ice turning, $5\text{-}10^{o}$ each time;

(e) Rudder turning to thick ice to avoid shell plating impacting thick ice due to bow turning to thin ice.

③ Applying for icebreaker escort, see 7.4.6.

④ High -risk ice region strengthening watch procedures: operating in the vicinity of ice region or in ice region, bridge watch command must clearly specify following conditions, call master and/or qualified personnel in the bridge:

(a) Observing ice at first sight;

(b) Unexpected change of ice or climate condition;

(c) Icing risk may happen;

(d) Decreased visibility.

Under the conditions of approaching iceberg and glacier ice, night operation or operation with low visibility, it is to arrange qualified personnel with ice region operation experience to assist watch, when necessary, it is to arrange bow watch, adopt manual steering mode and arrange two experienced helmsmen to steer, stand-by engine and record ice condition every hour (including ice amount, part ice amount, ice age, thickness and floating ice dimension).

⑤ Changing/reassigning route: when dangerous ice conditions needing special consideration occur, the master and officer are to operate carefully and take measures based on ice condition evaluation, see Table 7.4.2.1(2)⑤.

Table 7.4.2.1(2)⑤

<table>
<tr><th colspan="2">Ice condition</th><th>Operation measures</th></tr>
<tr><td colspan="2">Total ice amount encountered by ship less than 7/10</td><td>It is allowed that category A and category B ships navigate with safe speed applicable to ice class, ice region draught and proper manoeuver under the condition of continuous monitoring and updating ice information</td></tr>
<tr><td rowspan="3">Total ice amount encountered by ship more than 7/10</td><td rowspan="2">Static floating ice group</td><td>For static close pack without ice pressure, deviation or proceeding is determined according to ice type in ice condition</td></tr>
<tr><td>For static close pack with ice pressure, the ship is to stop prior to alleviating ice pressure or changing status, change course or leave from former route and reassign route</td></tr>
<tr><td>Dynamic floating ice group</td><td>Movement: when the ice is moving or there is no risk of become dense during ice movement, deviation or proceeding is determined according to ice type in ice regime. If the ship is blocked by ice, all possible continuous monitoring actions are to be taken to get out of block</td></tr>
</table>

Ice condition		Operation measures
		Dense: if the close pack becomes denser and denser, ice regime may deteriorate continuously. The ship is to stand still and monitor condition, when necessary or possible, leave the ice region
		Open: for ice condition of being open or to be continuously open, if all other safe navigation parameters for the ship are met, the ship is to consider speed, ice class, draught and maneuverability, and reselect route

⑥ Avoiding contact with glacier ice and iceberg: echo strength is determined depending on whether radar can find iceberg as well as iceberg size and angle of reflection surface. For iceberg 5 m above water surface, detectable distance is only about 2 nautical miles. Iceberg less than 0.3 vm above water surface is hard to observe. In sunny daytime, the visibility of big iceberg is more than 10 nautical miles. At night, if moon and iceberg are in front of ship, iceberg is hard to find. If moon is opposite to iceberg, the visibility of iceberg is the same as that in the daytime. For the waters that wind speed decreases sharply, surge lowers suddenly and sea water temperature drops abruptly, it indicates that iceberg is approaching about 2 nautical miles.

If the ship encounters iceberg and glacier ice, the ship is to keep a safe distance which is to be more than 3 times maximum height of glacier ice above water, and the manual is to keep record.

⑦ Examination of hull integrity: if the ship is possible to contact floating ice, the ship is to measure level of compartment and tank below hull waterline twice every day, for accessible compartment, it is to examine leakage and deformation of shell plating and internal components, if there is any doubt, it is to increase frequency of measurement and examination.

⑧ Measures to get rid of ice block: if the ship is blocked by ice and cannot move due to ship bow being clamped by ice, following methods are to be taken immediately:

(a) full speed ahead and full rudder so that bow can become flexible, then exit by quick astern and amidship;

(b) alternately draining water in each ballast tank so that the ship can incline and become flexible.

For ice block, whether taking escape measures or waiting for the ice breaker or the weather to getting better, the propeller or rudder is to be kept rotating so as to avoid the water channel behind being sealed by ice.

7.4.2.2 The manual is to provide master and officer in charge of watch with guidance on operational limitation when the ships encounter or are expected to encounter temperature below polar service temperature according to operation evaluation result, including:

(1) delaying sailing schedule;

(2) postponing certain operation;

(3) applying temporary heating;

(4) other measures to alleviate risk.

7.4.3 Emergency response

7.4.3.1 Where the possibility of encountering low air temperatures, sea ice and other hazards is present, the manual is to provide guidance on procedures that will increase the effectiveness of emergency response measures.

7.4.3.2 The manual is to consider damage control measure and arrangements for emergency transfer of liquids and access to tanks and spaces during salvage operations.
7.4.3.3 The manual is to provide special measures for emergency response in case of fire in polar waters (if any).
7.4.3.4 If it is determined by operation evaluation that the ship has following emergent escape and evacuation conditions, the manual is to provide procedures and requirements for the use, training and drills of shipborne supplementary or specialized life-saving appliances:
(1) prolonged durations prior to rescue;
(2) abandonment onto ice or adjacent land.

7.4.4 Coordinating emergency response service
7.4.4.1 Ship emergency response: the manual is to include procedures to be followed in preparing for a voyage and in the event of an incident arising.
7.4.4.2 Salvage: the manual is to include procedures to be followed in preparing for a voyage and in the event of an incident arising.
7.4.4.3 Search and rescue: the manual is to contain information on identifying relevant Rescue Coordination Centers for any intended routes, and is to require that contact information and procedures are verified and updated as required as part of any voyage plan.

7.4.5 Procedures for maintaining life support and ship integrity in the event of prolonged entrapment by ice
7.4.5.1 Where any ship incorporates special features to mitigate safety or environmental risks due to prolonged entrapment by ice, the manual is to provide information on how these are to be set up and operated. This may include, for example, adding additional equipment to be run from emergency switchboards, draining systems at risk of damage through freezing, isolating parts of HVAC systems, etc.

7.4.6 Icebreaker escorted operations
7.4.6.1 The manual is to contain or reference information on the rules and procedures set out by coast States who require or offer icebreaking escort services. For northeast route, reference is made to relevant requirements of parts III to V of Russia Rules of Navigation on the Water Area of the Northern Sea Route, and for northwest route, reference is made to relevant requirements of Chapter 1 of Canada Ice Navigation in Canadian Waters.
7.4.6.2 The manual is also to emphasize the need for the master to take account of the ship's limitations in agreeing on the conduct of escort operations.
7.4.6.3 With respect to navigation with icebreaker assistance, the following are to be considered:
(1) while approaching the starting point of the ice convoy to follow an icebreaker/icebreakers or in the case of escorting by icebreaker of one ship to the point of meeting with the icebreaker, ships are to establish radio communication on the VHF channel 16 and act in compliance with the icebreaker's instructions;
(2) the icebreaker rendering the icebreaker assistance of ship ice convoy is to command ships in the ice convoy;
(3) position of a ship in the ice convoy is to be determined by the icebreaker rendering the assistance;

(4) ship within the ice convoy, in accordance with the instructions of the icebreaker rendering the assistance, is to establish communication with the icebreaker by VHF channel indicated by the icebreaker;
(5) the ship, while navigating in the ice convoy, is to ensure compliance with the instructions of the icebreaker;
(6) position in the ice convoy, speed and distance to a ship ahead are to be as instructed by the icebreaker;
(7) the ship is to immediately notify the icebreaker of any difficulties to maintain the position within the ice convoy, speed and/or distance to any other ship in the ice convoy; and
(8) the ship is to immediately report to the icebreaker of any damage.

Section 5 POLLUTION PREVENTION OPERATION

7.5.1 General

7.5.1.1 Polar area is environment-sensitive waters, and it is difficult to recover environment and ecology due to pollutant leakage caused by ice and cold climate. Therefore, polar ship operating in polar waters is to follow Polar Water Operational Manual and operate carefully to avoid accident.

7.5.1.2 During operation in polar waters, in addition to MARPOL Convention, polar waters are to meet additional requirements of Polar Code. Requirements for pollutant discharge control are provided in this Section.

7.5.2 Prevention of pollution by oil

7.5.2.1 In polar waters, any discharge into the sea of oil or oily mixtures from any ship is prohibited.

7.5.2.2 Operation in polar waters is to be taken into account, as appropriate, in the Oil Record Books, manuals and the shipboard oil pollution emergency plan or the shipboard marine pollution emergency plans as required by MARPOL Annex I.

7.5.3 Control of pollution by noxious liquid substances in bulk

7.5.3.1 In polar waters, any discharge into the sea of noxious liquid substances or mixtures containing such substances is to be prohibited.

7.5.3.2 Operation in polar waters is to be taken into account, as appropriate, in the Cargo Record Book, the Manual and the shipboard marine pollution emertency plan for noxious liquid substances or the shipboard marine pollution emergency plan as required by MARPOL Annex II.

7.5.4 Prevention of pollution by sewage from ships

7.5.4.1 Discharges of sewage within polar waters are prohibited except when performed in accordance with MARPOL Annex IV and the following requirements:
(1) the ship is discharged comminuted and disinfected sewage in accordance with regulation 11.1.1 of MARPOL Annex IV at a distance of more than 3 nautical miles from any ice-shelf or fast ice and is to be as far as practicable from areas of ice concentration exceeding 1/10; or
(2) the ship is discharged sewage that is not comminuted or disinfected sewage in accordance with

regulation 11.1.1 of MARPOL Annex IV at a distance of more than 12 nautical miles from any ice-shelf or fast ice and is to be as far as practicable from areas of ice concentration exceeding 1/10; or

(3) the ship has in operation an approved sewage treatment plant certified by the Administration to meet the operational requirements in either regulation 9.1.1 or 9.2.1 of MARPOL Annex IV, and discharges sewage in accordance with regulation 11.1.2 of Annex IV and is to be as far as practicable from the nearest land, any ice-shelf, fast ice or areas of ice concentration exceeding 1/10.

7.5.4.2 Discharge of sewage into the sea is prohibited from category A and B ships constructed on or after 1 January 2017 and all passenger ships constructed on or after 1 January 2017, except when such discharges are in compliance with the requirements of paragraph 7.5.4.1(3).

7.5.4.3 Category A and B ships that operate in areas of ice concentrations exceeding 1/10 for extended periods of time, may only discharge sewage using an approved sewage treatment plant certified by the Administration to meet the operational requirements in either regulation 9.1.1 or 9.2.1 of MARPOL Annex IV. Such discharges are to be subject to the approval by the Administration.

7.5.5 Prevention of pollution by garbage from ships

7.5.5.1 In Arctic waters, discharge of garbage into the sea permitted in accordance with regulation 4 of MARPOL Annex V, is to meet the following additional requirements:

(1) discharge into the sea of food wastes is only permitted when the ship is as far as practicable from areas of ice concentration exceeding 1/10, but in any case not less than 12 nautical miles from the nearest land, nearest ice-shelf, or nearest fast ice;

(2) food wastes are to be comminuted or ground and are to be capable of pasing through a screen with openings no greater than 25mm. Food wastes are not to be contaminated by any other garbage type;

(3) food wastes are not to be discharged onto the ice;

(4) discharge of animal carcasses is prohibited; and

(5) discharge of cargo residues that cannot be recovered using commonly available methods for unloading is only to be permitted while the ship is en route and where all the following conditions are satisfied:

① cargo residues, cleaning agents or additives, contained in hold wahing water, do not include any substances classified as harmful to the marine environment;

② both the port of departure and the next port of destination are within Arctic waters and the ship will not transit outside Arctic waters between those ports;

③ no adequate reception facilities are available at those ports; and

④ where the conditions of above-mentioned ①, ②and ③ have been fulfilled, discharge of cargo hold washing water containing residues is to be made as far as practicable from areas of ice concentration exceeding 1/10, but in any case not less than 12 nautical miles from the nearest land, nearest ice shelf or nearest fast ice.

7.5.5.2 In the Antarctic area, discharge of garbage into the sea permitted in accordance with regulation 6 of MARPOL Annex V, is to meet the following additional requirements:

(1) discharges under regulation 6.1 of MARPOL Annex V is to be as far as practicable from areas of ice concentration exceeding 1/10, but in any case not less than 12 nautical miles from the

nearest fast ice; and

(2) food waste is not to be discharged onto ice.

7.5.5.3 Operation in polar waters is to be taken into account, as appropriage, in the Garbage Record Book, Garbage Management Plan and the placards as required by MARPOL Annex V.

7.5.6 Ballast water and invasive aquatic species control

7.5.6.1 Until the International Convention for the Control and Management of Ships' Ballast Water and Sediments enters into force, the ballast water management provisions of the ballast water exchange standard, set out in regulation D-1, or the ballast water performance standard, set out in regulation D-2 of the Convention, are to be considered as appropriate. The provisions of the Guidelines for ballast water exchange in the Antarctic treaty area (resolution MEPC.163(56)) are also to be taken into consideration.

7.5.6.2 In selecting the ballst water management system, attention is to be paid to limiting conditions specified in the appendix of the Type Approval Certificate and the temperature under which the system has been tested, in order to ensure its suitability and effectiveness in polar waters.

7.5.6.3 In order to minimize the risk of invasive aquatic species transfers via biofouling, measures are to be considered to minimize the risk of more rapid degradation of anti-fouling coatings associated with polar ice operations. Reference is made to the 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (resolution MEPC.207(62)). For application of anti-fouling coatings, reference may be made to Table 7.5.6.3.

Table 7.5.6.3

Ship type or operation duration	**Hull**	**Sea chest**
Year round operation in ice-covered polar waters	Abrasion resistant low friction ice coating Without anti-fouling system	Abrasion resistant coating Thickness of anti-fouling system to be determined by shipowner
Intermittent operation in ice-covered polar waters	Abrasion resistant low friction ice coating In sides, above bilge keel, maximum thickness of anti-fouling system 75 μm, to protect hull between applciation of anti-fouling system and next anticipated voyage to ice-covered waters. In bottom area, thickness to be decided by shipowner. Composition of anti-fouling system is to be determined according to International Convention on the Control of Harmful Anti-fouling System on Ships (AFS Convention).	Thickness of anti-fouling system to be determined by shipowner
Category B and C ships	Thickness of anti-fouling system to be determined by shipowner	Thickness of anti-fouling system to be determined by shipowner

Section 6 OPERATIONAL TRAINING

7.6.1 General

7.6.1.1 Crew operating in polar waters are to have special skill to ensure safe and effective operation of ship.

7.6.1.2 STCW Convention provides training requirements for crew operating in polar waters. This section is intended to provide the ship owner, operator and crew with training guidance on operation in polar waters as well as plan and implement operation in polar waters.

7.6.2 Training

7.6.2.1 Training for master, officer and engineer is to include:

(1) relevant characteristics of ice

① familiar with ice composition characteristics and identification knowledge as well as ice condition diagram and limitation of ice regime forecast;

② grasping physical property as well as forming, growing and melting process of ice;

③ knowing ice conditions of different area and season and under rapid change of climate conditions;

④ understanding effect of ice friction force and ice pressure on hull stress as well as effect of deck ice and snow accumulation due to splashing wave and accumulated snow on ship stability;

⑤ identifying difference between floating ice group and iceberg as well as floating principles of floating ice.

(2) Ship performance

① familiar with ship type, structure and anti-icing strengthening condition;

② grasping the relationship between ship ice region strengthening (ice class) and safe ice condition;

③ knowing local special provisions, including limitations on ship low temperature system performance, anti-cold climate equipment and anti-icing level.

(3) Conventions and regulations

① familiar with relevant international conventions;

② familiar with local regulations and suggestions of costal state and relevant area.

(4) Ice region maneuvering

① familiar with floating ice pressure on the hull as well as sailing speed and maneuvering technology in ice region of different density;

② knowing operational knowledge relating to icebreaking assistance and icebreaking pilot as well as convoy and communication requirements.

(5) High latitude limitation

① knowing navigational aids in polar waters and limitation of chart information;

② obtaining hydrologic data is necessary for safe navigation;

③ matters needing attention during navigation in waters with severe condition;

④ limitation of SAR preparation and responsibility, including limitation of GMDSS A4 area and SAR communication facility;

⑤ understanding on handling accidents;

⑥ understanding on dragging procedure;

⑦ importance of keeping contact with other vessel or local SAR organization;

⑧ understanding on risk of personnel exposed to low temperature condition, abandonment procedure and skill as well as self-rescue in ice region;

⑨ crew fatigue due to noise and shaking;

⑩ material carriage, e.g. fuel tank, food and additional clothing;

⑪ understanding on magnitude of consequences caused by accidents in polar waters;

⑫ knowing limitation of ship directing (compass) equipment, communication and navigation equipment as well as electronic positioning equipment at high latitude.

(6) Environment protection

① knowing polar navigation-forbidden, navigation-avoiding and sensitive areas as well as pollution-preventing special area;

② following pollution-prevention provisions and keeping sewage, bilge water, oily water and any garbage on board ship;

③ knowing limitation of pollution-preventing equipment in ice waters.

(7) Emergency handling

① knowing emergency SAR organization of coastal State and provision of rescue equipment in relevant sea area (ship capability);

② grasping contact details of each SAR organization and rescue boat;

③ knowing limitation of relevant communication equipment at high latitude waters.

7.6.2.2 All crew training is to include:

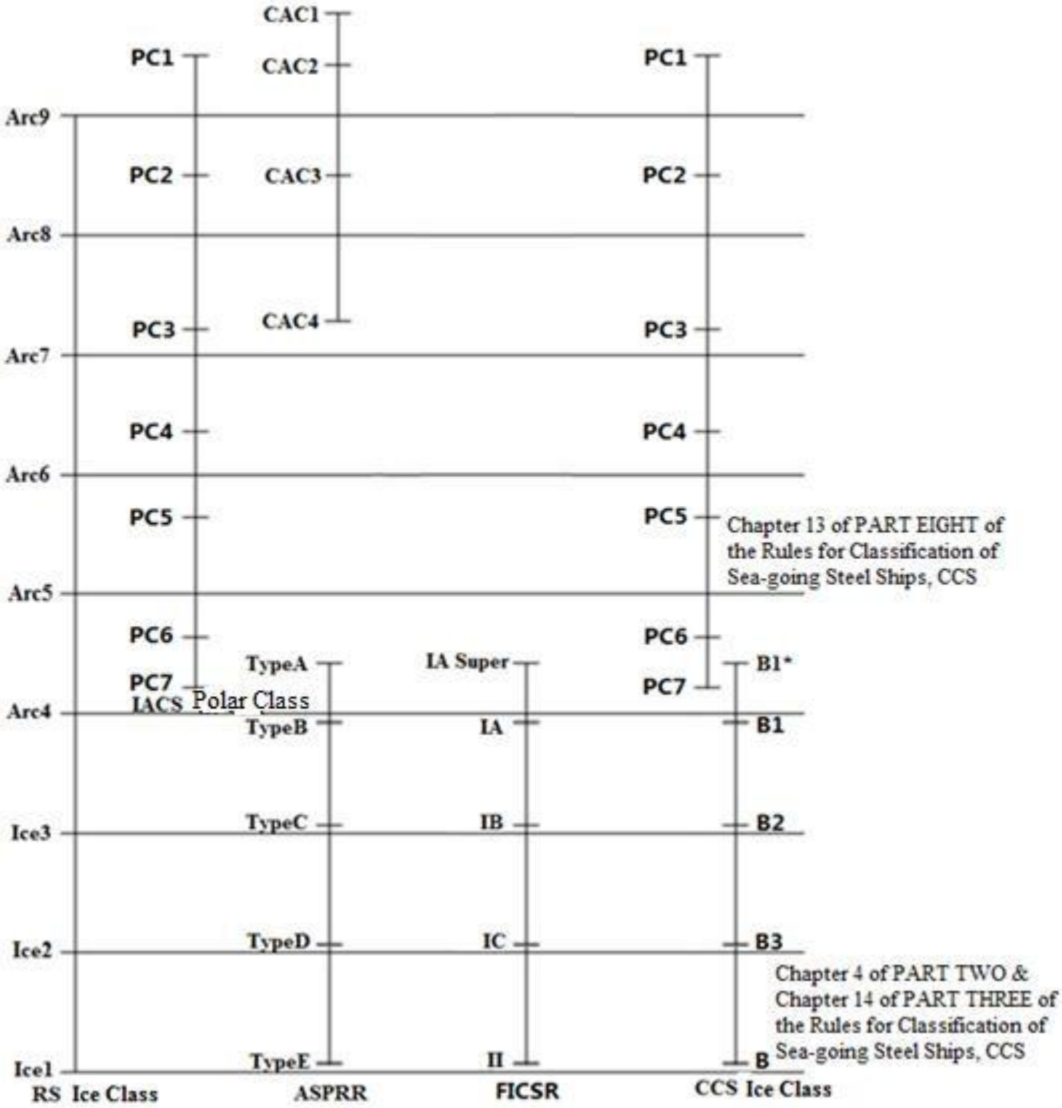
(1) survival knowledge: familiar with survival knowledge, measures and means under cold climate;

(2) life-saving appliances: using life-saving appliances properly in low temperature condition;

(3) first aid in low temperature: first aid treatment and treatment procedure for cold shock, decreasing body temperature and too low body temperature;

(4) evacuation on ice: identifying ice and snow composition and characteristics as well as safe evacuation on ice.

Appendix 1 Ice Class Contrast Diagram



Notes: (1) RS ice class: ice class of rules of Russian Maritime Register of Shipping;

(2) ASPPR: ice class of Arctic Shipping Pollution Prevention Regulations of Canada;

(3) FICSR: ice class of Finnish-Swedish Ice Class Rules;

(4) The ice class contrast diagram shows the rough corresponding relations between different ice classes.

Appendix 2 Methodology for Assessing Operational Capabilities and Limitations in Ice: Polar Operational Limit Assessment Risk Indexing System (POLARIS)

2.1 General

2.1.1 The Polar Operational Limit Assessment Risk Indexing System (POLARIS) has been developed incorporating experience and best practices from Canada's Arctic Ice Regime Shipping System, the Russian Ice Certificate supplemented by pilot ice assistance as prescribed in the Rules of Navigation on the water area of the Northern Sea Route and other methodologies.

2.1.2 The basis of POLARIS is an evaluation of the risks posed to the ship by ice conditions in relation to the ship's assigned ice class. It uses the WMO nomenclature and the ice class consistent with the ice class(es) referenced in the Polar Ship Certificate.

2.1.3 POLARIS uses a Risk Index of Risk Values (RIVs) which are assigned to a ship based on the ice class. The RIVs may be used to evaluate the limitations of the ship operating in an ice regime using input either from historic or current ice charts for voyage planning or in real time from the bridge of the ship.

2.1.4 The principal features of POLARIS are:

(1) the use of a combination of IACS Polar Class ice classes and ice classes assigned equivalence to Finnish Swedish Ice Class Rules under HELCOM①, which are consistent with ice class references used elsewhere in the Code;

(2) the use of ice type definitions generally consistent with WMO nomenclature and which can be found on international ice charts;

(3) consideration of different ice regimes (e.g. waters with partial ice concentrations of different ice types and developments stages and ice free waters);

(4) consideration of ice decay – the outcome of which is a reduced risk due to a reduction in ice strength for some ice types when operating in warmer ambient temperatures; and

(5) an acknowledgement that ships operating under icebreaker escort have a different risk profile to ships operating independently.

2.2 Polar Operational Limit Assessment Risk Indexing System

2.2.1 Risk Index Values

(1) Ships assigned an ice class and ships without an ice class have been assigned a Risk Index in POLARIS. The Risk Index Values (RIVs) within the Risk Index are values corresponding to a relative risk evaluation for corresponding ice types.

(2) Ice types in POLARIS generally conform to WMO nomenclature used on ice charts with the

① Refer to the annex to HELCOM Recommendation 25/7, Safety of Winter Navigation in the Baltic Sea Area, available at www.helcom.fi.

exception that Medium First Year ice and Multi Year Ice are given two RIVs. Where the operator can confidently determine that the Medium First Year ice in a regime is less than 1 metre in thickness, the RIVs in the column "Medium First Year Ice less than 1 m thick" may be used. Otherwise the RIVs in the column "Medium First Year Ice" should be used. Similarly, where the operator can confidently determine that the Multi-Year ice in a regime is less than 2.5 metres in thickness, the RIVs in the column "Light Multi-Year Ice" may be used. Otherwise the RIVs in the column "Heavy Multi-Year Ice" should be used.

(3) Risk Index values have been developed in Table 2.2.1(1) and Table 2.2.1(2). Table 2.2.1(2) reflects a reduction in risk associated with decayed ice during times of higher ambient temperatures for certain ice types. The standard Risk Index Values of Table 2.2.1(1) should be used unless ice decay is confirmed by ice information/visual observation by personnel on board qualified in accordance with chapter 12 of the Polar Code. Only then, Table 2.2.1(2) may be used.

2.2.2 Risk Index Outcome

(1) POLARIS uses a Risk Index Outcome (RIO) value to assess limitations for operation in ice. Risk Index Values (RIVs) are assigned to the ship based on ice class and ice types present according to Tables 2.2.1(1) and 2.2.1(2). For each ice regime encountered, the Risk Index Values are used to determine a RIO that forms the basis of the decision to operate or the limitation of operations.

(2) The RIO is determined by a summation of the RIVs for each ice type present in the ice regime multiplied by its concentration (expressed in tenths):

$$RIO = (C_1 x RIV_1) + (C_2 x RIV_2) + (C_3 x RIV_3) + \ldots (C_n x RIV_n)$$

Where $C_1 \ldots C_n$ are the concentrations (in tenths) of ice types within the ice regime; and $RIV_1 \ldots RIV_n$ are the corresponding Risk Index Values for each ice type.

2.2.3 Evaluation of the Risk Index Outcome for independent operations

(1) Operational limitations for ships operating independently are determined based on the criteria in Table 2.2.3, using the calculated value of the RIO for the ice regime encountered by the ship, given that due caution of the Mariner will be exercised, taking into account such factors as changes in weather and visibility.

(2) POLARIS addresses three levels of operation, normal operation, elevated operational risk and operation subject to special consideration. For the purpose of POLARIS the RIO values in Table 2.2.3 equals these three levels of operation.

Risk Index Outcome criteria **Table 2.2.3**

RIO_{SHIP}	Ice classes PC1-PC7	Ice classes below PC 7 and ships not assigned an ice class
$RIO \geq 0$	Normal operation	Normal operation
$-10 \leq RIO < 0$	Elevated operational risk*	Operation subject to special consideration**
$RIO < -10$	Operation subject to special consideration**	Operation subject to special consideration**

Notes: *See section 2.2.4

**See section 2.2.5

2.2.4 Elevated Operational Risk

(1) Ships operating in an elevated risk ice regime, based on the RIO outcome, should limit the speed to the values indicated in Table 2.2.4. Operational measures may also include, provision of additional watch keeping or use of icebreaker support. When the speed reduction may impair the ship manoeuvrability, the operation should be avoided.

Recommended speed limits for elevated risk operations Table 2.2.4

Ice Class	Recommended Speed Limit
PC1	11 knots
PC2	8 knots
PC3-PC5	5 knots
Below PC5	3 knots

(2) Ships equipped with ice load measurement and monitoring systems can utilize these systems to calibrate recommended speeds included in Table 2.2.4.

(3) Ships having undergone full scale ice trials and/or calculation-based methodologies can utilize these results to calibrate recommended speeds included in Table 2.2.4.

(4) Recommended speed limits for elevated operational risk conditions should be included in the PWOM.

(5) For voyage planning generally, areas in which the potential to encounter elevated risk operations has been identified should be avoided. Where elevated risk operations are identified and included in a voyage plan, contingency plans should be in place and documented in the PWOM.

2.2.5 Operations Subject to Special Consideration

(1) Operations subject to Special Consideration mean operations whereby extreme caution should be exercised by the Master and officers in charge of a navigational watch when navigating in ice.

(2) Where a ship encounters an ice regime where the RIO identifies Operations Subject to Special Consideration, suitable procedures should be contained in the PWOM and should be followed. Such procedures should contain guidance to the operator on reducing the increased risks present to the ship and should include course alteration / re-routing, further reduction in speed and other special measures.

(3) For voyage planning purposes, ice regimes where the RIO identifies Operations Subject to Special Consideration should be avoided.

2.2.6 Risk Index Outcome for ships under icebreaker escort

(1) In determining the RIO for a ship under icebreaker escort, the ice immediately ahead of the ship should be considered as its ice regime. This regime should include both the track of the icebreaker and, when the icebreaker has a smaller beam than the escorted ship, any unmodified ice out to the maximum beam of the escorted ship.

(2) The icebreaker itself should calculate its own RIO along the intended route.

(3) In general, escorted operations should be reconsidered if the icebreaker encounters a RIO below 0 or if the escorted ship is in an ice regime for which operation is subject to special consideration.

(4) For voyage planning purposes when icebreaker escort is intended to be used, the RIO derived from non-escorted historical ice data may be assumed to be modified by adding 10 to its calculated value. However, it is cautioned that this is an average value which can vary significantly. For actual operations, the RIO under escort should not be modified and should be derived as described in the previous paragraphs.

2.2.7 Operation in Ice Regimes Containing Glacial Ice

(1) The presence of glacial ice represents additional risks to the ship. Areas containing glacial ice should be approached with caution.

(2) Appropriate training should be provided to the Master and officers in charge of a navigational watch when navigating in ice on identification and avoidance of glacial ice and the consequences of collision. Measures to avoid glacial ice should be documented in the PWOM.

(3) Where glacial ice is encountered, in addition to the RIO, a safe stand-off distance should be observed by the ship. This stand-off distance should be recorded in the PWOM.

Risk Index Values **Table 2.2.1(1)**

Ice Class	Ice Free	New Ice	Grey Ice	Grey White Ice	Thin First year ice 1st Stage	Thin First Year Ice 2nd Stage	Medium First Year Ice less than 1 m. thick	Medium First Year Ice	Thick First year Ice	Second Year Ice	Light Multi Year Ice, less than 2.5 m. thick	Heavy Multi Year Ice
PC1	3	3	3	3	2	2	2	2	2	2	1	1
PC2	3	3	3	3	2	2	2	2	2	1	1	0
PC3	3	3	3	3	2	2	2	2	2	1	0	-1
PC4	3	3	3	3	2	2	2	2	1	0	-1	-2
PC5	3	3	3	3	2	2	1	1	0	-1	-2	-2
PC6	3	2	2	2	2	1	1	0	-1	-2	-3	-3
PC7	3	2	2	2	1	1	0	-1	-2	-3	-3	-3
IA Super	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
IA	3	2	2	2	1	0	-1	-2	-3	-4	-5	-5
IB	3	2	2	1	0	-1	-2	-3	-4	-5	-6	-6
IC	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8
Not Ice Strengthened	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

Risk Index Values–Decayed ice conditions **Table 2.2.1(2)**

Ice Class	Ice Free	New Ice	Grey Ice	Grey White Ice	Thin First year ice 1st Stage	Thin First Year Ice 2nd Stage	Medium First Year Ice less than 1 m. thick	Medium First Year Ice	Thick First year Ice	Second Year Ice	Light Multi Year Ice, less than 2.5 m. thick	Heavy Multi Year Ice
PC1	3	3	3	3	2	2	2	2	2	2	1	1
PC2	3	3	3	3	2	2	2	2	2	1	1	0
PC3	3	3	3	3	2	2	2	2	2	1	0	-1
PC4	3	3	3	3	2	2	2	2	1	0	-1	-2
PC5	3	3	3	3	2	2	2	2	1	-1	-2	-2
PC6	3	2	2	2	2	1	2	1	0	-2	-3	-3
PC7	3	2	2	2	1	1	1	0	-1	-3	-3	-3
IA Super	3	2	2	2	2	1	1	0	-1	-3	-4	-4
IA	3	2	2	2	1	0	0	-1	-2	-4	-5	-5
IB	3	2	2	1	0	-1	-1	-2	-3	-5	-6	-6
IC	3	2	1	0	-1	-2	-2	-3	-4	-6	-7	-8
Not Ice Strengthened	3	1	0	-1	-2	-3	-3	-4	-5	-7	-8	-8

Appendix 3 Form of Certificate for Ships operating in Polar Waters

3.1 Form of Polar Ship Certificate

Polar Ship Certificate

This Certificate shall be supplemented by a Record of Equipment for the Polar Ship Certificate

(Official seal) (State)

Issued under the provisions of the
International Convention for the Safety of Life at Sea, 1974, as amended
under the authority of the Government of

(name of the State)

by ____

(person or organization authorized)

Particulars of ship[①]

Name of ship…………………………………………………………………………
Distinctive number or letters…………………………………………………………
Port of registry……………………………………………………………..………
Gross tonnage…………………………………………………………...……………
IMO Number[②]………………………………………………………………...…

THIS IS TO CERTIFY:

1 That the ship has been surveyed in accordance with the applicable safety-related provisions of the International Code for Ships Operating in Polar Waters.

2 That the survey[③] showed that the structure, equipment, fittings, radio station arrangements, and materials of the ship and the condition thereof are in all respects satisfactory and that the ship complies with the relevant provisions of the Code.

---

① Alternatively, the particulars of the ship may be placed horizontally in boxes.
② In accordance with IMO ship identification number scheme adopted by the Organization by resolution A.1078(28).
③ Subject to 1.3 of the International Code for Ships Operating in Polar Waters.

Category A/B/C④ ship as follows:

Ice Class and Ice Strengthened Draft Range

Ice class	Maximum draft		Minimum draft	
	Aft	Fwd	Aft	Fwd

2.1 Ship type: tanker/passenger ship/other④

2.2 Ship restricted to operate in ice free waters/open waters/other ice conditions④

2.3 Ship intended to operate in low air temperature: Yes/No④

2.3.1 Polar Service Temperature:...°C/Not Applicable④

2.4 Maximum expected time of rescue .... days

3 The ship was/was not④ subjected to an alternative design and arrangements in pursuance of regulation XIV/4 of the International Convention for the Safety of Life at Sea, 1974, as amended.

4 A Document of approval of alternative design and arrangements for structure, machinery and electrical installations/fire protection/life-saving appliances and arrangements ④ is/is not ④ appended to this Certificate.

5 Operational limitations

The ship has been assigned the following limitations for operation in polar waters:

5.1 Ice conditions…………………………………………………………..

5.2 Temperature…………………………………..……………………..

5.3 High latitudes………………………………..………………………

This certificate is valid until …………………………………………………subject to the annual/periodical/intermediate surveys in accordance with section 1.3 of the Code④.

Completion date of the survey on which this certificate is based:……………………...

(dd/mm/yyyy)

Issued at …………………………………………………………………………...

(Place of issue of certificate)

④ Delete as appropriate.

④ Delete as appropriate.

……………………… ……………………………….

(Date of issue) (Signature of authorized official issuing the certificate)

(Seal or stamp of the issuing authority, as appropriate)

Endorsement for annual, periodical and intermediate surveys[①]

THIS IS TO CERTIFY that, at a survey required by 1.3 of the Code, the ship was found to comply with the relevant requirements of the Code.

Annual survey:

Signed:……………………………

(Signature of authorized official)

Place:……………………………

Date:……………………………

(Seal or stamp of the authority, as appropriate)

Annual/Periodical/Intermediate[①] survey:

Signed:……………………………

(Signature of authorized official)

Place:……………………………

Date:……………………………

(Seal or stamp of the authority, as appropriate)

Annual/Periodical/Intermediate[①] survey:

Signed:……………………………

(Signature of authorized official)

Place:……………………………

Date:……………………………

(Seal or stamp of the authority, as appropriate)

Annual survey:

Signed:……………………………

(Signature of authorized official)

Place:……………………………

Date:……………………………

(Seal or stamp of the authority, as appropriate)

① Delete as appropriate.

Endorsement to extend the certificate if valid for less than 5 years where regulation I/14(c) of the Convention applies①

The ship complies with the relevant requirements of the Convention, and this certificate shall, in accordance with regulation I/14(c) of the Convention, be accepted as valid until……….

Signed:…………………………..………….…..

(Signature of authorized official)

Place:………………………………………………

Date:……………………………………………….

(Seal or stamp of the authority, as appropriate)

Endorsement where the renewal survey has been completed and regulation I/14(d) of the Convention applies①

The ship complies with the relevant requirements of the Convention, and this certificate shall, in accordance with regulation I/14(d) of the Convention, be accepted as valid until………….

Signed:…………………………..………….…..

(Signature of authorized official)

Place:………………………………………………

Date:……………………………………………….

(Seal or stamp of the authority, as appropriate)

Endorsement to extend the validity of the certificate until reaching the port of survey or for a period of grace where regulation I/14(e) or I/14(f) of the Convention applies①

This certificate shall, in accordance with regulation I/14(e)/l/14(f) ① of the Convention, be accepted as valid until…………

Signed:…………………………..………….…..

(Signature of authorized official)

Place:………………………………………………

Date:……………………………………………….

(Seal or stamp of the authority, as appropriate)

Endorsement for advancement of anniversary date where regulation l/14(h) of the Convention applies①

In accordance with regulation I/14(h) of the Convention, the new anniversary date is………

Signed:…………………………..………….…..

(Signature of authorized official)

① Delete as appropriate.

Place:………………………………………………

Date:……………………………………………….

(Seal or stamp of the authority, as appropriate)

In accordance with regulation I/14(h) of the Convention, the new anniversary date is………

Signed:…………………………...…………..…..

(Signature of authorized official)

Place:………………………………………………

Date:……………………………………………….

(Seal or stamp of the authority, as appropriate)

3.2 Form of Record of Equipment for the Polar Ship Certificate

Record of Equipment for the Polar Ship Certificate

This record shall be permanently attached to the

Polar Ship Certificate

RECORD OF EQUIPMENT FOR COMPLIANCE WITH THE INTERNATIONAL CODE FOR SHIPS OPERATING IN POLAR WATERS

1 Particulars of ship

Name of ship:……………………………………………………………………

Distinctive number or letters:…………………………………………………

2 Record of equipment

2.1 Life-saving appliances

1 Total number of immersion suits with insulation	……………………
1.1 for crew	……………………
1.2 for passengers	……………………
2 Total number of thermal protective aids	……………………
3 Personal and Group Survival Equipment	……………………
3.1 Personal survival equipment – for number of persons	……………………
3.2 Group survival equipment – for number persons	……………………
3.3 Total capacity of liferafts in compliance with chapter 8 of the Polar Code	……………………
3.4 Total capacity of lifeboats in compliance with chapter 8 of the Polar Code	……………………

2.2 Navigation equipment

1 Two independent echo-sounding devices or a device with two separate independent transducers	………………………
2 Remotely rotatable, narrow-beam search lights controllable from the bridge or other means to visually detect ice	………………………
3 Manually initiated flashing red light visible from astern (for ships involved in icebreaking operations)	………………………
4 Two or more non-magnetic independent means to determine and display heading	………………………
5 GNSS compass or equivalent (for ships proceeding to latitudes over 80 degrees)	………………………

2.3 Communication equipment

1 Sound signaling system mounted to face astern to indicate escort and	………………………

emergency manoeuvres to following ships as described in the International Code of Signals (for ships intended to provide ice breaking escort).	
2 Voice and/or data communications with relevant rescue coordination centres.	………………………
3 Equipment for voice communications with aircraft on 121.5 and 123.1 MHz.	………………………
4 Two-way voice and data communication with a Telemedical Assistance Service (TMAS).	………………………
5 All rescue boats and lifeboats, whenever released for evacuation, have a device (for ships certified to operate in low air temperature):	
5.1 for transmitting vessel to shore alerts;	………………………
5.2 for transmitting signals for location;	………………………
5.3 for transmitting and receiving on-scene communications.	………………………
6 All other survival craft have a device:	
6.1 for transmitting signals for location; and	………………………
6.2 for transmitting and receiving on-scene communications.	………………………

THIS IS TO CERTIFY that this Record is correct in all respects

Issued at____________________________

(Place of issue of the Record)

____________________ ____

(Date of issue) (Signature of duly authorized official issuing the Record)

(Seal or stamp of the issuing authority, as appropriate)

Appendix 4 Ice Basin Model Test

4.1 General

4.1.1 The ice basin model test is usually used to determine various design parameters ensuring safe navigation of the ship in ice.

4.1.2 The ice is usually made through freezing the water sprinkled in the tank in low temperatures. The freezing time should be controlled for ice making so as to avoid resulting in too hard ice and fracturing due to too long time or too soft ice due to too short time. The typical ice-making time is 4 to 12 hours within which the thickness and strength required by the test are made.

4.1.3 The ship model scale depends on the ice thickness. The 8 m model (scale: 1:30) needs ice with the thickness of 10-12 mm. Usually the ice thickness ranges from 5 mm to 70 mm so as to realize the same strength level.

4.1.4 The test scheme generally includes various ice thicknesses and various conditions of different powers. In some cases, the test range allows interpolation between ice thicknesses and correction by means of full scale test.

4.1.5 The typical ice basin model test includes:

(1) the icebreaking capability in the level ice when the ship is running ahead and astern;

(2) the ice advancing performance in the frozen channel;

(3) the ice advancing performance in the unfrozen channel;

(4) the capability to sail out of the channel when the ship is running ahead and astern;

(5) the capability to run across and away from the ice ridge.

4.1.6 A reliable ice basin model test can replace rule requirements. The Finnish Swedish Ice Class Rules require that the ship should advance at 5 knots in a brash ice channel to ensure the continuous progress and determine the main engine power accordingly. For speed of less than 5 knots, it is more suitable for sailing at ports or in ice areas under the pilotage of icebreakers. This appendix, developed in accordance with Appendix 4 of Guidelines for the Application of the Finnish Swedish Ice Class Rules, is for your reference.

4.2 Ice Basin Model Test Procedure

4.2.1 The objective of ice basin model test is to verify the capability of the ship to operate at a certain speed in the waters specified for each ice class by the model tests. That is to determine the total resistance in the channel by the test and assess whether the thruster can produce enough thrust to overcome this resistance (taking into account the thrust deduction factor) to reach a certain speed. The mathematic expression is:

$$T \times (1 - t) \geq R_{itot}$$

where:

R_{itot} —— Total resistance, taken as $R_i + R_{ow}$

R_i—— Resistance due to ice;

R_{ow}—— Resistance in the open water test;

T—— Propeller thrust at a certain speed which is usually taken as 5 knots;

t—— Propeller thrust deduction factor at a certain speed.

4.2.2 Model Testing Process

The rule requirement is that the ship achieves at least 5 knots in a channel that is defined separately for each ice class. The rule resistance in the specified channel is given in the rules. The aim of the model tests is to determine the channel resistance and also the total resistance in the channel i.e. channel and open water resistances and then show that there is enough net propulsion thrust (i.e. taking into account the thrust deduction factor) available to overcome this resistance.

The results of the model tests should show the channel resistance, open water resistance at the same speed and the net thrust of the proposed propulsion arrangement in full scale at that speed. A propulsion test with stock propellers showing a self propulsion point at some speed is not enough. This fact is reflected also in the reporting requirements.

4.2.3 Geometry of the Ice Channel

The rule-based channels have been given a thickness for their mid part (H_M = 1 m for IA, 0.8 m for IB and 0.6 m for IC), and their profile thickens towards the edges by a gradient of 2º, see Figure 4.2.3. This profile is based on channel measurements in fairways to northern ports in the Gulf of Bothnia.

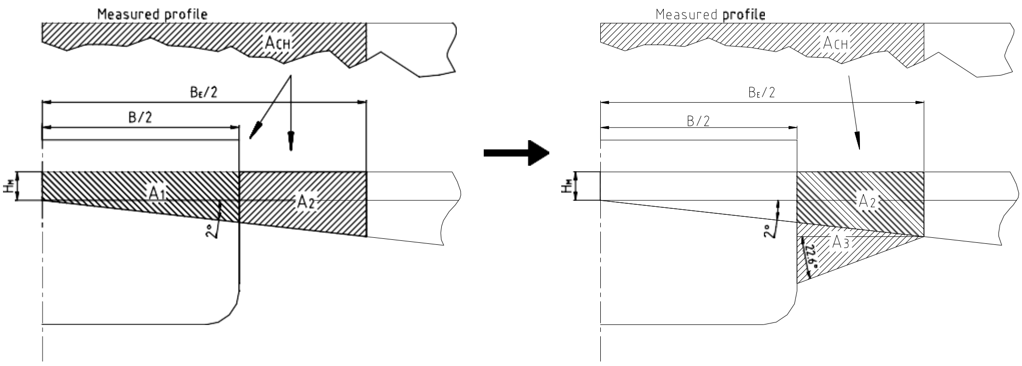


Figure 4.2.3

Figure 4.2.3: The geometry of a “real” brash ice channel profile and the corresponding profile of a rule channel before the ship’s passage and the assumed behaviour of the ice during the passage. The relations between the cross-sectional areas are: $A_{CH} = A_1 + A_2 = A_2 + A_3$.

However, it is difficult to achieve a channel profile in model test conditions that resembles the one referred to in the rules. An average channel thickness, H_{av}, may thus be used, which is affected by the breadth of the ship, being

$$H_{av} = H_M + 14.0 \cdot 10^{-3} B \qquad (1)$$

where:

B is the beam of the vessel.

The width of the ice channel should be 2 x *B* with level ice at sides. The thickness profile of the ice channel should be measured at a breadth of 1.6 x *B*.

The channel profile should be measured at sufficiently small intervals (about 10 … 20 cm intervals) in order to ensure that the cross sectional area of the ice channel is accurately determined. In the longitudinal direction, the step of cross sectional profiling should be at most 2 m.

The channel should be 100% covered with ice so that there are about two layers of ice pieces on top of each other.

4.2.4 Friction Coefficient

In full scale, the friction coefficient between ice floes and the hull, μ, ranges from 0.05 for new ships to 0.15 for corroded hull surface. In ice basin model tests a friction factor of 0.05 ~ 0.1 is usually applied for the model.

If a friction coefficient of less than 0.1 is used in the model tests to determine the ice channel resistance R_{CH}, the engine power and the propeller thrust should be selected so that the vessel is able to sail at 5 knots with a friction coefficient of 0.1 in full scale. Correction of the resistance due to different friction coefficient can be made by using the following formula:

$$R_{CH(\text{with } \mu_{target})} = \left[\left(0.6 + 4\mu_{target}\right) / \left(0.6 + 4\mu_{actual}\right) \right] R_{CH(\text{with } \mu_{actual})},$$

where: μ_{actual} is the actual friction coefficient measured in the tests and $\mu_{target} = 0.1$。

4.2.5 Model Tests for Ice Class IA Super

The preparation of a consolidated ice layer for ice class IA Super is difficult, since it often becomes very inhomogeneous (the pieces in nature are very small, but often larger in the test channels) or also too intact (resembling natural ice). For this reason, these tests could be carried out by superposing the level ice resistance and the channel resistance.

4.2.6 Determination of the Propulsion Power in Full Scale

When R_{CH} has been determined using model tests, and this resistance is used to verify the compliance with the speed requirements for the applicable ice class, the actual propeller thrust in full scale should be applied using the actual propeller and engine data in order to ensure that the propulsion system is able to produce the required thrust to overcome the channel resistance. This is especially important for slow speed direct drive diesel engines with a FPP. If the ice is observed to interact much with the propeller in the tests, the losses in propulsion due to this propeller-ice interaction must be taken into account in the calculation of the full scale power and speed of the ship. For the verification of the model scale bollard pull, the corresponding full scale bollard pull is to be given for the propeller planned to be used in the ship.

4.3 The following information should be included in the model test report.

4.3.1 General description of the ice model basin and the model ice

4.3.2 Ship model

(1) main particulars of the ship including displacement and deadweight;

(2) main particulars of the model;

(3) description of the ship geometry with hull lines drawing;

(4) model scale.

4.3.3 Propulsion

(1) description of the ship propulsion system including the net thrust and bollard pull curves;

(2) description of the model propellers;

(3) the bollard pull versus RPM curve of the ship model.

4.3.4 Test program and procedures

(1) model test program;

(2) hull friction coefficient measurement procedure;

(3) description of the measurement system for propulsion values;

(4) description of the measurement system in resistance and/or propulsion tests Analysis procedures;

(5) analysis procedures.

4.3.5 Model ice

(1) data on the parent level ice thickness;

(2) parent level ice strength (bending strength and also preferably compressive strength);

(3) description of the method of producing the channel;

(4) measurement of the channel profile at sufficiently small intervals (about 10 … 20 cm intervals) to allow an accurate determination of the cross sectional area of the channel. In longitudinal direction, the step of cross sectional profiling should be at most 2 m. The methods used in this measurement should be described;

(5) from each cross section an average thickness of the channel should be computed from a channel width of the ship breadth and of 1.6 times the ship breadth;

(6) description of the porosity of the brash ice. Photographs from above the channel to give the coverage of brash ice along the whole channel;

(7) for the ice class IA Super, a consolidated layer of 10 cm in thickness (full scale) is assumed to be on top of the brash ice. If this layer is modelled, the modelling procedure is to be described, including the way it was produced and how its thickness and strength were measured.

4.3.6 Test results

(1) measurements of the hull coefficient of friction with ice;

(2) the time histories of model speed, propeller thrust, torque and RPM from each test. Indication of the part of the time history from which the final values were calculated;

(3) description of the behaviour of the brash ice in the channel. A measurement of the cohesion and internal friction angle or some other parameters describing the strength of the brash ice should be done or at least an earlier result for these quantities from a brash ice channel similarly produced;

(4) photographs of the channel made by the vessel immediately after the tests, from above;

(5) the deduced (from time histories referred to in section 4.3.6(2) above) and calculated model propulsion, total model resistance and ice resistance values;

(6) full scale resistance and engine power prediction including a description of the extrapolation method. An estimate of the accuracy of the result obtained by extrapolation is to be given.

4.3.7 Other information

(1) estimate of the resistance of the model in open water;

(2) calculation of the required engine power according to the Finnish Swedish Ice Class Rules, 2010, with input data.

Appendix 5   Ship Operation Assessment Report Sample

5.1   Basic information of ship

Name of ship		Flag	
Type of ship		Nationality of crew	
Port of registry		Category of ship	A ☐ B ☐ C ☐
Registration number		Polar service area	
Call letters		Polar port of call	
IMO Number		Class of ship	
Gross tonnage		Class registration number	

Date of ship operation assessment		
Assessment personnel	Name	Technical background
Assessment approval personnel		
Date of assessment approval		

5.2   Description of ship operation assessment method

Stage	step	Requirements for report	Output worksheet
Preparation stage		Introducing background information (environmental information, accident statistics, etc.) and working method	
Assessment stage	Step 1: Identifying hazards	Making the list of hazards and identifying relevant accident scenarios including causes and initiating events	POLAR-01
	Step 2: Developing a risk analysis model	Defining the frequency index and severity index of accident scenario and finally determining the risk matrix	Table 3.3.3
	Step 3: Risk analysis and determining the acceptability	Qualitatively analyzing the probability and consequence of accident and determining the frequency index and severity index of accident scenarios; Listing the accident scenarios with relatively high risk index	POLAR-02
	Step 4: Developing risk control measures	For the accident scenarios with relatively high risk index, identifying the possible risk control measures and assessing the effectiveness on risk reduction of various control schemes	POLAR-03

Polar Ship Potential Hazard Identification Worksheet (FORM：POLAR-01)

Category of hazard	Trigger condition of accident	Potential Hazard				Description of accident scenarios
		Crew	Equipment	Hull	Environment	
Ice regime						
Icing						
Low temperature						
Polar day and polar night						
High latitude						
Lack of effective						

Category of hazard	Trigger condition of accident	Potential Hazard				Description of accident scenarios
		Crew	Equipment	Hull	Environment	
navigation data and information						
Lack of crew experience						
Lack of suitable emergency response equipment						
Extreme weather and environment						
Sensitivity of environment to harmful substances						

Accident Scenarios and Risk Assessment Worksheet (FORM：POLAR-02)

No.	Accident Scenarios	Risk Assessment			Risk level
		L	C	R	

Risk Control Measure and Assessment Worksheet

FORM：POLAR-03

No.	Accident Scenarios	Risk control measure	Effectiveness on risk reduction			Recommended action
			ΔL	ΔC	ΔR	

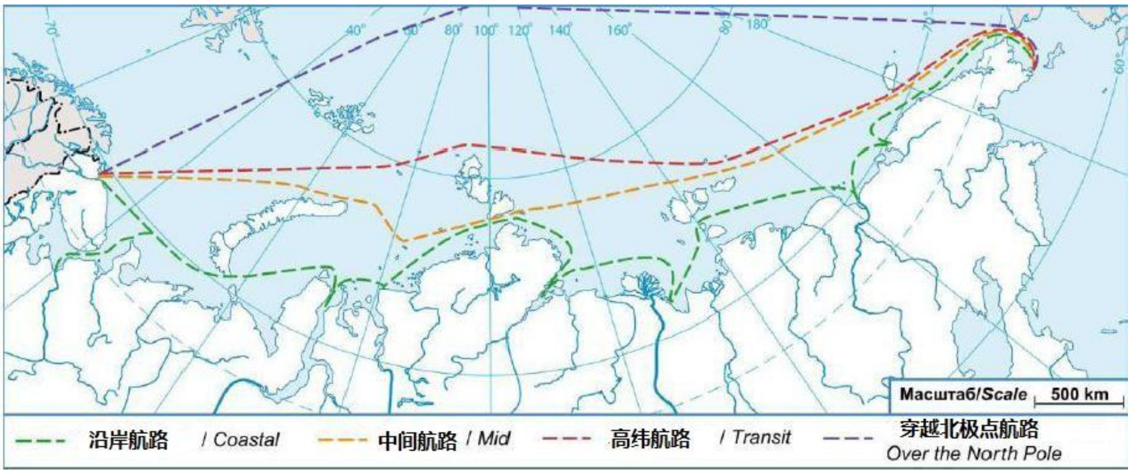
Appendix 6 State Control Special Requirements for Navigation in Arctic Passages

6.1 Northeast Passage

6.1.1 The Northeast Passage, with its west from the Northwestern Europe near the North Cape of Norway, is the collection of a series of sea routes crossing the Barents Sea in the south of the Arctic Ocean, the Kara Sea, the Laptev Sea, the East Siberian Sea, the Chukchi Sea and the Bering Strait to the Pacific Ocean. See Table 6.1.1 for the generally feasible routes.

Table 6.1.1

Routes	Description
Coastal Route	Navigating along the north shore waters of Russia, with features of many turns, distant detours and the longest accumulative voyage and sallow depth of the waters close to the coast; easily affected by the fast ice along the coast
Mid Route	Sailing into Chukchi Sea from the Bering Strait, entering the East Siberian Sea through the De Long Strait to the south of the Wrangel Island, passing by the Laptev Sea along the north of Siberian Islands, crossing the Vil'kitskogo Strait, going southwestward, turning to the northwest on the north of Dikson Port and navigating along the islands of Novaya Zemlya to reach the Barents Sea
Transit Route	Having the features of high navigation latitude and short voyage; sailing towards the northwest after passing by the north of New Siberian Islands, going through the north of Severnaya Zemlya and turning southwestwards to reach the Barents Sea; this route has the risk of being troubled by ice resistance due to the increasing effects of high latitude ice
Over the North Pole Route	Crossing over the North Pole Route and being severely obstructed by the Arctic high latitude ice sheet; it is almost impossible for merchant ships to go through this route at the present time; the route is mostly used by scientific research ships



6.1.2 The Northeast Passage is the shortest route connecting the Atlantic and Pacific oceans and the most attractive and feasible commercial shipping route in the Arctic region nowadays. It has advantages of short voyage and saving shipping date compared with the conventional route.

Table 6.1.2

Port of departure	Port of destination	Conventional route		Northeast Passage		Saving shipping date (day)
		Voyage (miles)	Shipping date (day)	Voyage (miles)	Shipping date (day)	
Murmansk, Russia	Ningbo, China	11848	35.8	6577	19.9	15.9
	Busan, South Korea	12266	37	6097	18.4	18.6

	Kobe, Japan	12291	37.1	6010	18.3	19
Rotterdam, the Netherlands	Ningbo, China	10336	31.2	8177	24.7	6.5
	Busan, South Korea	10754	32.5	7697	23.2	9.3
	Kobe, Japan	10969	33.1	7610	23	10.1

6.1.3 Except the Over the North Pole Route, the other routes of the Northeast Passage need to go through the Northern Sea Route which is controlled by the Northern Sea Route Administration of the Russian Federation. The Rules of Navigation on the Water Area of the Northern Sea Route developed by the Administration include the order of the organization of navigation of ships, rules of the icebreaker assistance, rules of the ice pilotage of ships, rules on the track assistance of ships, provision on the navigational-hydrographic and hydro-meteorological support, rules of the radio communication and environmental protection requirements.

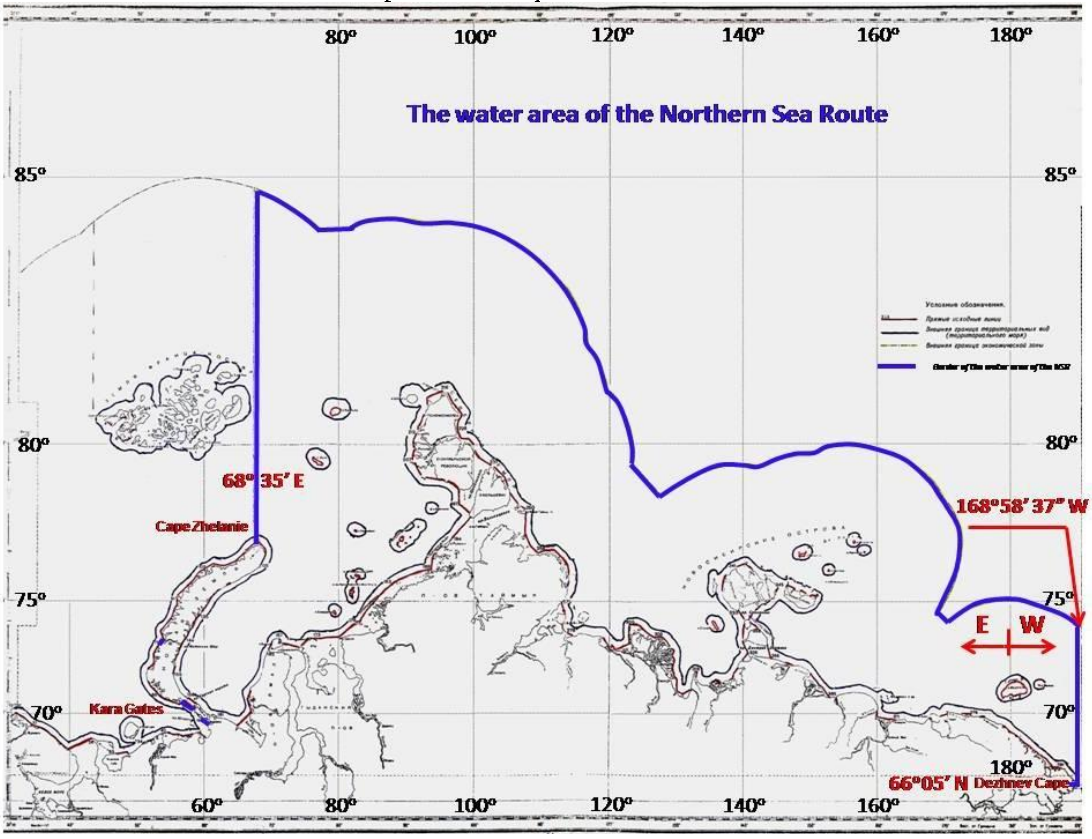


Figure 6.1.3

6.1.4 The Government of the Russian Federation requires that ships navigating in the Arctic waters of Russia should have the ice class or equivalent ice class defined by the rules of Russian Maritime Register of Shipping (RS). For the stipulated navigation restrictions based on seasons, ice conditions in various sea areas and ship ice classes, see Table 6.1.4.

Navigation restrictions for ships in the Northern Sea Route in Arctic

Table 6.1.4

Category of ice strengthening of ship	**Mode of ice navigation**	**Kara Sea**		**Laptev Sea**		**East-Siberian Sea**		**Chukchi Sea**
		south-western art	**north-eastern part**	**western part**	**eastern part**	**south-western part**	**north-eastern part**	
		H M L	**H M L**	**H M L**	**H M L**	**H M L**	**H M L**	**H M L**
Navigation restrictions for ships with Arctic class ships								
Summer navigation periods from July to Novermber								
Arc4	Ind	– + +	– + +	– – +	– – +	– – +	– – +	– + +
	IA	+ + +	+ + +	– + +	– + +	– + +	– + +	– + +
Arc5	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	– + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc6	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc7	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc8	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc9	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Winter navigation periods from November to December and from January to June								
Arc4	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Arc5	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Arc6	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– + +	– + +	– – +	– – +	– – +	– – +	– + +
Arc7	Ind	+ + +	– + +	– – +	– – +	– – +	– – +	– + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc8	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc9	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Navigation restrictions for ships with category of ice strengthening Ice1 – Ice3 and without ice strengthening								
Category of ice strengthening of ship	Mode of ice navigation	Kara Sea		Laptev Sea		East-Siberian Sea		Chukchi Sea
		south-western art	north-eastern part	western part	eastern part	south-western part	north-eastern part	
		H M L	H M L	H M L	H M L	H M L	H M L	H M L
No	Ind	– – –	– – –	– – –	– – –	– – –	– – –	– – –
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Ice1	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Ice2	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– + +	– + +	– – +	– – +	– – +	– – +	– – +
Ice3	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	+ + +	+ + +	– – +	– – +	– – +	– – +	– + +

Notes: 1) Ind: independent navigation; IA: navigation under the icebreaker assistance; +: navigation of ship is permitted; –: navigation of ship is prohibited; H: heavy ice conditions; M: medium ice conditions; L: light ice conditions (in compliance with the official information of Roshydromet);

2) During the period of navigation from July to November 15 navigation is permitted. Navigation in the water area of the Northeast Passage from November 16 to December 31 and from January to June is prohibited;

3) For ships without ice strengthening it is allowed to independently navigate in the water area of the Northern Sea Route only in open water;

4) Oil tankers, gas carriers, chemical carriers with a gross tonnage of 10 000 and over without ice strengthening can navigate in the water area of the Northeast Passage only in open water assisted by icebreaker during the period from July to November 15.

6.1.5 The Rules of Navigation on the Water Area of the Northern Sea Route ships stipulate the following controls and services for the ships navigating in the water area of the Northern Sea Route:

(1) implementing the system of permission for navigation;

(2) regular mandatory reports;

(3) special requirements for safe navigation and pollution prevention equipment;

(4) ice qualification and ice pilotage service of crew;

(5) control of pollutants emission;

(6) icebreaker assistance and ice pilotage service;

6.1.6 For the official information and relevant provisions of the Northern Sea Route, please refer to http://www.nsra.ru.

6.2 Northwest Passage

6.2.1 The Northwest Passage, as the general term of various routes crossing the Canadian Arctic Archipelago along the northern coast of North America between the Atlantic and Pacific oceans, is the shortcut connecting the Atlantic and Pacific oceans. There are five recognized tracks or routes crossing the Archipelago in Canadian Northwest Passage. See Table 6.2.1 for the generally feasible routes.

Table 6.2.1

No.	Route (from east to west)	Notes
1	Lancaster Sound—Barrow Strait—Viscount Melville Sound—Prince of Wales Strait—Amundsen Gulf	Applicable to deep draft ships; It is the route which St.Roch and SS Manhattan used in sailing westwards respectively in 1944 and 1969
2	Lancaster Sound—Barrow Strait—Viscount Melville Sound—M'Clure Strait	The Russian icebreaker Kapitan Klebnikov successfully went through this route in 2001. The satellite photos taken in September 2007 showed that no Arctic sea ice existed in the limited time; However, quite a lot of sea ice existed in 2008
3A	Lancaster Sound—Barrow Strait—Peel Sound—Franklin Strait—Larsen Sound—Victoria Strait—Queen Maud Gulf—Dease Strait—Coronation Gulf—Dolphin and Union Strait—Amundsen Gulf	It is regarded as the best route except for the restriction of 10 m draft
3B	Lancaster Sound—Barrow Strait—Peel Sound—Franklin Strait—Larsen Sound—James Ross Strait—Ray Strait—Simpson Strait—Queen Maud Gulf—Dease Strait—Coronation Gulf—Dolphin and Union Strait—Amundsen Gulf	It is the route used by Roald Amundsen and MS Explorer in 1984 as well
4	Lancaster Sound—Barrow Strait—Prince Regent Inlet—Belet Strait—Franklin Strait—Larsen Sound—Victoria Strait—Queen Maud Gulf—Dease Strait—Coronation Gulf—Dolphin and Union Strait—Amundsen Gulf	It is the route used by Saint Roch in sailing eastwards in 1942-1944
5	Hudson Strait—Foxe Channel —Foxe Basin—Fury and Hecla Strait—Gulf of Boothia—Belet Strait—Franklin Strait—Larsen Sound—Victoria Strait—Queen Maud Gulf—Dease Strait—Coronation Gulf—Dolphin and Union Strait—Amundsen Gulf	Generally, it is not regarded as a feasible commercial route for medium draft ships

Figure 6.2.1 Diagram of the Northwest Passage

6.2.2 The Canadian Arctic Waters crossed by the Northwest Passage are actually under the control of Canadian authorities. The issued laws, regulations and guidelines include:

(1) Arctic Waters Pollution Prevention Act;

(2) Arctic Shipping Pollution Prevention Regulations;

(3) Shipping Safety Control Zones Order;

(4) TP12259 Arctic Ice Regime Shipping System Standards;

(5) TP 12260 Equivalent Standards for the Construction of Arctic Class Ships;

(6) TP 10783 Arctic Waters Oil Transfer Guidelines

(7) TP 11663 Guidelines for the Operation of Tankers and Barges in Canadian Arctic Waters;

(8) TP11690 Cold Weather Marine Survival Guide;

(9) TP11929 Cold Region Marine Survival Manual.

6.2.3 Arctic Shipping Pollution Prevention Regulations stipulates that the entry control systems adopted by ships navigating in the Canadian Arctic Waters are divided into the Zone/Date System (Z/D) and the Arctic Ice Regime Shipping System (AIRSS).

6.2.4 The Zone/Date System (Z/D) divides the Canadian Arctic Waters into 16 Safety Control

Zones (see Figure 7.2.4) and provides the dates when ships of various ice capabilities may enter various zones (see Table 6.2.4).

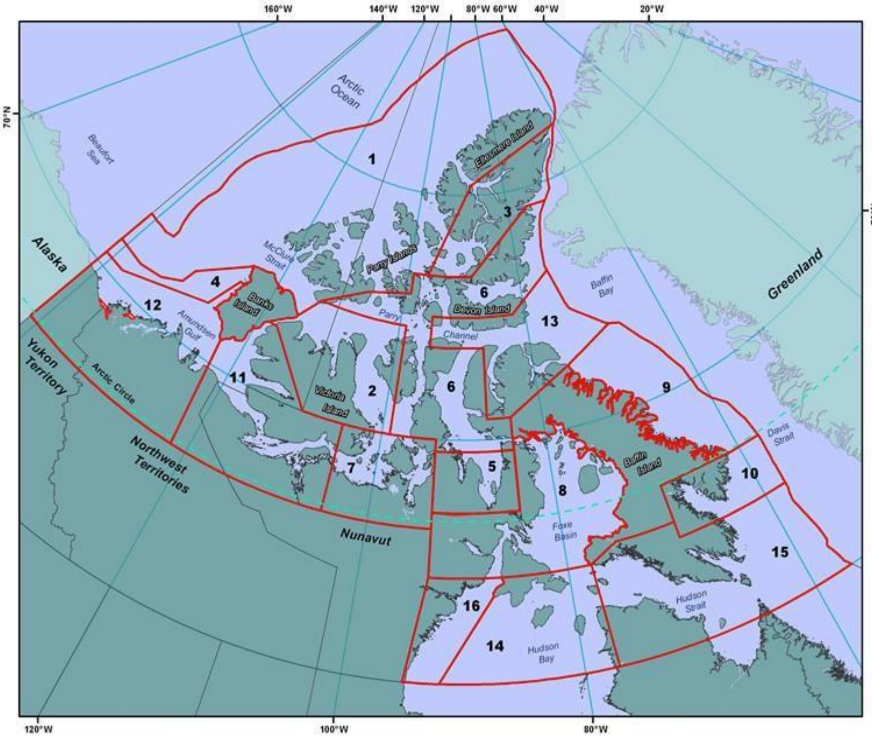


Figure 6.2.4 Shipping Safety Control Zones in the Canadian Arctic Waters

Dates of Entry into Shipping Safety Control Zones **Table 6.2.4**

	Col. I	Col. II	Col. III	Col. IV	Col. V	Col. VI	Col. VII	Col. VIII	Col. IX	Col. X	Col. XI	Col. XII	Col. XIII	Col. XIV	Col. XV	Col. XVI	Col. XVII
Item	Category	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16
1.	Arctic Class 10	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
2.	Arctic Class 8	July 1 to Oct. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
3.	Arctic Class 7	Aug. 1 to Sept. 30	Aug. 1 to Nov. 30	July 1 to Dec. 31	July 1 to Dec. 15	July 1 to Dec. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
4.	Arctic Class 6	Aug. 15 to Sept. 15	Aug. 1 to Oct. 31	July 15 to Nov. 30	July 15 to Nov. 30	Aug. 1 to Oct. 15	July 15 to Feb. 28	July 1 to Mar. 31	July 1 to Mar. 31	All Year	All Year	July 1 to Mar. 31	All Year	All Year	All Year	All Year	All Year
5.	Arctic Class 4	Aug. 15 to Sept. 15	Aug. 15 to Oct. 15	July 15 to Oct. 31	July 15 to Nov. 15	Aug. 15 to Sept. 30	July 20 to Dec. 31	July 15 to Jan. 15	July 15 to Jan. 15	July 10 to Mar. 31	July 10 to Feb. 28	July 5 to Jan. 15	June 1 to Jan. 31	June 1 to Feb. 15	June 15 to Feb. 15	June 15 to Mar. 15	June 1 to Feb. 15
6.	Arctic Class 3	Aug. 20 to Sept. 15	Aug. 20 to Sept. 30	July 25 to Oct. 15	July 20 to Nov. 5	Aug. 20 to Sept. 25	Aug. 1 to Nov. 30	July 20 to Dec. 15	July 20 to Dec. 31	July 20 to Jan. 20	July 15 to Jan. 25	July 5 to Dec. 15	June 10 to Dec. 31	June 10 to Dec. 31	June 20 to Jan. 10	June 20 to Jan. 31	June 5 to Jan. 10
7.	Arctic Class 2	No Entry	No Entry	Aug. 15 to Sept. 30	Aug. 1 to Oct. 31	No Entry	Aug. 15 to Nov. 20	Aug. 1 to Nov. 20	Aug. 1 to Nov. 30	Aug. 1 to Dec. 20	July 25 to Dec. 20	July 10 to Nov. 20	June 15 to Dec. 5	June 25 to Nov. 22	June 25 to Dec. 10	June 25 to Dec. 20	June 10 to Dec. 10
8.	Arctic Class 1A	No Entry	No Entry	Aug. 20 to Sept. 15	Aug. 20 to Sept. 30	No Entry	Aug. 25 to Oct. 31	Aug. 10 to Nov. 5	Aug. 10 to Nov. 20	Aug. 10 to Dec. 10	Aug. 1 to Dec. 10	July 15 to Nov. 10	July 1 to Nov. 10	July 15 to Oct. 31	July 1 to Nov. 30	July 1 to Dec. 10	June 20 to Nov. 30
9.	Arctic Class 1	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 31	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov. 30	June 20 to Nov. 15
10.	Type A	No Entry	No Entry	Aug. 20 to Sept. 10	Aug. 20 to Sept. 20	No Entry	Aug. 15 to Oct. 15	Aug. 1 to Oct. 25	Aug. 1 to Nov. 10	Aug. 1 to Nov. 20	July 25 to Nov. 20	July 10 to Oct. 31	June 15 to Nov. 10	June 25 to Oct. 22	June 25 to Nov. 30	June 25 to Dec. 5	June 20 to Nov. 20
11.	Type B	No Entry	No Entry	Aug. 20 to Sept. 5	Aug. 20 to Sept. 15	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 25	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov. 30	June 20 to Nov. 10
12.	Type C	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 25	Aug. 10 to Oct. 10	Aug. 10 to Oct. 25	Aug. 10 to Oct. 25	Aug. 1 to Oct. 25	July 15 to Oct. 15	July 1 to Oct. 25	July 15 to Oct. 10	July 1 to Nov. 25	July 1 to Nov. 25	June 20 to Nov. 10
13.	Type D	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 10 to Oct. 5	Aug. 15 to Oct. 20	Aug. 15 to Oct. 20	Aug. 5 to Oct. 20	July 15 to Oct. 10	July 1 to Oct. 20	July 30 to Sept. 30	July 10 to Nov. 10	July 5 to Nov. 10	July 1 to Oct. 31
14.	Type E	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 10 to Sept. 30	Aug. 20 to Oct. 20	Aug. 20 to Oct. 15	Aug. 10 to Oct. 20	July 15 to Sept. 30	July 1 to Oct. 20	Aug. 15 to Sept. 20	July 20 to Oct. 31	July 20 to Nov. 5	July 1 to Oct. 31

6.2.5 The Arctic Ice Regime Shipping System (AIRSS) Standards are based on the concept that ice conditions can be quantified through a simple Ice Numeral calculation which indicates whether or not a given set of ice conditions will be safe for a particular vessel. The system includes a wide range of ice navigation parameters including visibility, vessel speed, manoeuvrability, the availability of an icebreaker escort and the knowledge and experience of the crew.

6.2.6 The Ice Numeral is the sum of the products of the concentration, in tenths, of each ice type in each ice regime and the corresponding Ice Multiplier (IM). The Ice Numeral must be zero or higher for a ship to enter an ice regime and accept supervision. If the Ice Numeral is NEGATIVE, the vessel should select an alternate route.

$$\mathrm{IN} = \sum (\mathrm{C_i} \times \mathrm{IM_i})$$

Where: IN —— Ice Numeral;

$\mathrm{C_i}$ —— Concentration in tenths of ice type "*i*";

$\mathrm{IM_i}$ —— Ice Multiplier for ice type "*i*", refer to Table 6.2.6 for the Ice Multipliers of CAC and TYPE ice class developed by Canada.

Ice Multiplier Table **Table 6.2.6**

WMO Ice Codes	Ice Types	Ice Multipliers (*IM*) for each Ship Category (*IM*)						
		Type E	Type D	Type C	Type B	Type A	CAC 4	CAC 3
7▪/9▪	Old/Multi-Year Ice (MY)	-4	-4	-4	-4	-4	-3	-1
8▪	Second-Year Ice (SY)	-4	-4	-4	-4	-3	-2	1
6/4▪	Thick First-Year Ice (TFY) >120 cm	-3	-3	-3	-2	-1	1	2
1▪	Medium First-Year Ice (MFY) 70~120 cm	-2	-2	-2	-1	1	2	2
7	Thin First-Year Ice (FY) 30~70 cm	-1	-1	-1	1	2	2	2
9	Thin First-Year Ice (2nd Stage) 50-70 cm	-1	-1	-1	1	2	2	2
8	Thin First-Year Ice (1st Stage) 30-50 cm	-1	-1	1	1	2	2	2
3/5	Grey-White Ice (GW) 10~30 cm	-1	1	1	1	2	2	2
4	Grey Ice (G) 10~15 cm	1	2	2	2	2	2	2
2	Nilas, Ice Rind<10 cm	2	2	2	2	2	2	2
1	New Ice (N) <10 cm	2	2	2	2	2	2	2
	Brash (ice fragments < 2 m)	2	2	2	2	2	2	2
=△	Bergy Water	2	2	2	2	2	2	2
⁞⁞⁞⁞	Open Water	2	2	2	2	2	2	2

Notes: (1) For Decayed Ice, +1 may be added to the *IM* in the table above;

(2) For Ridged Ice, the *IM* in the table above shall be decreased by 1;

(3) For Brash Ice, +2 may be added to the *IM* in the table above.

6.2.7 For main information and relevant regulations of the main water of the Northwest Passage, the Canadian Arctic Waters, please refer to "Ice Navigation in Canadian Waters" developed by the Canadian Coast Guard which can be found and downloaded on Canada's official website.

Appendix 7   Special Requirements for Antarctic Waters

7.1   Ballast Water Management

7.1.1   Poplar ship intended to operate in the Antarctic Waters is to take into account the Guidelines for Ballast Water Exchange in the Antarctic Treaty Area.

7.2   Control of Pollution Prevention

7.2.1   Poplar ship intended to operate in the Antarctic Waters is to meet:

(1) Regulation 43 of Annex I to MARPOL special requirements for the use or carriage of oils in the Antarctic area;

(2) the relevant regulations of Annex IV to the Protocol on Environmental Protection to the Antarctic Treaty "Prevention of Marine Pollution".

Appendix 8   High Strength Steels for Polar Ship

8.1   General requirements

8.1.1   This Appendix provides additional non-mandatory requirements for high strength steels for polar ship with suffix "ARC-M(X)" on the basis of Section 3 HIGHER STRENGTH HULL STRUCTURAL STEELS of Chapter 3, PART ONE of ISC Rules for Materials and Welding. Extra strength steels for polar ship are to be specially considered by ISC.

8.1.2   Suffix ARC-M(X) may be assigned to steels complying with the requirements of this Appendix, where X refers to temperature, e.g.: FH32-ARC-M(-30). ARC-M(X) is to be subdivided into five grades: ARC-M(-20), ARC-M(-30), ARC-M(-40), ARC-M(-50) and ARC-M(-60).

8.1.3   This Appendix applies to 25mm-70mm thick high strength steels for polar ship. Steels of thickness exceeding 70mm are to be specially considered by ISC.

8.1.4   Unless otherwise specified by this Appendix, high strength steels for polar ship with suffix of ARC-M(X) are to comply with the requirements of Section 3 HIGHER STRENGTH HULL STRUCTURAL STEELS of Chapter 3, PART ONE of ISC Rules for Materials and Welding.

8.2   Approval

8.2.1   See 8.13 of this Appendix for approval requirements of high strength steels for polar ship with suffix of ARC-M(X).

8.3   Manufacture

8.3.1   Steel is to be manufactured by electric furnace, open hearth processes or by other processes specially approved by ISC.

8.3.2   Steel is to be fully killed, and is to be fine grain treated in accordance with an approved manufacturing process.

8.3.3   The rolling reduction ratio of slab, billet, bloom or ingot is not to be less than 3:1.

8.4   Chemical composition

8.4.1   The chemical composition is to meet the requirements of Table 8.4.1.

Chemical composition of high strength steels for polar ship **Table 8.4.1**

Grade		AH32-ARC-M(X), AH36-ARC-M(X), AH40-ARC-M(X), DH32-ARC-M(X),DH36-ARC-M(X), DH40-ARC-M(X), EH32-ARC-M(X), EH36-ARC-M(X), EH40-ARC-M(X)	FH32-ARC-M(X) FH36-ARC-M(X), FH40-ARC-M(X)
Chemical composition (%)⑤⑥	C	≤0.18	≤0.12
	Mn	0.90-1.60	0.90-1.60
	Si	≤0.50	≤0.40
	S	≤0.008	≤0.005
	P	≤0.015	≤0.010
	Al (acid soluble)	≥0.015①②	≥0.015①②
	Nb	0.02~0.05②	0.02~0.05②
	V	0.05~0.10②	0.05~0.10②
	Ti③	≤0.02	≤0.02
	Cu	≤0.35	≤0.35
	Cr	≤0.20	≤0.20
	Ni④	≤0.40	≤0.80
	Mo	≤0.08	≤0.08
	N	—	≤0.009(if Al is present, t≤0.012)

Note:

① The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0.02%.

② The steel is to contain suitable grain refining elements (Al, Nb, V, etc.), either singly or in any combination. When used singly, the steel is to contain the specified minimum content of the grain refining element; and when used in combination, the specified minimum content of each element is not applicable. However, the approved technical conditions are to be satisfied.

③ The contents of Nb, V and Ti are, in addition, to comply with Nb% + V% + Ti% ≤ 0.12%.

④ Higher Ni content may be approved at the discretion of ISC.

⑤ Where any other element has been added as part of the steel making practice, the content is to be stated in the certificate.

⑥ In order to achieve the specified properties, the chemical composition is allowed to be different from the above requirements with the consent by ISC. However, where any element intended to be added/limited, the content is to be stated in the certificate.

8.4.2 For steels supplied in TMCP condition, the carbon equivalent C_{eq} is to meet the requirements of Table 8.4.2. The carbon equivalent C_{eq} is to be calculated from the chemical composition using the following formula:

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \quad (\%)$$

Carbon Equivalent C_{eq} of TMCP Higher Strength Steel **Table 8.4.2**

Grade	Carbon equivalent C_{eq} (%)	
	Thickness t (mm)	
	$25 \le t \le 50$	$50 < t \le 70$
H32-ARC-M(X)	≤0.36	≤0.38
H36-ARC-M(X)	≤0.38	≤0.40
H40-ARC-M(X)	≤0.40	≤0.42

8.4.3 For steels supplied in TMCP condition, if needed, the cold cracking susceptibility P_{cm} may be used instead of the carbon equivalent, in which case the following formula is to be used. The value of P_{cm} is not to be greater than 0.22%.

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B \qquad (\%)$$

8.5 Condition of supply

8.5.1 The condition of supply is to comply with the requirements of Section 3 HIGHER STRENGTH HULL STRUCTURAL STEELS of Chapter 3, PART ONE of ISC Rules for Materials and Welding.

8.6 Mechanical properties

8.6.1 Tensile properties are to comply with the requirements of Table 8.6.1 and the tests are to be carried out at an ambient temperature.

Tensile properties **Table 8.6.1**

Grade	Yield strength R_{eH} (N/mm^2), min.	Tensile strength Rm (N/mm^2)	Elongation A_5 (%), min.
H32-ARC-M(X)	315	440~570	22
H36-ARC-M(X)	355	490~630	21
H40-ARC-M(X)	390	510~660	20

8.6.2 Drop-weight tests are to be carried out according to the requirements of Section 10 of Chapter 2, PART ONE of ISC Rules for Materials and Welding. Specimens P1, P2 and P3 with maximum thickness are to be taken as far as possible and the rolling scale is to be maintained at least at one side. For the steel with thickness of 40 mm or above, the specimens are to be located additionally at a position lying at a distance of $t/2$ from the surface, where specimen P1 or specimen P2 is taken if 40mm≤thickness≤50mm, specimen P2 is taken if thickness ＞ 50mm. Specimens are not to break at the temperature specified in Table 8.6.2.

Temperature for drop-weight test **Table 8.6.2**

Thickness (mm)	ARC-M(-20)	ARC-M(-30)	ARC-M(-40)	ARC-M(-50)	ARC-M(-60)
$25 \le t \le 30$	-30	-40	-50	-60	-70
$30 < t \le 40$	-35	-45	-55	-65	-75
$40 < t \le 50$	-40	-50	-60	-70	-80
$50 < t \le 70$	-45	-55	-65	-75	-85

8.7 "Z" quality

8.7.1 Z quality of high strength steels for polar ship over 50 mm in thickness is to comply with the requirements of Z35.

8.8 Ultrasonic testing

8.8.1 Ultrasonic testing is to be carried out to high strength steels for polar ship by the manufacturer according to the recognized standards, and steels over 50 mm in thickness are to meet the requirements for non-destructive testing of Z-direction steels.

8.9 Test materials

8.9.1 The sampling and batch test of chemical composition, tensile properties and impact properties are to be in accordance with the requirements of Section 3 Higher Strength Hull Structural Steels of Chapter 3, PART ONE of ISC Rules for Materials and Welding.

8.9.2 The location of drop-weight test specimen is to be in accordance with the requirements in 8.6.2 of this Appendix. The batch test of specimens is to be in accordance with that of Charpy V-notch impact test.

8.10 Grade

8.10.1 Suffix of ARC-M(X) may be assigned for steels complying with the requirements of this Appendix, e.g.:FH32-ARC-M(X)(-30).

8.11 Mark

8.11.1 Every finished item is to be clearly marked, at least at one position, by the manufacturer with the following particulars:

(1) name of manufacturer or trade mark;

(2) steel grade, including suffix of ARC-M(X);

(3) cast number or identification number or initials which will enable the full history of the item to be traced;

(4) condition of delivery;

(5) ISC stamp;

(6) if required by the purchaser, his order number or other identification mark.

In addition to the name of manufacturer and trade mark are stamped on the finished product, the other markings mentioned above are to be encircled with paint or otherwise marked for easy recognition.

8.12 Certificate

8.12.1 The manufacturer is to provide certificates containing the following items to the Surveyor.

(1) name of manufacturer;

(2) purchaser's name and order number, and if any, the structure number for which the material is intended;

(3) steel grade, including suffix of ARC-M(X);

(4) size, number and weight of the cargo;

(5) cast/piece number and chemical composition of ladle samples;

(6) C_{eq} or P_{cm} value;

(7) condition of delivery;
(8) mechanical test results, including traceable test identification;
(9) surface quality and inspection results;
(10) UT result.

8.13 Approval

8.13.1 General requirements

8.13.1.1 High strength steels for polar ship with suffix of ARC-M(X) are to be approved by ISC according to the requirements of this Section.

8.13.1.2 Unless otherwise specified by this Section, the approval is to comply with the requirements for high strength hull structural steels as specified in “W-01 Rolled Steel” of ISC Guidelines for Survey of Marine Products.

8.13.2 Plans and information

8.13.2.1 Plans and information submitted by the manufacturer are to comply with the requirements for high strength hull structural steels as specified in “W-01 Rolled Steel” of ISC Guidelines for Survey of Marine Products.

8.13.3 Approval tests

8.13.3.1 Approval tests are to be carried out according to the approved test programme.

8.13.4 Typical product for type tests

8.13.4.1 Selecting of typical product for type tests and position of specimen are to be in accordance with the requirements for high strength hull structural steels as specified in “W-01 Rolled Steel” of ISC Guidelines for Survey of Marine Products.

8.13.5 Steel tests

8.13.5.1 Unless otherwise specified by this Appendix, steel tests are to comply with the requirements for high strength hull structural steels as specified in “W-01 Rolled Steel” of ISC Guidelines for Survey of Marine Products.

8.13.5.2 Chemical composition is to comply with the requirements of 8.4 of this Appendix.

8.13.5.3 Nil-ductility transition temperature (NDTT) is to be tested by drop-weight test according to the requirements of 8.6.2 of this Appendix. Nil-ductility transition temperature (NDTT) is to comply with the requirements of Table 8.13.5.3.

Nil-ductility transition temperature (NDTT) (℃) Table 8.13.5.3

Thickness (mm)	ARC-M(-20)	ARC-M(-30)	ARC-M(-40)	ARC-M(-50)	ARC-M(-60)
25≤*t*≤30	≤-35	≤-45	≤-55	≤-65	≤-75
30<*t*≤40	≤-40	≤-50	≤-60	≤-70	≤-80
40<*t*≤50	≤-45	≤-55	≤-65	≤-75	≤-85
50＜*t*≤70	≤-50	≤-60	≤-70	≤-80	≤-90

8.13.5.4 CTOD tests on parent plate are to be carried out according to the requirements of Section 8 of Chapter 2, PART ONE of ISC Rules for Materials and Welding.

Test temperature is at X. At least three effective CTOD tests are to be carried out. Average crack tip opening displacement is not to be lower than the minimum value specified in Table 8.13.5.4. The individual values is not to be lower than 70% of the specified minimum average value.

Minimum average value for base metal CTOD test **Table 8.13.5.4**

Thickness (mm)	Average crack tip opening displacement (mm), minimum		
	H32-ARC-M(X)	H36-ARC-M(X)	H40-ARC-M(X)
25≤*t*≤35	0.15	0.15	0.15
35<*t*≤50	0.20	0.20	0.20
50<*t*≤70	0.20	0.20	0.25

8.13.5.5 Z quality is to be tested for high strength steels for polar ship over 50 mm in thickness , which is at least to achieve Grade Z35.

8.13.5.6 Non-destructive testing is to be carried out according to the recognized standards.

8.13.6 Weldability tests

8.13.6.1 Unless otherwise specified by this Appendix, weldability tests are to comply with the requirements for high strength hull structural steels as specified in "W-01 Rolled Steel" of ISC Guidelines for Survey of Marine Products.

8.13.6.2 CTOD test for weld assembly are to be carried out according to the requirements of Section 8 of Chapter 2, PART ONE of ISC Rules for Materials and Welding. Crack tip is in way of grain coarsened area, the test temperature is at X. At least three effective CTOD tests are to be carried out. Average crack tip opening displacement is not to be lower than the minimum value specified in Table 8.13.6.2. The individual values is not to be lower than 50% of the specified minimum average value.

Minimum average value for weld joint CTOD test **Table 8.13.6.2**

Thickness (mm)	Average crack tip opening displacement (mm), minimum		
	H32-ARC-M(X)	H36-ARC-M(X)	H40-ARC-M(X)
25≤*t*≤30	0.10	0.10	0.15
30<*t*≤50	0.10	0.10	0.15
50<*t*≤70	0.15	0.15	0.15

8.14 Welding procedure qualification test

8.14.1 In addition to the requirements for high strength hull structural steels as specified in Chapter 3, PART THREE of Rules for Materials and Welding, CTOD tests are to be carried out according to Section 8 of Chapter 2, PART ONE of Rules for Materials and Welding.

8.14.2 Crack tips are to be located in way of the center of weld and grain coarsened area respectively. At least three effective CTOD tests are to be carried out in each position. Test temperature is at X. Average crack tip opening displacement is not to be lower than the minimum value specified in Table 8.14.2.

Minimum average value for CTOD tests for welding procedure qualification tests

Table 8.14.2

Thickness (mm)	Average crack tip opening displacement (mm), minimum		
	H32-ARC-M(X)	H36-ARC-M(X)	H40-ARC-M(X)
25≤*t*≤30	0.10	0.10	0.15
30<*t*≤50	0.10	0.10	0.15
50<*t*≤70	0.15	0.15	0.15