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GUIDELINES FOR POLAR WATER OPERATIONAL MANUAL

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Introduction

0.1 Purpose of the Guidelines

0.1.1 Due to the severe environmental conditions, remote geographic location and fragile ecological environments in polar waters, ships navigating in polar waters will face higher levels of risk. Since the 1990s, the international maritime community has been devoted to improving the safety and environmental protection of ships navigating in the Antarctic and Arctic waters. The International Code for Ships Operating in Polar Waters (Polar Code) was adopted by IMO Resolution MEPC.264(68) in May 2015, which has set the mandatory conditions for ship design and construction, equipment and system, operation and training and anti-pollution. The Polar Code will take effect on ships engaged on voyages in polar waters on 1 January 2017 upon entry into force of Chapter XIV of International Convention for the Safety of Life at Sea (SOLAS) and the associated amendments to annexes of International Convention for the Prevention of Pollution from Ships (MARPOL).

0.1.2 In accordance with the requirements of the Polar Code, the Polar Water Operation Manual (PWOM) is the document to be prepared and provided on board for ships operating in polar waters so as to provide the owner, operator, the master and crew with information regarding the ship's operational capabilities and limitations and operation procedures and measures to support the safe navigation in polar waters, which is one of the important measures of the safe shipping in polar waters.

0.1.3 Chapter 2 of Part I-A of the Polar Code specifies PWOM goal, functional requirements and risk-based operation procedures, and recommends the model table of contents, but the specific contents depending on the type of ship, ice class and anticipated operating area are different in order to meet the actual needs of particular ships.

0.1.4 Chapters 1-5 of the Guidelines provide the standard format of the Polar Water Operation Manual, mainly provides the ice conditions of polar waters and identification methods of dangerous ice conditions, and ice manoeuvring methods, ship equipment and system in low temperature environment operation control procedure measures and ship emergency handling measures for ice, low temperature and remoteness, and provides guidance for developing the Polar Water Operation Manual for the ships intended to operate in polar waters.

0.2 PWOM development procedures

0.2.1 The Polar Water Operation Manual (PWOM), as the supplement to the existing ship operation and management documents, provides the master and crew with guidance on safe operation in polar waters, and includes ship operation with caution in order to ensure avoiding encountering conditions that exceed the ship's capabilities and limitations.

0.2.2 Although the Guidelines provide the format and contents of PWOM, the following general procedures are to be followed when developing the guidelines:

(1) determining ship operational capabilities and limitations in polar waters;

(2) carrying out an operational assessment of the polar ship and its equipment and system (see Section 3 Operational Assessment of Chapter 2 of Guidelines for Polar Ship, CCS);

(3) based on the ship operational capabilities, anticipated operating range (areas and seasons) and environmental conditions, considering sources of hazards in polar waters and determining the operation procedures and operational limitations of the ship and its equipment.

0.2.3 As for the sources of hazards listed in Section 3 of Introduction of the Polar Code, the sources of hazards involved in ships of various categories operating in polar waters may be considered as follows:

Sources of hazards listed in Section 3 of Introduction of the Polar Code		Category of ship			
No.	Category of hazard	A	B	Ci	Co
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
2	Icing: icing at the hull and equipment above the waterline , with potential reduction of stability and equipment functionality;	H	H	M	N
3	Low temperature: as it affects the working environment and human performance, maintenance and emergency preparedness tasks, material properties and equipment efficiency, performance of safety equipment and systems and survival time;	H	M	L	N
4	Extended periods of darkness or daylight: as it may affect safe navigation and human rest and performance;	H	M	M	M
5	High latitude: as it affects navigation systems, communication systems and the quality of ice imagery information;	H	H	H	H
6	Remoteness: possible lack of accurate and complete hydrographic data and information, reduced availability of navigational aids (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
7	Crew: potential lack of ship crew experience in the above knowledge and polar operations, increases the safety risk of ship;	H	H	H	M
8	Emergency response equipment: potential lack of suitable emergency response equipment, with the potential for limiting the effectiveness of mitigation measures;	H	M	M	L
9	Severe weather conditions: rapidly changing and severe weather conditions, with the potential for escalation of incidents;	H	H	H	L
10	Sensitive environment: the sensitivity of environment to harmful substances and other environmental impacts which needs longer restoration.	H	H	H	H

Note: ① H—high probability; M-- medium probability; L—low probability; N—non-existent.

② A, B and C are respectively the category A, B and C ships operating in polar waters defined in the Polar Code. Ci means a category C ship with an ice class; Co means a category C ship without any ice class, such as the ship briefly crossing the Northeast Passage in the Arctic in summer.

0.2.4 The Polar Water Operation Manual (PWOM) is to be prepared in a separate version. In the preparation, the following is to be considered (but not limited to):

(1) using ship design information;

(2) taking the result of operational (risk) assessment (see 0.2.3) into account;

(3) direct or indirect operation experience in polar waters;

(4) applicable IMO conventions, rules, guidelines and circulars, and national rules, standards and guidelines;

(5) rules and guidelines of classification societies and guidelines of WMO and trade organizations;

(6) making reference to other ship's documents and coordinating them with ship safety management system (SMS) documents.

0.3 Application of the Guidelines

0.3.1 In the Guidelines:

(1) the contents for direct selection or selection after editing in combination with practical ship conditions are written in Times New Roman;

(2) *examples on ship types and contents on providing the development methods are written in Italics*;

(3) the related appendices may be selected and used.

0.3.2 Based on the result of operational (risk) assessment, for the very low-probability operation situations, making written procedures is not required, but the related section/regulation in the manual may be identified as "not applicable".

0.3.3 The operation procedures established in PWOM are to be fully implemented at the corresponding posts of ship and shore to enhance the operability according to the responsibility and authority determined by the ship safety management system.

0.4 References of the Guidelines (may be referred to when preparing the Polar Water Operation Manual):

(1) International Code for Ships Operating in Polar Waters (IMO MEPC.264(68))

(2) Guidances on Arctic Navigation in the Northeast Route (2014) (Maritime Safety Administration of the People's Republic of China)

(3) Rules of Navigation on the Water Area of the Northern Sea Route (2013) (Northern Sea Route Administration)

(4) Ice Navigation in Canadian Waters (2012) (Canadian Coast Guard)

(5) Offshore Vessel Operations in Ice and/or Severe Sub-zero Temperatures in Arctic and Sub-Arctic Regions (2014) (OCIMF)

(6) Chapter 23, PART EIGHT, Rules for Classification of Sea-going Steel Ships (CCS)

(7) Guidelines for Polar Ship (2016) (CCS)

(8) Statistical Data on Temperature in Polar and Sub-polar Regions (IMO/DSC1/INF.12)

(9) A Tiered Risk Assessment Approach to Polar Operations Safety and the Mandatory Polar Code (IMO/DE54/INF.2)

(10) Guidance on Methodologies for Assessing Operational Capabilities and Limitations in Ice (IMO/MSC.1/1519)

(11) Guidelines for Ships Operating in Polar Waters (IMO A.1024 (26))

(12) Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE) (Canada)

(13) Sailing Directions (Pilots) (NP10/NP9/NP/11/NP23/NP12)

(14) Antarctic Treaty (1959)

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

(16) Guidelines on Voyage Planning for Passenger Ships Operating in Remote Areas (IMO Res. A.999(25))

(17) Guidelines for Owners/Operators on Preparing Emergency Towing Procedures (MSC.1/Circ.1255)

(18) International Medical Guide for Ships (WHO02)

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Chapter 1 General

Section 1 General provisions

1.1.1 Manual goal

1.1.1.1 The goal of this Manual is to provide all relevant management personnel, master and crew of companies with sufficient information regarding the ship's operational capabilities and limitations in polar waters in order to support their decision-making process.

1.1.1.2 Based on the operation mode of ships in polar waters and the special risks they may encounter, the Manual develops risk control measures and operation procedures to provide the master and crew with operation procedures and guidance to be followed by ships engaged on voyages in polar waters. The Manual constitutes a part of ship safety management system documents and includes:

(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) special equipment system operation;

(5) measures to maintain equipment and system functionality under low temperature, topside icing and the presence of sea ice;

(6) emergency response providers for salvage, search and rescue (SAR), spill response, etc.;

(7) maintaining life support and ship integrity in the event of prolonged entrapment by ice;

(8) operational measures to be taken in the event of encountering dangerous ice and/or temperatures which exceed the ship's design capabilities or limitations.

(9) operating independently or with icebreaker escort in ice.

1.1.1.3 The Manual and the references shall be regarded as one of the training contents for the crew engaged on voyages in polar waters.

1.1.2 Ship training and implementation

1.1.2.1 For ships navigating in polar waters, the company shall the ensure crew training which is to at least include the following:

(1) identification methods of ice conditions, referring to the Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE);

(2) ice navigation;

(3) escorted operation;

(4) emergency handling and drill;

(5) personnel protection.

1.1.2.2 Every crew member working on board the ship is to be familiar with the Manual and relevant procedures and documents in relation with their duties onboard, so that they can easily find reference when needed.

1.1.2.3 Persons on board are to perform in accordance with the procedural requirements of the Manual so as to ensure ship safe navigation.

Section 2 Terminology

1.2.1 Terms related to sea ice

1.2.1.1 Sea ice means any form of ice found at sea which has originated from the freezing of sea water.

1.2.1.2 First year ice means sea ice of not more than one winter's growth, developing from young ice with thickness 0.3m ～ 2.0m[①]. First year ice may be subdivided into thin first-year ice/white ice (0.3m ～ 0.7m), medium first year ice (0.7m ～ 1.2m) and thick first-year ice (1.2m ～ 2.0m).

1.2.1.3 Old ice means sea ice which has survived at least one summer's melt, with a typical thickness of up to 3.0 m or more. It is subdivided into residual first-year ice, second-year ice and multi-year ice.

(1) Residual first-year ice means first-year ice that has survived the summer's melt and is now in the new cycle of growth. It is 0.3 to 1.8 m thick depending on the region where it was in summer. After 1 January in the Northern Hemisphere (in the Southern Hemisphere, after 1 July), such ice becomes second-year ice;

(2) Second-year ice means old ice which has survived only one summer's melt; typical thickness up to 2.5m and sometimes more. Because it is thicker than first-year ice, it stands higher out of the water. Ridged features as a result of melting during the preceding summer attain a smoothed rounded shape. In summer numerous puddles of extended irregular shape form on its surface;

(3) Multi-year ice means old ice up to 3m or more thick that has survived at least two summers' melt. Hummocks are even smoother than in second-year ice and attain a look of mounds and hills. The surface of multi-year ice fields in places not subject to deformations is also hillocky due to non-uniform multiple melting. The ice is almost salt-free. Its colour, where bare, is usually blue. As a result of melting, round puddles appear at its surface in summer and a well-developed drainage system is formed.

① Refer to the terminology for marine ice conditions from World Meteorological Organization (WMO).

1.2.1.4 Fast ice means the consolidated solid ice attached to the shore. It forms by freezing to the shore of the ice cover forming in the coastal zone or as a result of freezing of drifting ice of any age category to the shore or fast ice. Vertical movement may be observed during tidal oscillations. It can be preserved without fracturing for two or more years transforming from first-year ice to multiyear ice and even shelf ice. The fast ice width can vary from several hundreds of meters to several hundreds of kilometres. That part of fast ice presenting a narrow fringe of ice directly attached to the coast with a shallow bottom and unresponsive to tidal oscillation that remains after the fast ice has moved away is called the ice foot. Fast ice, at the initial stage of formation, consisting of nilas and young ice with a width up to 100-200m is called young coastal ice.

1.2.1.5 Drift ice means any sea ice other than fast ice. Drift ice is moved by wind, current and tide.

1.2.1.6 Ice island means a large piece of floating ice protruding about 5 m above sea-level, which has broken away from an Arctic ice shelf, having a thickness of 30-50m and an area of from a few thousand square meters to 500 km² or more, and usually characterized by a regularly undulating surface which gives it a ribbed appearance from the air.

1.2.1.7 Glacier ice means ice in, or originating from, a glacier, whether on land or floating on the sea as icebergs, bergy bits or growlers. The ship is to avoid touching the glacier ice as it may damage the ship in any form.

(1) Bergy bit means a large piece of floating ice of land origin, showing less than 5m above sea-level and no more than 20m long;

(2) Growler means a piece of ice of land origin that is smaller than a bergy bit. The colour is usually white, but sometimes transparent or blue-green or nearly black, normally occupying an area of about 20m². Growlers are distinguished with difficulty when they are surrounded by ice and also in a heavy swell as they are often awash.

1.2.1.8 Pack ice means any sea ice in any form other than fast ice broken by wind, current and tide, which forms floes of any shape and size drifting with the wind current. The concentration pack ice is 7/10 or more. Floating ice group may distribute and form the ice regime within a certain region.

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

1.2.1.10 Ice concentration means the proportional of floating ice covering sea level within field of vision, measured by in-tenth method.

1.2.1.11 Deformed ice means ice which has been squeezed together and broken up with the formation of surface and underwater conglomerations (such as rafted ice, rough ice, ridged ice, hillocky multiyear ice, etc.). Surface features of deformed ice are referred to as Sails and underwater features are referred to as keels.

1.2.1.12 Ice ram means an underwater ice projection from an ice wall, ice front, iceberg or floe. Its formation is usually due to a more intensive melting and erosion of that part which is not submerged.

1.2.2 Terms related to operation in ice

1.2.2.1 Ice Class Notation means the notation assigned to the ship showing that the ship has been designed for navigation in waters covered by sea ice.

1.2.2.2 Ice draught means the ship draught corresponding to the upper ice water line (UIWL) and lower ice water line (LIWL) defined in the design of ice class ships navigating in ice-covered waters.

1.2.2.3 Independent operation in ice means any Escorted operation means any operation in which a ship is capable of independently moving at a continuous and safe speed in polar waters.

1.2.2.4 Escorted operation means any operation in which a ship's movement is facilitated through the intervention of an icebreaker.

1.2.2.5 Safe speed means the maximum possible ship speed under certain ice conditions when the hull/ ice interaction in channels does not result in hull and machinery damage.

1.2.2.6 Ice navigator means a properly certificated Officer who holds documentary evidence of having satisfactorily completed an approved training programme in ice navigation. Such a training programme shall have provided knowledge, understanding and proficiency required for operating a vessel in polar ice-covered waters, including recognition of ice formation and characteristics, ice indications, ice manoeuvring, use of ice forecasts, atlases and codes, understanding of hull stress caused by ice, ice escort operations, ice-breaking operations and effect of ice accretion on vessel stability.

1.2.2.7 Ice accretion means the process by which a layer of ice builds up on solid objects which are exposed to freezing precipitation or to super-cooled fog or cloud droplets. It is most likely during time periods when surface air temperatures are between zero and -15°C. Below this threshold spray tends to freeze directly in the air so that it does not adhere to surfaces.

1.2.2.8 Sticking means the adhesion of small pieces of broken ice to the vessel's hull as it proceeds and breaks large ice formations.

1.2.2.9 Beset means the situation of a ship to be surrounded and trapped by ice so that movement of the ship is not possible.

1.2.2.10 Ice management means the combination of activities aimed at reducing or avoiding actions from various ice features. It includes but is not limited to the following activities:

(1) ice detection, tracking and forecasting;

(2) ice threat evaluation;

(3) physical ice management, e.g. ice breaking, iceberg towing;

(4) separation procedure of offshore facilities.

1.2.2.11 Egg Codes are an oval coding system used in ice charts to provide information on concentration, development and form of ice.

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

1.2.2.13 POLARIS is the abbreviation of Methodology for Assessing Operational Capabilities and Limitations in Ice: Polar Operational Limit Assessment Risk Indexing System issued MSC.1/ Circ1519 by IMO.

1.2.3 Terms related to low temperature operation

1.2.3.1 Low temperature means the temperature of which the Lowest Mean Daily Low Temperature (LMDLT) is lower than -10°C.

1.2.3.2 Polar Service Temperature (PST) means a temperature specified for a ship which is intended to operate in low temperature, which is to be set at least 10°C below the lowest MDLT for the intended area and season of operation in polar waters. The generally set polar service temperature is regarded as the design service temperature of a ship and vice-versa.

1.2.3.3 Winterization means the measures ensuring that a vessel is capable of, and suitably prepared for, operations in low temperature. This is provided for by setting functional requirements to functions, systems and equipment considered important to safety and which are intended to be in operation in cold-climate conditions. Winterization includes but is not limited to:

(1) Anti-freezing Systems are the devices to prevent the freezing of ballast tanks and equipment as well as the icing of weather decks and equipment on weather decks, including using antifreezing medium, low condensation point hydraulic oil/ lubricating oil and grease. Measures for preventing the freezing of ballast tanks are to use heating devices/systems, continuous circulating agitating system and air bubbling systems, etc.

(2) Anti-icing Systems are the systems to prevent icing by heating devices using water or steam, including fixed or removable covers made of steel and waterproof low temperature materials (e.g. PVC).

(3) Deicing Systems are the systems to remove ice, including hammers without sharp edges, wooden mallets, axes, steam/hot water jets and heating.

1.2.3.4 Working decks mean the area of a vessel where the operations for which it is designed are carried out, for example cargo operations or towage operations. In the specific example of offshore vessels it may refer to the large open deck aft.

1.2.3.5 Cold soaking means the process of the steelwork of a vessel gradually getting colder so that it acts as a ‘soak’ and then retains the cold, even if there is a temperature increase. It can result in the formation of ice when liquid water, either as condensation or rain, comes into contact with the affected surface.

Section 3 Ice Conditions

1.3.1 Ice accretion

1.3.1.1 Ice accretion onboard is a serious hazard for the safety of ship operations in polar waters. It can be caused by sea spray or by fog, sea fog, rain or snow. The main dangers are:

(1) The most serious form of ice accretion is usually formed by sea spray and the most obvious danger of ice accretion from sea spray is that of vessel instability and, in extreme cases, capsizing;

(2) Ice accretion from fog, rain or sea fog can cause radar, aerial and insulator failures as well as rigging damage and consequential danger to those on deck;

(3) There are other dangers and operational problems to consider including malfunctioning machinery, blocked vents and the physical dangers to crew members trying to work or rectify problems in such conditions.

1.3.1.2 Ice accretion from sea spray occurs when wind and wave-generated spray comes into contact with cold exposed surfaces and the air temperature is below freezing. There are two general factors to be considered:

(1) Environmental factors which contribute to ice accretion from ship sea spray include:

1) Wind speed, e.g. typically above 18 knots or 9 m/s but sometimes lower;

2) Air temperature, e.g. -2˚C or lower;

3) Water temperature, e.g. near freezing;

4) Wind direction, relative to the ship;

5) Swell and wave characteristics:

- Wave size
- Wave length
- Wave propagation direction

(2) Vessel characteristics which affect the severity of ice accretion from sea spray include the following:

1) Speed

2) Heading (with respect to wind, waves and swell).

3) Bow design

4) Ship length

5) Freeboard

6) Cold soaking (surface area of exposed steelwork). When a vessel has been in cold temperatures for a long time, for example two or three weeks, the body of the ship will remain cold even if the air temperature rises above zero. This cold soaking may result in icing being more severe than expected given the prevailing environmental conditions.

1.3.1.3 When a vessel is in the environmental conditions where ice accretion from sea spray may occurs, to minimize the effect of ice accretion, and if unable to reach shelter or warmer conditions, measures may need to be taken to reduce the amount of sea spray by heading into the wind and sea at the slowest speed to maintain steerage way. If weather conditions do not permit this manoeuvre, the vessel should be manoeuvred to run before the wind, also at a minimum speed to maintain steerage way.

1.3.2 Ice types and conditions

1.3.2.1 The most extensive form of floating ice encountered at sea within polar waters is that which results from the freezing of the sea surface, namely sea ice, but mariners may also be concerned with 'ice of land origin' – icebergs, ice islands, bergy bits and growlers. Both icebergs and sea ice can be dangerous to shipping and their presence will impact on navigation.

1.3.2.2 Refer to Table 1.3.2.2 for the ice types likely to be encountered in polar waters. A full description of ice types is contained in the World Meteorological Organization (WMO) Code Sea Ice Nomenclature (WMO No. 259). In most cases, such as on ice charts or interpretations of satellite imagery, the ice cover is characterized using the following categories:

(1) Ice concentration

(2) Stages of development

(3) Forms of floating ice

(4) Openings in the ice

(5) Ice-surface features

(6) Terms related to shipping

(7) Ice of land origin

Ice Types **Table 1.3.2.2**

Ice terms	Description	
Floating Ice Types: Ice Concentration (see definition 1.2.1.10)		
Consolidated Pack Ice	Floating ice in which the concentration is 10/10 and the floes are frozen together	
Compact Ice	Floating ice in which the concentration is 10/10 and no water is visible	
Very Close Pack Ice	Floating ice in which the concentration is 9/10 to less than 10/10	
Close Pack Ice	Floating ice in which the concentration is 7/10 to 8/10, composed of floes mostly in contact	
Open Pack Ice	Floating ice in which the ice concentration is 4/10 to 6/10, and the floes are generally not in contact with one another	
Very Open Pack Ice	Floating ice in which the concentration is 1/10 to 3/10 and water preponderates over ice	
Open Water	A water area in which sea ice is present in concentrations less than 1/10; no ice of land origin is present	
Bergy Water	No sea ice present; ice of land origin is present	
Ice-Free	No ice of any kind is present	
Ice Massif	A variable accumulation of close or very close ice covering hundreds of square kilometres which is found in the same region every summer	
Ice Field	An area of floating ice of any size, which is greater than 10km across. The characteristics, position and sizes of fields are described as separate zones.	
Stages of Development		
New Ice	Recently formed ice, including frazil ice, grease ice, etc.	
Nilas	Dark Nilas	Thickness ≤5cm
	Light Nilas	Thickness 5-10cm
Young Ice	Grey Ice	Thickness 10-15cm
	Grey-WhiteIce	Thickness 15-30cm
First-Year Ice	First-Year Thin Ice	Thickness 30-70cm
	First-Year Medium Ice	Thickness 70-120cm
	First-Year Thick Ice	Thickness 120-200cm
Old Ice	Second-Year Ice	Old ice which has survived only one summer's melt; typical thickness up to 2.5 m and sometimes more
	Multi-Year Ice	Old ice up to 3m or more thick which has survived at least two summers' melt.
Forms of Floating Ice		
Brash Ice	Fragments not more than 2m across; the wreckage of other forms of ice	
Pancake Ice	Predominantly circular pieces of ice 30cm - 3m across	
Ice Cake	Up to 20m across	
Small Ice Cake	Up to 2m across	
Floe	Piece of sea ice 20m or more across	
Small Floe	20-100m	
Medium Floe	100-500m	
Big Floe	500-2000m	
Vast Floe	2-10kg	
Giant Floe	>10kg	

Ice terms	Description
Fast Ice	Sea ice which forms and remains fast along the coast, where it is attached to the shore
Openings in the Ice	
Fracture	Any break or rupture through compact ice
Crack	Any fracture ranging from a few centimeters to 1 m.
Lead	Any passage-way through sea ice which is navigable
Polynya	Any non-linear shaped opening enclosed in ice
Ice Surface Features	
Level Ice	Sea ice which is unaffected by deformation
Deformed Ice	Sea ice which has been squeezed together and forced upwards and downwards
Rafted Ice	Deformed ice formed by one piece of ice overriding another
Ridge	A line or wall of broken ice forced up by pressure
Rubble Field	Composed of refrozen broken ice pieces
Terms Related To Shipping	
Ice Under Pressure	Ice in which deformation processes are actively occurring
Beset	The situation of a ship surrounded by ice and unable to move
Nip	Ice which forcibly presses against a ship
Ice Bound	A harbour, inlet, etc. where navigation is prevented on account of ice, except possibly with the assistance of an icebreaker.

Note: A full description of ice types is contained in the World Meteorological Organization (WMO) Code Sea Ice Nomenclature (WMO No. 259).
For sea ice types, please refer to Atlas of Sea Ice along Polar Voyages (Written by Wei Lixin, Sun Hulin and Ren Beiqi in 2016).

1.3.3 Sea ice properties affecting a vessel's navigation performance in ice

1.3.3.1 There are many sea ice properties that can affect a vessel's navigation performance. The most obvious is the thickness of the ice but other properties, such as hardness, are also important. Multi-year ice is normally harder than first-year ice owing to the amount of salt that will have leached out during warmer periods. There can also be differences in the hardness of first-year ice, depending on the formation process and source. The type and amount of snow cover on the ice adversely impacts the friction against the hull of a vessel.

1.3.3.2 Another impediment to navigation is ice deformation. Drifting sea ice is continually in motion, under the influence of wind, current and internal stresses, and where it becomes subjected to pressure the surface often becomes deformed. Pressure can be caused by a number of factors but can be expected where drifting sea ice comes into contact with stationary fast ice, coastline features, cyclonic weather events and converging currents. Where the ice is thinner, it may raft with ice sheets or floes riding over each other. Where the ice is thicker, pressure is likely to cause ridging or hummocks.

1.3.3.3 Normally, the visible top of a ridge, known as the sail, is significantly smaller than the downward extension below, known as the keel. As ridges form, more ice is forced downwards than upwards in order to support the weight of the ice above the water surface. In deep water a typical ratio of keel to sail may be four or five to one. The consolidated ice in a ridge is not as strong as level ice because it is made up of chunks refrozen together. However the dimensions can be considerable and may present a significant navigational obstacle to vessels, including ice-capable vessels.

1.3.3.4 A significant impediment to ice navigation is pressure itself. Ice pressure features in the development of deformed ice is under pressure. When a vessel encounters pressure, its ability to break ice and clear ridges is diminished, as is its ability to manoeuvre. The hulls, rudders and propellers of vessels beset in ice may be subject to pressure forces that can become significant.

1.3.3.5 When land fast ice forms over shallow waters and there are defined port approach channels, continual breaking of the ice can lead to the eventual blocking of the ice channel by refreezing of broken submerged ice chunks. Keeping these channels clear can be enhanced by the careful selection of suitable icebreakers and propulsion systems.

1.3.3.6 Key to safe and efficient navigation in ice, even for icebreaking capable ships, is avoiding as far as possible difficult ice conditions and maintaining freedom to manoeuvre. In ice the shortest route is often not the safest and quickest route. Real time knowledge of the ice conditions through ice reports, observations and satellite imagery aided by ice forecasting, route modelling, weather, current and tidal informational play an important role in aiding the selection of the safest and most efficient routes.

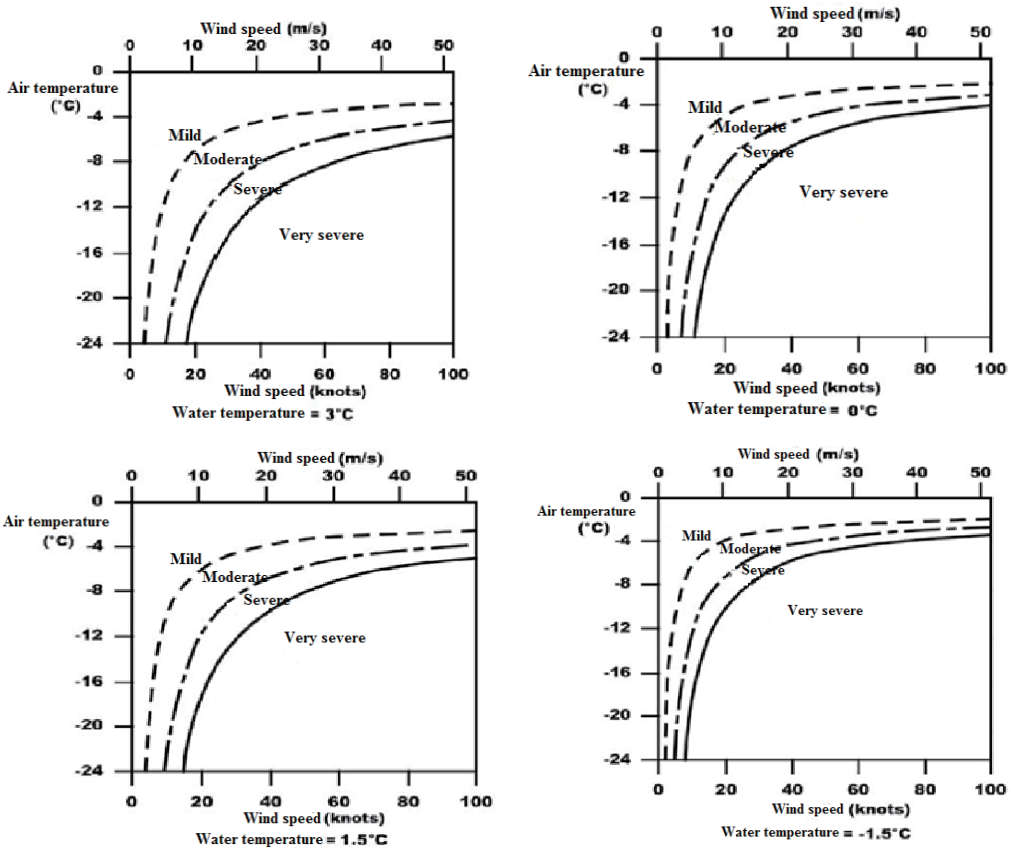
1.3.3.7 In determining the ability of a vessel to safely operate in a particular area, the specific ice conditions should be carefully studied, with particular regard to the ice regime characteristics and anticipated weather conditions for the period of operation.

1.3.4 Sea ice accumulation on the hull affecting a vessel's navigation performance

1.3.4.1 Sea ice accumulation on the hull of the vessel, or sticking, can typically occur when the ambient air temperatures fall just below zero. The most typical ice conditions for sticking are young ice (grey-white ice) or first-year thin ice. Sticking represents a particular hazard as icebreaking vessels may be capable of steaming at normal speeds in light ice conditions. The sudden onset of sticking quickly reduces their speed and manoeuvring capabilities which, when the vessel is leading a convoy or undertaking ice management operations, introduces danger of collision from any following vessels.

1.3.4.2 The intensity of the ice accumulation on the hull depends on the air temperature and the roughness of the vessel's shell plating. Ice accumulation can be reduced by applying special coatings to the shell plating, thereby reducing its roughness.

1.3.4.3 When the vessel operates in waters in which sea ice is present in concentrations less than 6/10, the master is to pay close attention to weather forecast and ice accretion from sea spray warning, and to predict the possible icing condition according to the corresponding air temperature, wind speed and water temperature in the icing rate table (see Figure 1.3.4.3). When the vessel operates at heavy sea (winds of force 6 or above on the Beaufort scale) with the air temperature lower than -2℃ and water temperature lower than 6℃, the shipping sea is to cause ice accretion at superstructure and hull above the waterline. The master is to take prudent operation measures.



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

FFigure 1.3.4.3 Icing rate table

Section 4 Main Parameters of Ship

Main parameters of ship are to be listed in this section.

Chapter 2 Operational Capability and Limitation

Section 1 Operation in Ice

2.1.1 Purpose

2.1.1.1 This section describes the designed operational capability of the ship in ice, stipulates the operational limitations of the ship in ice and the method of defining operational limitations in ice and provides guidance for safe operation of the ship.

2.1.1.2 All persons on watch are to be familiar with the operational capability and limitation of the ship in ice according to their duties, master and skillfully use the method of operational limitations in ice described in the related sections of this manual so as to ensure safe navigation of the ship within the range of designed operational capability at any time.

2.1.2 Safe operation

2.1.2.1 The ship belongs to Category A/B/C ships. Please see Table 2.1.2.1 for its designed ice class and navigation in ice.

Ice Class and Ice Strengthened Draft Range Table 2.1.2.1

Ice class	Maximum draft		Minimum draft	
	Aft	Fwd	Aft	Fwd

2.1.2.2 The ship is restricted to navigate in ice conditions of first-year thin ice (mixed up with old ice) and the concentration of ice type and ice melt condition are to be taken into full account. When the ship independently navigates in ice, the master and officer are to observe and analyze the ice condition on the ice charts provided by shore base in real time and adopt IMO Polar Operational Limit Assessment Risk Indexing System (see Appendix 1 for POLARIS) to calculate Risk Index Outcome (RIO) value so as to determine whether the ice condition of the planned voyage exceeds the designed operational capability of the ship and take appropriate measures and carefully operate.

2.1.3 Icebreaking capability

As one of the ice performances of polar ships, icebreaking capability is the capability which has been verified and determined, based on structural strengthening and the suited power of installed main engine, to independently and continuously advance or operate in the specific ice-covered waters and to avoid ice block. Icebreaking capability is determined by the ship owner through balancing different requirements during the design process according to the expected functions, purpose and operation mode in ice of the polar ship and is usually described using ice types and speed corresponding to the thickness. The examples are as follows:

(1) *Level ice ahead: The ship speed must be 13 knots in 50cm thick first-year level ice with thin snow cover. The ship must be able to proceed with a 3 knots speed in 1.5m thick level ice.*

(2) *Level ice astern: The ship must be able to go astern with 7 knots speed in 70cm thick first-year level ice with thin snow cover*.

(3) *Channel widening: The ship has to be able to make a 40 m wide channel in 50 cm thick first-year level ice with thin snow cover at 4 knots speed*.

(4) *Advancing in deformed ice: The ship keeps advancing in the ice under pressure of 50cm in thickness at 9 knots*.

(5) *Advancing in rubble channel: The ship advances in the brash ice channel corresponding to the selected ice class requirement at 14 knots*.

The icebreaking capability data stated in the manual may be taken from the data obtained from the numerical analysis, ice basin model tests or full scale ice trials designed for the polar ship.

If the ship does not have the icebreaking capability, this paragraph describes it as "not applicable".

2.1.4 Maneuvering performance in ice

Maneuvering performance in ice is also one of the ice performances of polar ships. It is the capability of starting, cyclotron response, braking/stopping in specific ice conditions verified and determined by ice basin model tests based on the designed hull shape, selected matching rudder and propulsion plant, and determined by the ship owner taking different requirements into account according to the expected functions, purpose and operation mode in ice of the polar ship. The operating characteristic data may be obtained from the ice basin model test, digital simulation data or full scale ice trial data. The examples are as follows:

(1) *the maximum time for the ship to turn on spot (180º) in ice with specific thickness*.

(2) *the ramming speed of the ship passing through ice ridges with specific thickness and/or the channel in which the ship immediately turn out from side ridges with specific thickness*.

(3) *the crash stopping distance of the ship in ice with specific thickness*.

2.1.5 Special performance

This paragraph describes structure strengthening at the spaces and positions special hull of polar ships and the special performances of fitted structure monitoring system and ice operation performance enhancement system and etc., which are as follows:

No.	*Special performance*	*Nature*	*Descriptive information*		*Compilation basis*
			Position	*Operational limitations and requirements*	
1	*Hull structure strengthening and monitoring system*				
1.1	*Special structure strengthening*	*While the overall strength meets the rule requirements, the local structure may not meet the related requirement for ice class of 1.2.1 of this chapter, but local damage risk would not cause environmental pollution.*	*Frame section and structure scantlings of ice belt, variance of material and inboard compartments*	*allowable maximum ice condition and matters needing attention for safe operation in ice including operation mode limitations, power limitations, etc.*	*Ice class equivalence assessment results*
		An ice class of which the strength level is higher than that required by the basic ice class of 1.2.1 of this chapter has been applied for the specific hull area structure so as to meet the requirements for special operation.	*Name of hull area, such as bow shoulder, stern shoulder and their ice class*		*Direct design results based on risk assessment*
1.2	*Structure monitoring system*	*The ice load measurement and monitoring system has been installed to control speed in ice and provide decision support for selecting route so as to ensure the ship load is within the range of structure capability.*	*Installation positions and numbers of system acceleration transducers and structural load measuring instrument*	*The worst environmental conditions of system operation and operation procedures including alarm, record, processing requirements and system periodic calibration requirements*	*Requirements for system data and classification society notation*
2	*Operating performance enhancement system*				
2.1	*Heeling system*	*Where the ship gets stuck or runs aground in ice area with pressure, the system is to be used to make the ship transversely sway so as to reduce the effects of stiction.*	*System installation position*	*System usage and operation procedures and environmental conditions for usage*	*System data and onboard installation and arrangement data*
2.2	*Hull lubrication system*	*This kind of system includes compressed air bubbling system, deluge system and water wash system. Where the ship proceeds in the ice with thick snow cover, or maneuvers in the ice with pressure, or operates ramming icebreaking and manoeuvers docking, the system is to be used to reduce the friction between hull and ice so as to prevent ice accumulation on hull and enhance maneuverability in ice.*	*The water of system and installation positions and numbers of air nozzles*	*System usage and operation procedures and environmental conditions for usage*	*System data and onboard installation and arrangement data*

If there are no special cases regarding performance of polar ship, it is unnecessary to describe the details. Just leave it blank.

Section 2 Operation in Low temperature

2.2.1 Purpose

2.2.1.1 This section describes the polar service temperature and anti-cold climate measures for equipment and systems subject to low temperature to ensure operational capability and limitation of ship in in low temperature.

2.2.2 Polar service temperature

2.2.2.1 The ship design service temperature (PST) is【X】℃(*to be in consistent with the description in Polar Ship Certificate*).

2.2.2.2 The ship (PC7) is to be limited to operate in the areas and/or seasons where the expected lowest mean daily low temperature (LMDLT) is not lower than 【X】℃(PST+10℃) (*applying to the ships which are intended to operate in low temperature*) or -10℃ (*applying to the ships which are not intended to operate in low temperature*).

2.2.3 System design

2.2.3.1 The anti-cold climate measures have been designed/taken for equipment, systems and accommodations subject to low temperature according to polar service temperature so as to avoid malfunction in low temperature environments. See Table 2.2.3.1 for details.

List of Anti-cold Climate Measures for Equipment and Systems Design (*Examples*) **Table 2.2.3.1**

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
1	*Machinery installations*		
1.1	*Essential main and auxiliary machinery and equipment on open deck including emergency equipment and navigational equipment*	*1. Low temperature type test, or*	*DST*
		2. To provide heating arrangements such as heating-tracing belt	
1.2	*Fixed essential main and auxiliary machinery and equipment in spaces including emergency equipment and navigational equipment*	*1. Operating in the expected indoor temperature, or*	*DST*
		2. To provide heating arrangements	
2	*Main propulsion and essential auxiliary engine*		
2.1	*Air system arrangements*	*1. Preheating intake air, or* *2. Heating machinery room, or* *3. Air cooler bypass or exhaust gas bypass*	*The minimum air inlet temperature specified by the manufacturer*
		4. Main engine lubricating oil temperature	*The minimum temperature specified by the manufacturer*

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
2.2	*Sea intakes of cooling system*	*1. To provide anti-icing cofferdam for suction, or*	
		2. Arranging main engine cooling water internal circulation	
2.3	*Hydraulic system of azimuth propulsion plant*	*1. Heating arrangement, and/or*	
		2. Using anti- freezing lubricating oils/hydraulic oils	*DST*
2.4	*Steering gear*	*1. Using low-temperature-resistant greases and lubricating oils*	*DST*
3	*Auxiliary machinery system and deck work area*		
3.1	*Piping components on deck*	*1. Using low-temperature-resistant materials, or*	*DST*
		2. To provide heating arrangements	
3.2	*Anti-freezing protection for system piping*	*1. To provide drainage valves for residual water at the low position;*	*≤ 0℃*
		2. Installing isolation valves on branches near mains	*≤ 0℃*
3.3	*Anti-freezing of condensate water of exposed steam lines*	*1. Insulation wrapping, and/or*	*≤ 0℃*
		2. Air blowing connection	*≤ 0℃*
3.4	*Anti-freezing of steam deck machinery*	*1. Continuous steam cycle*	*≤ 0℃*
3.5	*Essential service valves, instruments, indicators and monitoring equipment*	*1. Anti-icing measures, or*	*≤ 0℃*
		2. Deicing measures, or	*≤ 0℃*
		3. To provide shield or arranging in the heating space, or	
		4. To provide heating arrangement (valve driving mechanism, battery valve and pressure gage), or	
		5. To provide low-temperature-resistant products	*DST*
3.6	*Exposed remote control valve on hydraulic pipes*	*1. Heating arrangements*	
3.7	*Hydraulic oil power unit*	*1. To be installed at closed heating space; or*	
		2. Using low-temperature-resistant material for hydraulic oils and piping systems	*DST*
3.8	*Anti-freezing measures for exposed fresh water and sea water pipes and valves*	*1. Installing isolation valves inside the heating space; or*	*≤ 0℃*
		2. To provide drainage valves and air blowing connection at the lowest position; or	*≤ 0℃*
		3. Heating arrangements or continuous cycle	*≤ 0℃*

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
3.9	*Anti- freezing of pneumatic device gas supply system on deck*	*1. One of the following measures may be taken* *1) Appropriate dew point design;*	*DST*
		2) To provide air desiccants	
		3) Proper heating arrangements	
		2. To provide drainage valves at the lowest position of exposed deck piping	
3.10	*Preventing ice suction by ballast system sea inlets*	*1. Isolation and heating arrangements, or*	*≤ 0℃*
		2. Steam blowing arrangements	*≤ 0℃*
3.11	*Preventing sea inlets and overboard discharge valves from ice jam*	*1. Installing low pressure steam connection;*	
		2. Internal cycle arrangement of ballast tanks or assigned double bottom ballast water or fresh water storage tank	
3.12	*Lookout/ security watch cabins*	1. *Heating arrangements*	*DST*
		2. To provide deicing measures for glass windows	
3.13	*Oil discharge monitoring equipment (ODEM)*	*Heating and steam blowing arrangements*	
4	*Anchor mooring equipment and deck lifting appliances*		
4.1	*Anti-icing measures for windlass and mooring winches*	*1. Proper canvas hoods, or*	*≤ 0℃*
		2. Arranging shelter deck area, or	
		3. To provide a set of manual deicing tools for the forecastle (including 3 shovels, 3 hammers/mallets and 3 scrapers)	
4.2	*Anti-icing of exposed control panel*	*1. Steel cover*	
4.3	*Lubricating components and hydraulic system*	*1. Using low-temperature-resistant lubricating oils and hydraulic oils*	*MAT*
4.4	*Hydraulic control system*	*The same as 3.6 and 3.7*	
4.5	*Chain pipes*	*1. Being located at heating space, or*	
		2. Heating arrangements, or	
		3. Installing deck steam connection	
4.6	*Hydraulically operated equipment and system*	*Steam deicing measures*	
4.7	*Flushing pipelines of chain pipes*	*1. Continuous cycle*	
		2. Heating arrangements	
		3. Installing deck steam connection	
4.8	*Favorable working environment of crane cab*	*1. Heating arrangement*	
		2. To provide heating windows and windscreen wipers for visual windows	

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
4.9	*Providing cold start for exposed deck lifting appliances*	*1. Using low-temperature-resistant lubricating oils and grease*	*MAT*
4.10	*Lifting appliance material grades*	*1. Using low-temperature-resistant materials*	*DST*
5	*Electrical installation*		
5.1	*Capacity of main source of electrical power*	*Meeting the demands of power supply of air-conditioning system and heating equipment in accommodations*	
5.2	*Generators and motors installed on open deck and in low temperature space*	*1. Anti-condensation equipment*	
		2. Using low-temperature-resistant lubricating oils for bearing	*DST*
5.3	*Electric distribution box, switchboard and control equipment installed on open deck and in low temperature space*	*1. Anti-condensation equipment*	
5.3	*Cables located on open deck and in low temperature space*	*1. Carrying out low temperature type test*	*DST*
		2. To be protected by metal pipes, conduits or trunking	
5.4	*Illumination lights and navigation lights installed on open decks*	*1. Carrying out low temperature type test*	*DST*
5.5	*Closed circuit television systems fitted on exposed decks*	*1. Heating arrangements, or*	
		2. Using covers	
6	*Emergency equipment*		
6.1	*Fire pumps and emergency fire pumps*	*To be installed in space with positive temperature*	
6.2	*Anti-freezing of pipes and hydrants of exposed parts of fire main*	*1. Installing isolation valves in space with positive temperature*	
		2. To provide drainage valves	
6.3	*Sea suctions of fire pumps*	*1. Steam blowing arrangements*	
6.4	*Water spray system*	*1. To provide drainage facilities and dry air blowing arrangements, or*	
		2. To provide heating arrangements	
6.5	*Fixed foam fire-fighting system*	*1. Setting safe operation temperature for hoses and nozzles*	*DST*
		2. Piping drainage valves	
		3. Monitors being protected by canvas hoods	
6.6	*Foam extinguishing agents*	*1. Safety operation temperature*	*DST*
6.7	*Fire hose*	*1.To provide heating arrangements for storage facilities, or*	
		2. To provide 2 spare hoses for replacement	

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
6.8	*Lifeboats, liferafts and rescue boats*	*1. To be arranged in the protection position*	
6.10	*Lifeboats*	*1. Totally enclosed type, to be provided with internal space heaters and powered by emergency switchboard*	*DST(<-30℃)*
6.11	*Lifeboat/ rescue boat control panel*	*1. Heating arrangements* *2. To provide deicing equipment for visual windows*	*DST(<-30℃)*
6.12	*Lifeboat/ rescue boat engines*	*1. Using low temperature fuel oils and lubricating oils* *2. Appropriate anti-freezing of cooling system*	*DST(<-30℃)*
6.13	*Lifeboat/ rescue boat battery*	*1. Low temperature type*	*DST(<-30℃)*
6.14	*Lifeboat/ rescue boat winches*	*1. Cover or a set of manual deicing tools (including 3 shovels, 3 hammers/mallets and 3 scrapers)*	
		2. Using low-temperature-resistant greases	*DST(<-30℃)*
		3. To provide steam deicing measures for hydraulic system	*<0℃*
6.15	*Lifeboat and rescue boat davit/ block/release hook*	*1. Using low-temperature-resistant greases*	*DST*
		2. Canvas hoods or heating arrangements	*<0℃*
6.16	*Embarkation ladders*	*1. Canvas hoods*	*<0℃*
6.17	*Lifeboat water spray piping*	*Anti-freezing type external nozzles, or*	*<0℃*
		Drainage facilities and dry air blowing arrangements	*<0℃*
6.18	*Life-saving appliances*	*1. Carrying out low temperature type test*	*DST(<-30℃)*
		2. Lifeboat equipment including selfigniting light low temperature operation type	*DST(<-30℃)*
6.18	*EPIRB/SART*	*Manual deicing tools*	
6.19	*Scrubbers and exposed pipes of eye washing system*	*1. Water tank heating arrangements, heat insulation binding or heating-tracing arrangements of exposed pipes; or*	*+5℃*
		2. To provide standby eye washer station at accommodation spaces	*<0℃*
6.20	*Materials of exposed steel davit and hydraulic components*	*1. Applicable low-temperature-resistant materials*	*DST*
6.21	*Immersion suits*	*Low-temperature-resistant type, to be stored at heating spaces or containers and to be provided with deicing measures*	*DST*
7	*Compartments*		
7.1	*Air-conditioning system of accommodations*	*Keeping internal temperature*	*DST*

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
7.2	*Essential machinery and equipment not covered by air-conditioning system, including emergency equipment space*	*Heating arrangement and setting minimum temperature for alarm*	*DST*
7.3	*Engine room*	*1. To provide regulating temperature measures*	*DST*
		2. Funnel shutter opening regulation	
7.4	*Air intakes and exhaust louvres of accommodations and machinery space*	*1. Deicing measures and heating arrangements*	
7.5	*All cargo control rooms*	*1. Heating arrangements and deicing measures*	*<0℃*
7.6	*Bridge windows*	*1. Heating arrangements and To provide hot air blowing system internally*	*<0℃*
		2. To provide window washing system for anti-freezing pipes and nozzle clogging	*<0℃*
7.7	*Bridge wing protection*	*1. To provide heating arrangements and covers for exposed bridge wings and wing control/equipment*	*<0℃*
		2. Personnel anti-cold climate measures	*<0℃*
8	*Accommodations and escape routes*		
8.1	*Outside doors*	*To be arranged at the protection positions*	
8.2	*Enclosed spaces on the escape route near the outside door*	*Heating arrangements*	*<0℃*
8.3	*Personnel anti-cold climate*	*To provide dressing rooms near the exits and entrances*	*<0℃*
8.4	*External exposed boundaries (accommodation bulkheads/deck ceilings) insulation*	*1. To provide steam protection screen to prevent insulation from damage due to moisture and freezing*	*<0℃*
		2. To provide drainage trays under deck	*<0℃*
8.5	*All external exposed boundaries of bathrooms*	*1. To provide insulation and heating arrangements*	*<0℃*
9	*Tanks*		
9.1	*fresh water and sea water ballast tanks with hull boundaries above the top ballast waterline*	*1. Heating coils/continuous circulation system/ air bubbling system/ tank pressure system or equivalent measures*	*<0℃*
9.2	*Heating tanks*	*1. Failure alarm monitoring system designed by low temperature operation*	*DST*
9.3	*sewage tanks and related piping system near hull boundaries*	*1. To be provided in heating tanks or provide heating arrangements*	*<0℃*
9.5	*Exposed air pipe heads of tanks*	*1. To be located at protection positions and to be provided with covers*	*<0℃*
9.6	*Overboard ballast water discharge pipes above the waterline*	*1. Heating arrangements*	*DST*
10	*Deicing and protection measures*		

No.	Equipment and system	Anti-cold Climate Measures	Design temperature
10.1	*Exposed deck: safe access to the bow, lifeboat, rescue boat and pilotage embarkation position, areas adjacent to emergency exits, lifeboats/rescue boats, davits and liferafts including landing areas, storage facilities adjacent to fire equipment, anchoring and mooring operation areas, open navigation and lookout areas, helicopter deck areas and open deck working areas (including deicing measures for hatch covers, containers and grain loading covers)*	*1. Heated deck, grating, checkered iron plate, welding anti-cold climate point or antiskid deck and coarse sand embedding paint* *2. Steam or hot water piping connection*	*<0*℃
10.2	*Manual deicing tool employment*	*To provide at least 1 set of tools including 3 shovels, 3 hammers/mallets and 3 scrapers at all positions of bow, amidship (port and starboard entrance and embarkation area) and stern (near life-saving appliance landing area)*	*<0*℃

The contents of the above list have been developed according to the corresponding anti-cold climate design plan approved by the Administration or its recognized organization.

Section 3 Communication and Navigation Capabilities at High Latitudes

2.3.1 Purpose

2.3.1.1 This section describes the function effectiveness limitations for shipboard communication and navigation equipment at high latitudes to ensure the correct use of communications and navigation equipment when the ship navigates in polar waters so as to ensure navigation safety.

2.3.1.2 The master and person on watch at bridge are to ensure the function integrity of communication and navigation equipment and understand the loss of functions of special water equipment.

2.3.2 Limitations and use of communication and navigation equipment and system at high latitudes

2.3.2.1 Limitations and use of shipboard communication equipment and system at high latitudes are shown in Table 2.3.2.1 below:

Table 2.3.2.1

Name of equipment and system	Type No.	Limiting latitude	Cause of limitation
VHF, HF and MF		*None*	
GMDSS		*80°*	*Unsteadiness and interrupt of signal*
VHF DSC		*None*	
AIS		*None*	*Insufficient regional base station*
121.5 and 123.1 MHz air VHF		*None*	
Iridium satellite telephone		*None*	

2.3.2.2 Limitations and use of shipboard navigation equipment and system at high latitudes are shown in Table 2.3.2.2 below:

Table 2.3.2.2

Name of equipment and system	Type No.	Limiting latitude	Cause of limitation
Gyrocompass		*85°*	*Tolerance of 2^o-5^o begins to occur at latitude 70^o*
Magnetic compass		*60°*	*The directing force of earth magnetic field level is weakened and unstable*
GNSS compass		*None*	
Radar		*None*	
Search light		*None*	
Weather facsimile receiver		*None*	
GPS		*80°*	*Unsteadiness and interrupt of signal*

Section 4 Ship Endurance

2.4.1 Purpose

2.4.1.1 This section describes the information regarding ship endurance limitations which are provided to the company and/or master for consideration when making navigation planning and voyage plan in polar waters, so as to ensure enough fuel oil, fresh water and food for the planned voyage and to ensure enough sewage storage ability.

2.4.2 Fuel oil and fresh water capacity

2.4.2.1 Marine fuel oil and fresh water tanks are shown in Table 2.4.2.1 below. The maximum voyage endurance is【XX】days.

Arrangement and capacity of fuel oil and fresh water tanks Table 2.4.2.1

Name of fuel oil tank	Capacity (m^3)	Name of fresh water tank	Capacity (m^3)

2.4.2.2 The sea water desalting plant is to be provided on the ship (type【XXX】) (if any), with water production capacity XX tons/day.

2.4.2.3 The daily fuel oil consumption data is to be listed.

Daily fuel oil consumption (T/d)	
F.O	
D.O	

2.4.3 Stores

2.4.3.1 The marine provision store capacity is shown in Table 4.3.1 below. The maximum capacity is【XX】days.

Arrangement and capacity of provision store Table 2.4.3.1

Name of dry provision room	Capacity (m^3)	Name of refrigerating chamber	Capacity (m^3)

2.4.3.2 *(Other special important materials necessary for safety navigation of vessels are to be elaborated).*

2.4.4 Pollutant disposal or storage power

2.4.4.1 The ship is to be provided with sewage tanks, slop tanks and bilge tanks. The tank capacities and positions are shown in the table below.

Name of tank	Position of tank	Capacity of tank (m^3)
Machine oil sludge tank		
Fuel oil sludge tank		
Slop tank		
Sewage tank		
Sewage storage tank		

The capacity of tanks used for storing slop is to hold the slop generated throughout the navigation in polar waters.

2.4.4.2 *The marine sewage treatment plant is to be listed.*

Chapter 3 Ship Operation

Section 1 Voyage Planning

3.1.1 Purpose

3.1.1.1 This section provides guidance for voyage planning procedures in polar waters to ensure that the entire voyage operation does not exceed the designed operational capacity and limitations specified in Chapter 2.

3.1.1.2 The guidance given or procedure followed in this section will neither replace the master's rights nor reduce the normal responsibilities of the officer on duty and the principle of good seamanship.

3.1.2 Planning

3.1.2.1 When planning the route plan in ice, the personnel in charge of the department of the company and/or the master are to follow the basic principle of route planning in the Guidelines for voyage planning (IMO Resolution A. 893 (21)) and take sea ice existing, animal protection area into account. Continuous assessments are to be carried out throughout the voyage.

3.1.2.2 Planning includes (but is not limited to) voyage planning and real time planning in ice and has four steps including appraisal, plan, execution and monitoring. The voyage planning is to be completed before navigation. The real time planning in ice is to be carried out when the ship navigates in polar waters.

3.1.2.3 The voyage planning is to follow the following basic procedures:

(1) Appraisal:

Collecting all the materials required for voyage planning including any of the most complete ice condition image data that can be obtained and confirming the reliability of data; Confirming if the related national services in ice can provide ice condition data and obtain it from the related official website (see Appendix 2).

(2) Plan

The detailed voyage plan is to be made according to the route, destination port and expected ice conditions. For making the voyage plan, besides the weather forecast, ice condition forecast, standard nautical publications, special provisions or requirements of the coastal states and icebreaker escort service, the following are to be taken into account:

- any limitations of the hydrographic information and aids to navigation available;
- current information on the extent and type of ice and icebergs in the vicinity of the intended route;

- statistical information on ice and temperatures from former years;
- places of refuge;
- 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;
- current information on relevant ships' routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas;
- national and international designated protected areas along the route;
- operation in areas remote from search and rescue (SAR) capabilities; and
- other factors to be considered for navigation in polar waters.

(3) Execution: During the execution period, the voyage plan is to:

- forecast estimated time of arrival based on the ice conditions expected along the route;
- take into account the factors such as poor visibility on the route, compact ice condition, areas of higher concentrations of old ice, delays in waiting for information, expected reduction in speed or deviations in course;
- consider ballasting down to ice draft and reduce the speed;
- consider adding extra lookouts or doubling watches for entering ice or approaching areas of low visibility or high numbers of icebergs/bergy bits/growlers.

(4) Monitoring: The master is to continue monitoring the ice conditions of route before the ship reaches the ice-covered waters. As the ship approaches ice-covered waters, the quality and quantity of ice information improves, which increases the accuracy of estimates for times of arrival and may perhaps indicate a change in route.

3.1.2.4 The ship is to be carried out according to the voyage plan if the information on the ice conditions is consistent with the forecast before the ship reaches the ice-covered waters. The company and ship should make all efforts to obtain the real-time information on ice conditions. The real time planning in ice is to be carried out particularly when consolidated ice is likely to be encountered, where high concentrations of old ice are expected or in highly mobile ice. The basic procedures are as follows:

(1) Appraisal: These procedures are to accept and appraise the following information on ice conditions (if applicable):

- Reception of ice observation and analysis charts provided by national ice services involved in the route or ice charts downloaded from their web sites;
- Marine radar (X and S-bands), visual observations and processed radar imagery;
- Helicopter reconnaissance.

(2) Plan:

① The route plan is to consider choosing the best route with the least or lightest ice condition, including:

- finding open water leads;
- finding first-year ice leads in close ice or old ice fields;
- avoiding areas of ridging; and
- avoiding areas of ice pressure or potential ice pressure.

② Once the track has been laid out, it has to be transferred to large-scale charts and checked for adequate water depth so as to ensure that the best route is also the safest route. It is to indicate the need for further information.

(3) Execution: The estimated times of arrival are to be revised and reported based on the determined route. Any change in weather conditions, particularly visibility or wind direction and speed, are to be considered before executing the plan so as to estimate ice pressure areas or where open water leads may be located.

(4) Monitoring: Progress is to be monitored on the chart by conventional means and ice navigation continues.

3.1.3 Avoiding dangerous ice conditions

Arctic waters

3.1.3.1 In the Arctic Ocean, the extent of sea ice cover varies considerably in different seasons and regions. Usually, almost all of the water is covered by sea ice (100%) in March while the sea ice extent shrinks significantly in September. It reached a minimum of 3.47 million square kilometers in 2012, accounting for just 25 percent of the entire Arctic Ocean. Regionally, the marginal sea ice of northern edge of Eurasia (lower concentration and smaller thickness) is lighter than that of middle and north waters of the Canadian Arctic Archipelago (higher concentration and larger thickness).

Northeast Passage

3.1.3.2 Sea ice may be encountered at any time during the voyage of the ship in the Northern Sea Route (NSR) of Russia of the Northeast Passage. In the year of severe ice conditions, the waters of the Northeast Passage are almost completely covered with floating ice throughout the summer. In the year of light ice conditions, the ice edge extends to the northern sea boundary of Russia. Ice that covers the Arctic Ocean begins to melt in mid-June every year and the north of the Kara Sea, the Laptev Sea, and Eastern Siberia Sea and the north of the Chukchi Sea begin to freeze again in mid to late September. In late October, the average ice thickness reaches 25～30㎝, 70～90 in December and the largest thickness (140～210㎝) in May. The thickness of second-year ice and multi-year ice may exceed 2～3 m.

3.1.3.3 The most important feature of the Northeast Passage ice condition in summer is the location and quantity of accumulation of ice massifs. The accumulation of ice massifs of Novaya Zemlya, Severnaya Zemlya, Taymyr Peninsula and Ayon Island (see Figure 3.1.3.3) is the biggest obstacle to navigation in the Northeast Passage.

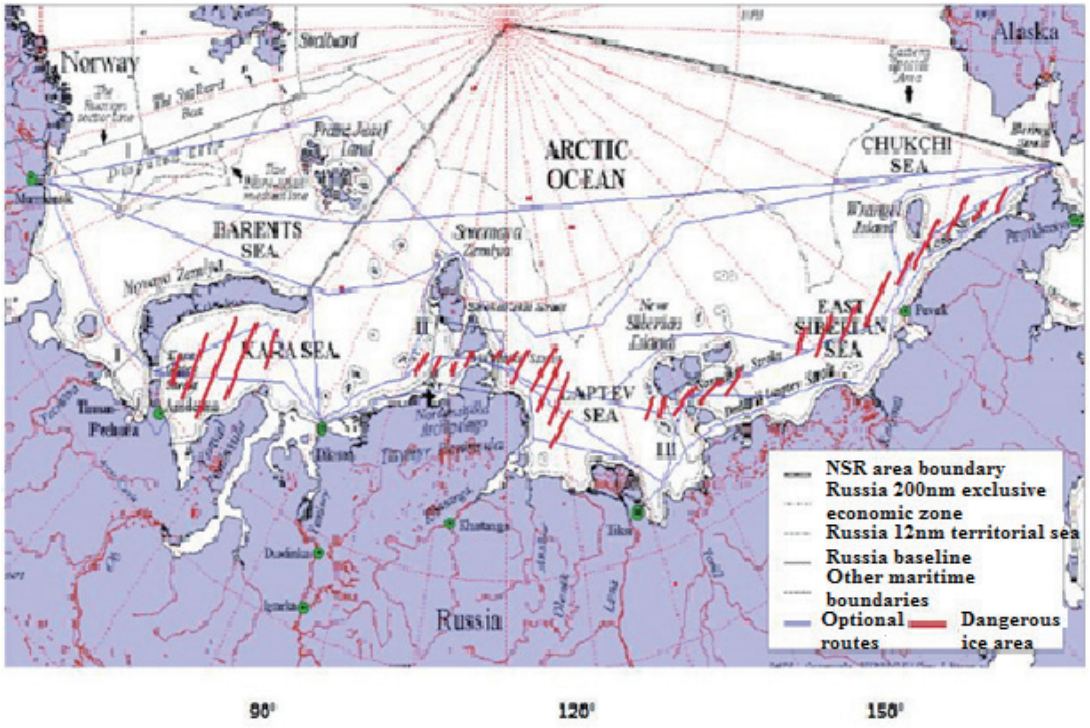


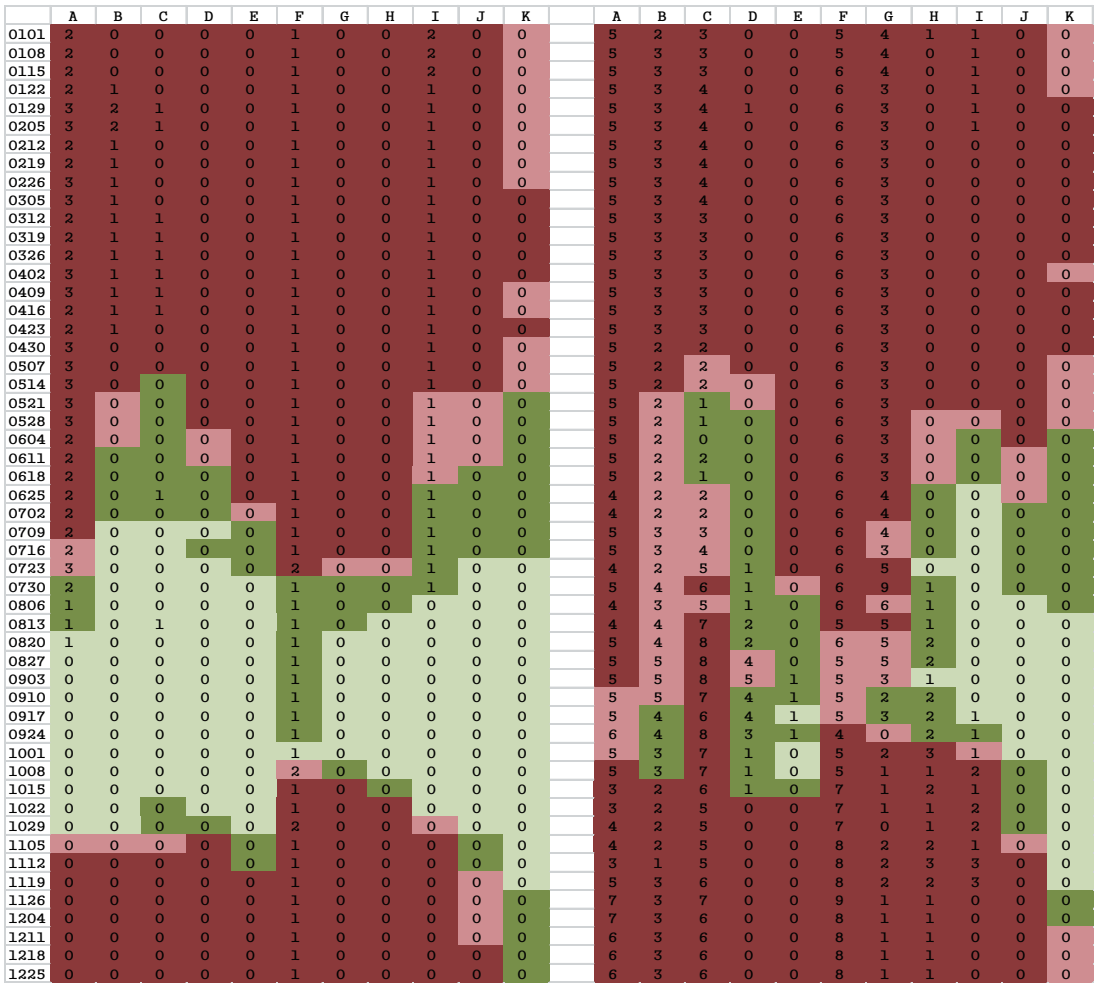
Figure 3.1.3.3 Main passages and dangerous ice areas of the Northeast Passage in Arctic waters

3.1.3.4 The ice condition may change rapidly with the rapid movement of wind and floating ice driven by flow. When the ship navigates in the ice of the Northeast Passage, the master is to consider applying for icebreaker escort service and follow the instructions of the icebreaker's captain or ice pilot.

3.1.3.5 When navigating in the Northern Sea Route of Russia, the ship is to comply with the Rules of navigation on the water area of the Northern Sea Route of Russia according to its design ice class (see Appendix 3).

Northwest Passage

3.1.3.6 The Northwest Passage includes the Chukchi Sea, the Beaufort Sea, the Canadian Arctic Archipelago and Baffin Bay. The Canadian Arctic Archipelago, from Banks to Baffin Island, spans about 2,400 kilometers with numerous channels, bays and shoals, which is the most complex area of the Northwest Passage. The north line deep water routes are often blocked by multi-year ice drifting from the Arctic Ocean, the ice conditions of which are shown in Figure 3.1.3.6.



	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	I	J	K
0101	2	0	0	0	0	1	0	0	2	0	0	5	2	3	0	0	5	4	1	1	0	0
0108	2	0	0	0	0	1	0	0	2	0	0	5	3	3	0	0	5	4	0	1	0	0
0115	2	0	0	0	0	1	0	0	2	0	0	5	3	3	0	0	6	4	0	1	0	0
0122	2	1	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	1	0	0
0129	3	2	1	0	0	1	0	0	1	0	0	5	3	4	1	0	6	3	0	1	0	0
0205	3	2	1	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	1	0	0
0212	2	1	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	0	0	0
0219	2	1	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	0	0	0
0226	3	1	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	0	0	0
0305	3	1	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	0	0	0
0312	2	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0319	2	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0326	2	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0402	3	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0409	3	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0416	2	1	1	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0423	2	1	0	0	0	1	0	0	1	0	0	5	3	3	0	0	6	3	0	0	0	0
0430	3	0	0	0	0	1	0	0	1	0	0	5	2	2	0	0	6	3	0	0	0	0
0507	3	0	0	0	0	1	0	0	1	0	0	5	2	2	0	0	6	3	0	0	0	0
0514	3	0	0	0	0	1	0	0	1	0	0	5	2	2	0	0	6	3	0	0	0	0
0521	3	0	0	0	0	1	0	0	1	0	0	5	2	1	0	0	6	3	0	0	0	0
0528	3	0	0	0	0	1	0	0	1	0	0	5	2	1	0	0	6	3	0	0	0	0
0604	2	0	0	0	0	1	0	0	1	0	0	5	2	0	0	0	6	3	0	0	0	0
0611	2	0	0	0	0	1	0	0	1	0	0	5	2	2	0	0	6	3	0	0	0	0
0618	2	0	0	0	0	1	0	0	1	0	0	5	2	1	0	0	6	3	0	0	0	0
0625	2	0	1	0	0	1	0	0	1	0	0	4	2	2	0	0	6	4	0	0	0	0
0702	2	0	0	0	0	1	0	0	1	0	0	4	2	2	0	0	6	4	0	0	0	0
0709	2	0	0	0	0	1	0	0	1	0	0	5	3	3	0	0	6	4	0	0	0	0
0716	2	0	0	0	0	1	0	0	1	0	0	5	3	4	0	0	6	3	0	0	0	0
0723	3	0	0	0	0	2	0	0	1	0	0	4	2	5	1	0	6	5	0	0	0	0
0730	2	0	0	0	0	1	0	0	1	0	0	5	4	6	1	0	6	9	1	0	0	0
0806	1	0	0	0	0	1	0	0	0	0	0	4	3	5	1	0	6	6	1	0	0	0
0813	1	0	1	0	0	1	0	0	0	0	0	4	4	7	2	0	5	5	1	0	0	0
0820	1	0	0	0	0	1	0	0	0	0	0	5	4	8	2	0	6	5	2	0	0	0
0827	0	0	0	0	0	1	0	0	0	0	0	5	5	8	4	0	5	5	2	0	0	0
0903	0	0	0	0	0	1	0	0	0	0	0	5	5	8	5	1	5	3	1	0	0	0
0910	0	0	0	0	0	1	0	0	0	0	0	5	5	7	4	1	5	2	2	0	0	0
0917	0	0	0	0	0	1	0	0	0	0	0	5	4	6	4	1	5	3	2	1	0	0
0924	0	0	0	0	0	1	0	0	0	0	0	6	4	8	3	1	4	0	2	1	0	0
1001	0	0	0	0	0	1	0	0	0	0	0	5	3	7	1	0	5	2	3	1	0	0
1008	0	0	0	0	0	2	0	0	0	0	0	5	3	7	1	0	5	1	1	2	0	0
1015	0	0	0	0	0	1	0	0	0	0	0	3	2	6	1	0	7	1	2	1	0	0
1022	0	0	0	0	0	1	0	0	0	0	0	3	2	5	0	0	7	1	1	2	0	0
1029	0	0	0	0	0	2	0	0	0	0	0	4	2	5	0	0	7	0	1	2	0	0
1105	0	0	0	0	0	1	0	0	0	0	0	4	2	5	0	0	8	2	2	1	0	0
1112	0	0	0	0	0	1	0	0	0	0	0	3	1	5	0	0	8	2	3	3	0	0
1119	0	0	0	0	0	1	0	0	0	0	0	5	3	6	0	0	8	2	2	3	0	0
1126	0	0	0	0	0	1	0	0	0	0	0	7	3	7	0	0	9	1	1	0	0	0
1204	0	0	0	0	0	1	0	0	0	0	0	7	3	6	0	0	8	1	1	0	0	0
1211	0	0	0	0	0	1	0	0	0	0	0	6	3	6	0	0	8	1	1	0	0	0
1218	0	0	0	0	0	1	0	0	0	0	0	6	3	6	0	0	8	1	1	0	0	0
1225	0	0	0	0	0	1	0	0	0	0	0	6	3	6	0	0	8	1	1	0	0	0

Figure 3.1.3.6 The weekly average concentration of sea ice and old ice in each segment of the deep water route in the Northwest Passage in 1991 (right) and 2012 (left)

(Canadian Ice Service, http://ice-glaces.ec.gc.ca)

Notes: ① A: Beaufort Sea – Alaska; B: Beaufort Sea – Mackenzie Bay; C: Beaufort Sea – Banks Island; D: Mouth of Amundsen Bay; E: Amundsen Bay; F: Viscount Melville Sound; G: West Barrow Strait; H: East Barrow Strait – Lancaster Sound; I: East Lancaster Sound; J: Baffin Bay; K: Davis Strait.

② Sea ice concentration: >8; 5-7; 1-3; <1. Number 0-9: old ice

3.1.3.7 The opening period of the south route of the Northwest Passage is mainly concentrated in the early to mid August to early October, and the total number of days is 50 ~ 60 days. The opening period of the north route of the Northwest Passage is mainly in September. The key area affecting the opening of the north route is M'Clure Strait and Viscount Melville Sound in the Northwest of Banks Island. The key affecting the north route is the ice conditions of Victoria Strait near King William Island, Peel Sound to the east of Prince of Wales Island and the north of Barrow Strait (see Figure 3.1.3.7 for ice resistance points).

3.1.3.8 The ice condition in the north route of the Northwest Passage is significantly heavier than that in the south route. The ice condition of the west is heavier than that of the east in the north route while the ice condition of the east is heavier than that of the west in the south route. According to the remotely sensed data of 1979～2012, it is analyzed that:

In July, the average sea ice concentration of the north route of the Northwest Passage is 6/10～8/10 while that of the south route is 5/10～7/10;

In August, the average sea ice concentration of the north route of the Northwest Passage is 5/10～6/10 while that of the south route is 3/10～5/10;

In September, the average sea ice concentration of the north route of the Northwest Passage is 3/10～6/10 while that of the south route is 2/10～5/10, where the ice condition is further relieved.

In October, the sea ice in the route increases rapidly. The north route increases faster than the south route. The sea ice concentration of the north route is 6/10～9/10 while that of the south route is 2/10～6/10.

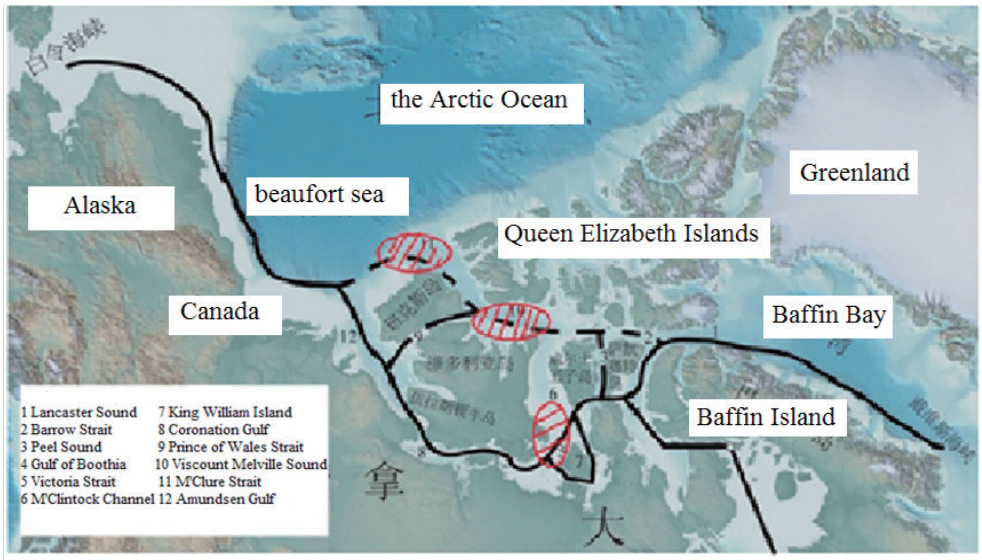


Figure 3.1.3.7 Routes and ice resistance points of the Northwest Passage

3.1.3.9 In recent years, the ice condition of the Northwest Passage generally has relieved. However, the multi-year ice from the Arctic Ocean enters the Northwest Passage due to the sea ice liquidity enhancement, which causes the changing sea ice in the passage and affects the navigation. The north route of the Northwest Passage is mostly deep water channel, but the ice condition is heavy and the opening time is short. The ice condition of the south route is relatively lighter and the opening time is longer. However, due to shoals and rocks, some channels are only about 10 meters deep, which seriously affects navigation. Moreover, the numerous large icebergs in Davis Strait and Baffin Bay in the east of the Northwest Passage cause difficulties in navigation.

3.1.3.10 According to the Zone/Date System of the Arctic Shipping Pollution Prevention Regulations (ASPPR), the Arctic waters are divided into sixteen Shipping Safety Control Zones, which specifies that ships of different ice classes can navigate in the Northwest Passage of the Arctic at different dates. According to the Regulations, the window period of the ship's entry into the Northwest Passage in X years is determined: the earliest and latest entry dates for Zone 1 is form mm/dd to mm/dd and the latest leaving date is mm/dd (see Appendix 4).

The Antarctic

3.1.3.11 In the Antarctic, the waters around the Antarctic continent form the sea ice belt. In winter, the sea ice belt extends far away to the Southern Ocean and the sea ice area is 50% bigger than sea ice cover area of the Arctic in winter. However, around 85% of the ice of the Antarctic continent ice belt melts in summer and some floes still exist. Some regions of the Antarctic are completely ice-free for less than a month throughout the year. The Antarctic landform and positions of China scientific research stations are shown in Figure 3.1.3.11.

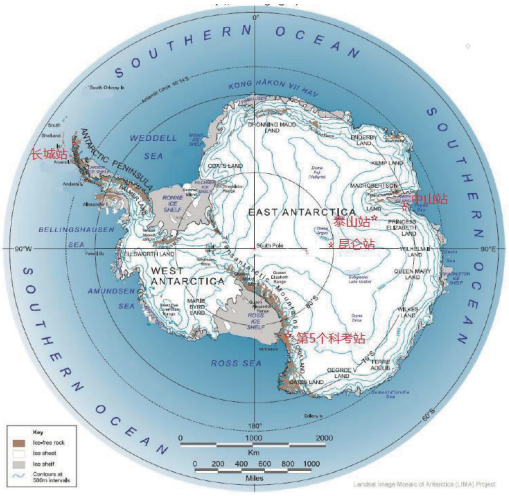
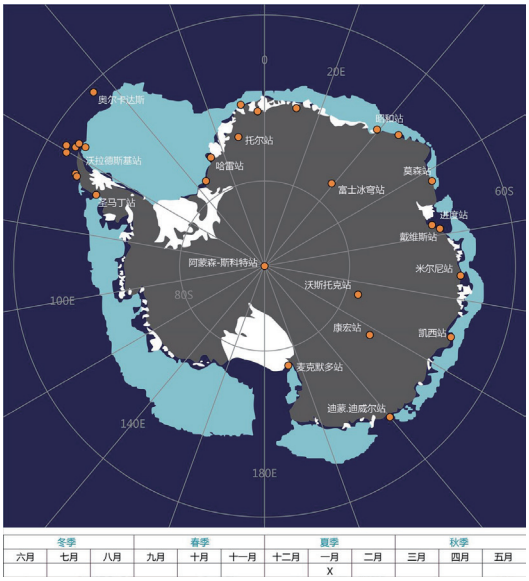
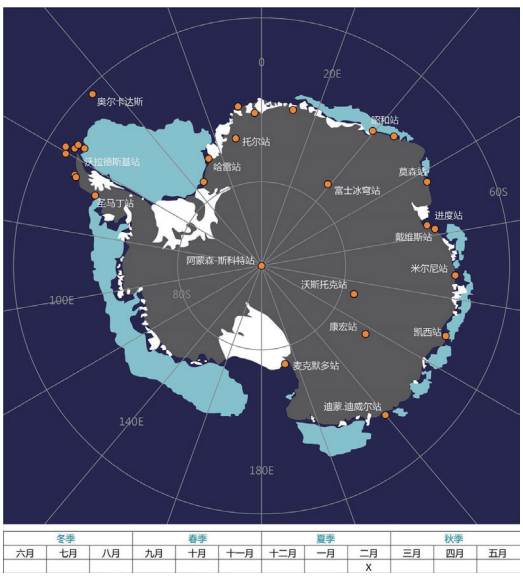


Figure 3.1.3.11 Antarctic landform and China scientific research stations

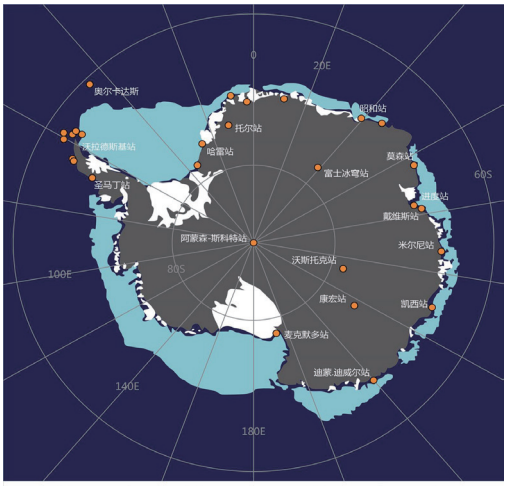
3.1.3.12 The average extents of sea ice in the Antarctic waters in each month are shown below with the sea ice concentration 2/10～10/10:



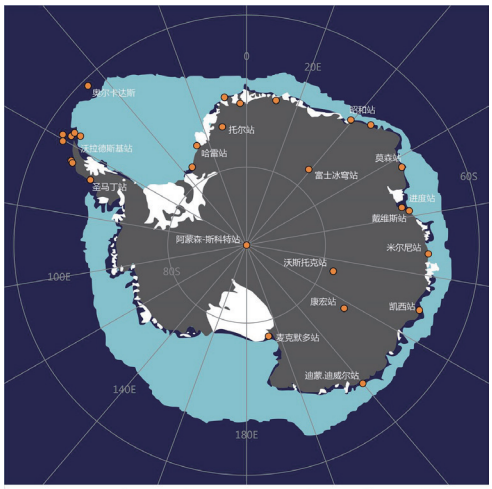
冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
							X				



冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
								X			



冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
									X		



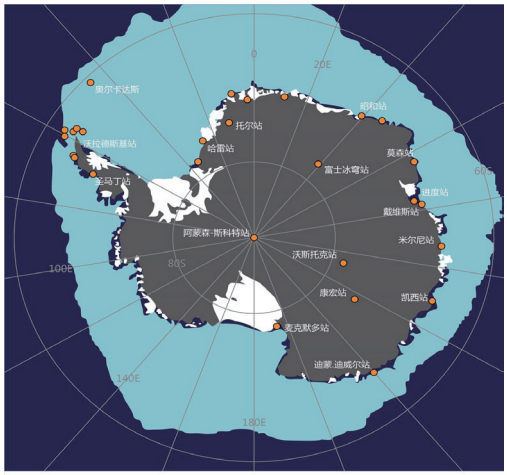
冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
										X	



冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
											X



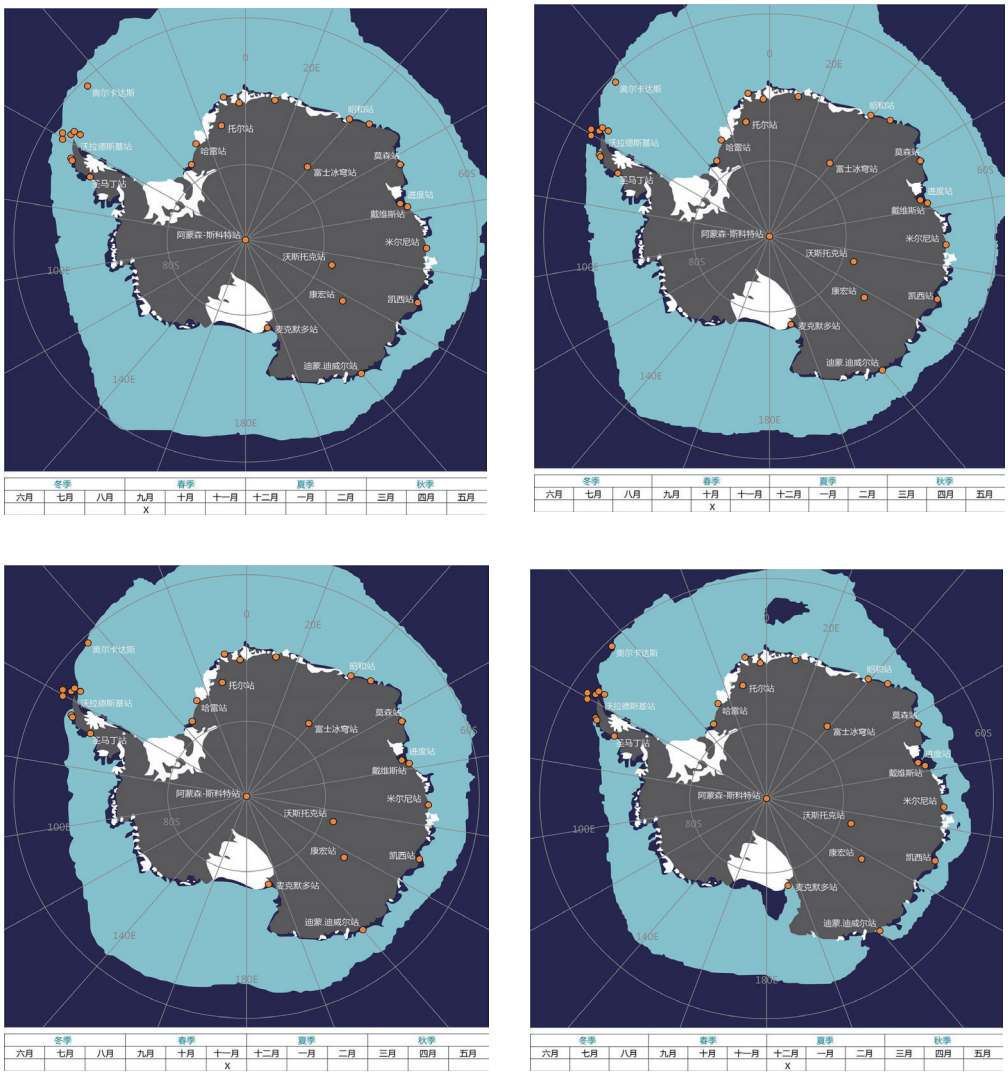
冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
X											



冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
	X										



冬季			春季			夏季			秋季		
六月	七月	八月	九月	十月	十一月	十二月	一月	二月	三月	四月	五月
		X									



3.1.3.13 The glacier ice originating from the Antarctic continent is the main danger of navigation in Antarctic waters.



Figure 3.1.3.13 Bergy bits and growlers

3.1.4 Avoiding dangerous temperature

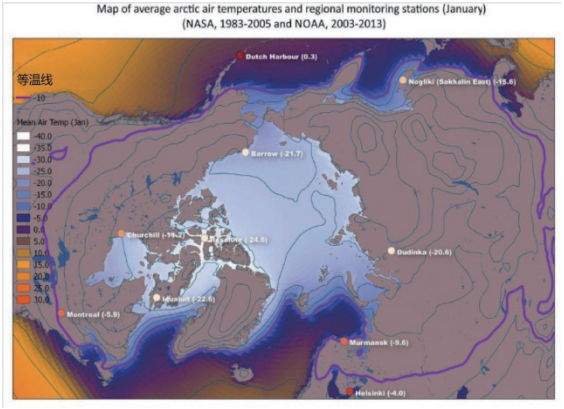
3.1.4.1 The polar regions has the most extreme and sensitive environment on the earth. The temperature in the winter is very low in sharp contrast to the temperature in the summer. The lowest temperatures recorded in the North Pole and South Pole are -67℃ and -89℃ respectively, creating harsh working environment for humankind.

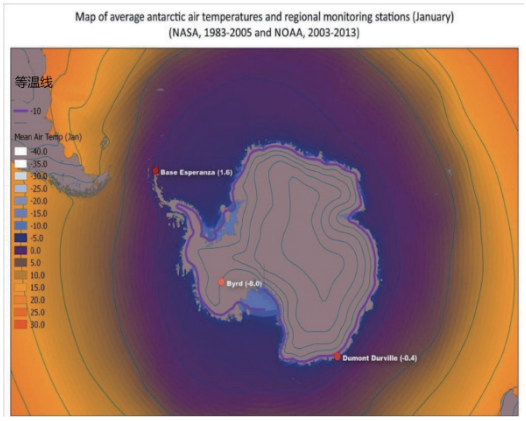
3.1.4.2 Monthly average temperature, -10℃ temperature contours and coastal monitoring stations in the Arctic and Antarctic Regions in January, April, July and October are indicated below. The data is from Appendix 1, IMO/SDC1/INF.12.

The Arctic Region

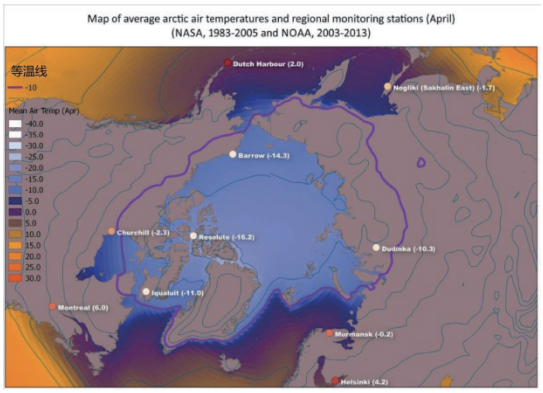
The Antarctic Region

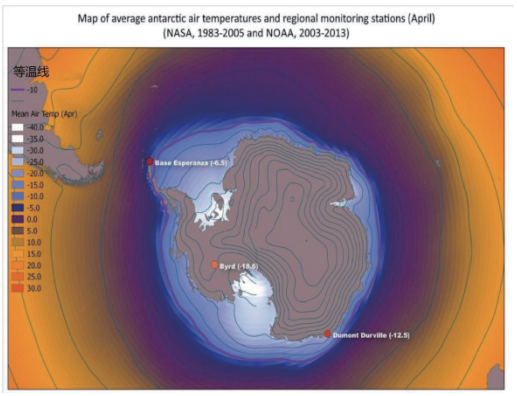
January



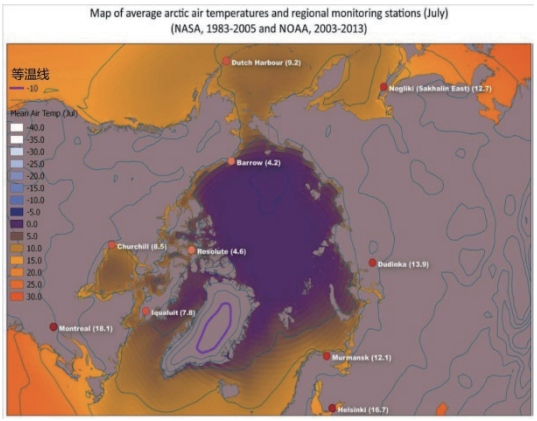


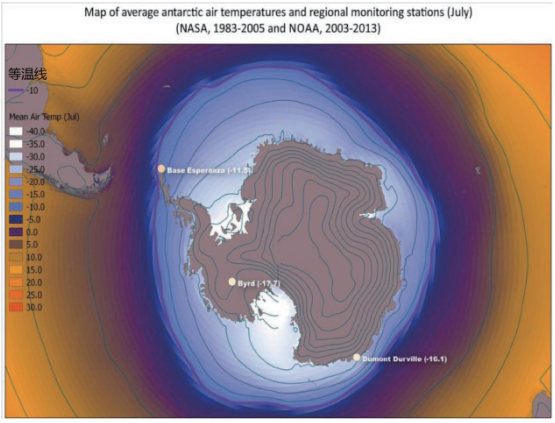
April



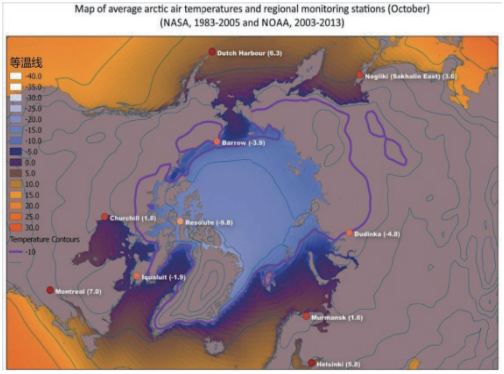


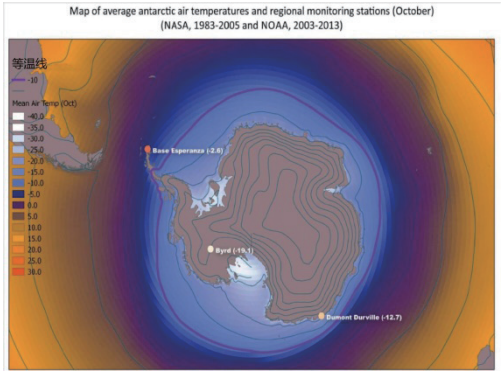
July





October





Northeast passage in the Arctic waters

3.1.4.3 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℃.

3.1.4.4 In the winter season of northeast passage, the Eurasia gradually freezes and the Pole of Cold is located in the East Siberia. Cold wind blows from the continent to the north, passing the coastline of the North Sea in Russia. The temperature of Novaya Zemlya is -15℃, gradually lowering eastwards. In the Laptev and East Siberia, the daily lowest temperature is around -35℃. The extreme lowest temperature of the waters in the northeast passage is between -40℃ and -50℃.

Northwest passage in the Arctic waters

3.1.4.5 The dates when the daily mean temperature drops below 0℃ and rises above 0℃ in the waters of the northwest passage are shown in Figures 3.1.4.5(a) and 3.1.4.5(b) respectively. Daily temperature in the navigational areas may be obtained from the weather forecasts issued by the Canadian Marine Communications and Traffic Services (MCTS) (issued four times every day, for detailed time of issuance and frequency look up the Radio Aids to Marine Navigation, Part 2).

3.1.4.6 In the northwest passage, the lowest temperature is -23℃ in February and the summer season is from May 15 to October 15.

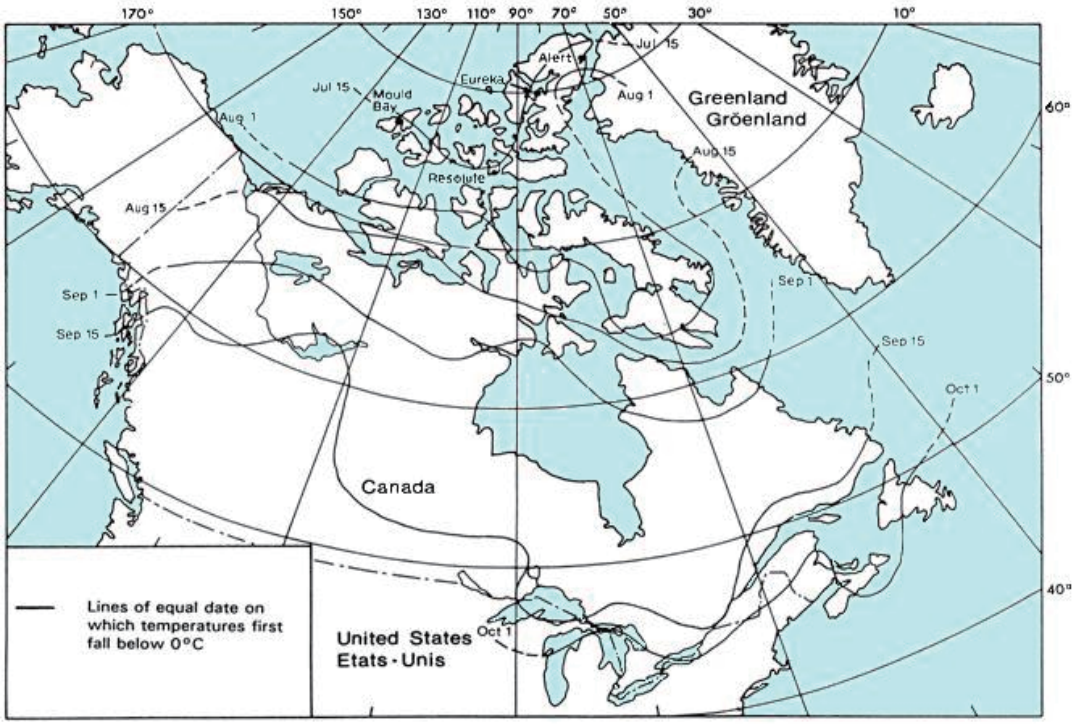


Figure 3.1.5.4(a) Dates when the daily mean temperature drops below 0℃

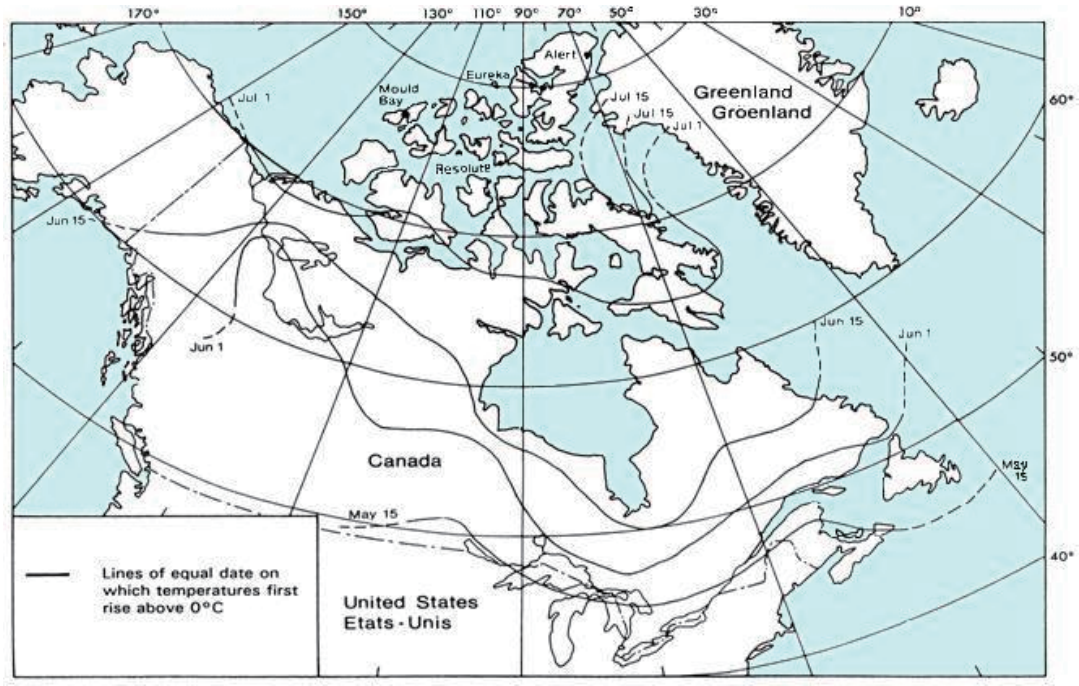


Figure3.1.5.4(b) Dates when the daily mean temperature rises above 0℃
(Source: Ice Navigation in Canadian Waters_Revised August 2012)

The Antarctic Region

3.1.4.7 The temperature in the Antarctic waters is between +1℃ and -30℃. See Figure 3.1.4.8 for the monthly temperature of different regions.

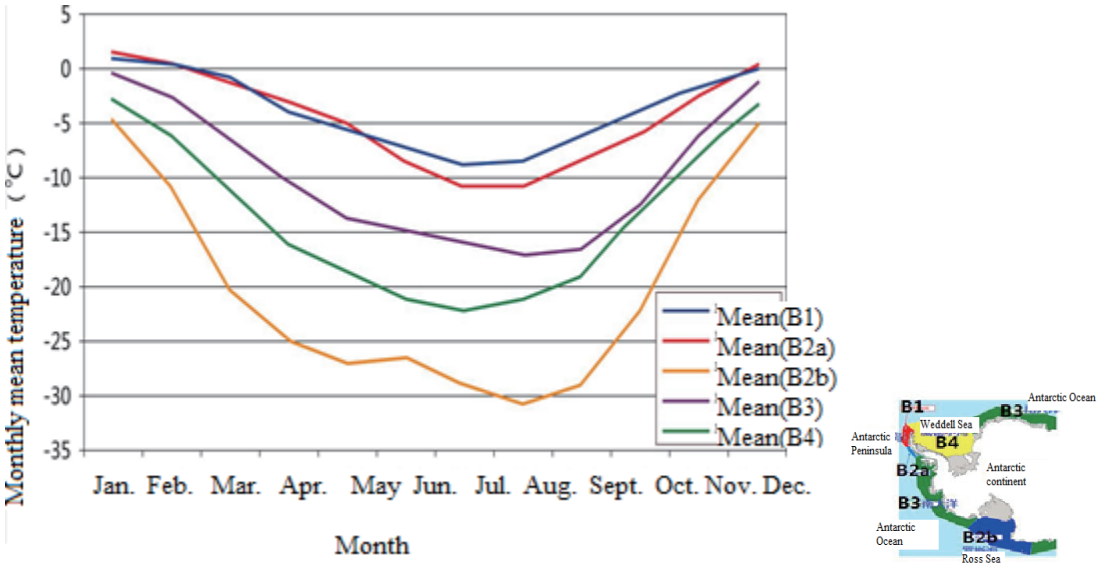


Figure 3.1.4.8 Monthly mean temperature in the Antarctic waters

3.1.5 Avoiding dangerous gale

Northeast passage in the Arctic waters

3.1.5.1 The primary disastrous weather system in the northeast passage in the Arctic waters is the extratropical and polar cyclones, which occur frequently in the Bering Strait, Barents Sea and Norwegian Sea. In the summer the extratropical and polar cyclones are low in strength and normally will not cause adverse weather and sea conditions. However, after cyclones the north wind will move the sea ice southwards, affecting ships navigating in the northeast passage. In the summer, both the wind and the wave in the Arctic Ocean are not strong, affecting navigation only slightly. With the warming of the weather, the iceless water in the Arctic Ocean will expand continuously and strong wind and current will increase continuously.

3.1.5.2 Local strong wind may occur in some regions due to the topography, which the mariners should pay attention to. Local wind mainly include the following two types: (1) funneling increases the wind speed, such as strong wind in Vilkitskogo Strait and Dmitri Laptev Strait; (2) katabatic wind (fall wind) occurs around some islands, particularly around Novaya Zemlya; (3) the waters near Novaya Zemlya are affected by katabatic wind and force 8 or even force 10 and above gale may occur locally.

Northwest passage in the Arctic waters

3.1.5.3 Wind in areas north of the Arctic Circle is affected by seasonal changes of air pressure in Siberia and North Alaska. In summer the prevailing wind direction is from east to northeast However, in the western part of the sea area the wind turns from south to southwest. In winter the prevailing wind direction is from east to northeast. However, each year witnesses significant changes. In the area between 50°N and 60°N, the wind direction is changeable in winter. In the western sea area the northeast wind is relatively strong while in the eastern sea area the south wind is relatively strong. The wind direction is also changeable in summer. In the western sea area the southwest wind is relatively strong while in the eastern sea area the west wind is relatively strong.

3.1.5.4 In the regions around the Arctic archipelago and Greenland, the prevailing wind direction is northwest while southeast wind and northwest wind are of the same frequency in the Beaufort Sea. In the side close to the Greenland of the Baffin Bay and Davis Strait the prevailing wind direction is northwest and southeast wind while in the side close to Canada the prevailing wind direction is northwest.

The Antarctic Region

3.1.5.5 To the south of the subtropical high in the Southern Hemisphere, around 40°S to 60°S, there is a low pressure belt around the earth. The prevailing wind direction is west all year round. Consequently the belt is also named the Roaring Forties. In the westerly belt, cyclones occur very frequently. One cyclone passes every two or three days. Strong cyclones, in particular, bring strong wind and snowstorm as well as huge waves more than 10 m high.

3.1.5.6 In addition, in the westerly belt force 6 to 7 westerly and swells of 4 to 5 m are present all year round. In the latitude band around 45°S to 58°S, there are on average more than 7 days monthly when the force 7 and above wind is present.

3.1.6 Navigation duration and endurance ability

3.1.6.1 The master is to determine supply quantities of fuel oil, freshwater and materials when developing the voyage plan based on navigation distance, mode, anticipated speed in conjunction with the following factors to ensure safe allowance:

(1) during icebreaker piloting, the ship is not sailing at the same speed;

(2) expected ship speed in the ice region;

(3) deviations in course due to adverse weather and ice conditions;

(4) no docking during the voyage and difficulty of bunkering fuel oil;

In particular the followings are to be considered:

(5) the actual ice condition is more severe than the forecast condition so that the navigation duration is increased;

(6) the longest anticipated duration waiting for salvage (5 days).

3.1.6.2 The master is to arrange for the supply of fuel oil, freshwater and materials before entering the polar waters and make arrangement in the voyage plan.

3.1.7 Human resources management

3.1.7.1 As the ship may collide with ice floes when navigating in ice-covered waters, the master is to arrange extra lookout based on the actual working conditions of the crew when sailing in or near the ice region.

3.1.7.2 When the ship sails in the ice region, the master is to consider the following personnel arrangement so as to avoid work fatigue during operation in ice:

(1) when the ship is escorted by an icebreaker and/or guided by an ice navigator, two steering mariners with ice region experience are to be arranged for each shift;

(2) when the ship sails independently, two officers in charge of a navigational watch and mariners with ice region experience are to be arranged for each shift;

(3) arrange personnel on duty in the engine room to operate machinery in the engine room and wash sea suctions;

(4) when the ship is sailing in the ice region, the master is to be on duty or monitor at the bridge.

3.1.7.3 The master is to determine whether to apply for an ice navigator as well as the location and time for extra lookout in the voyage plan in advance.

3.1.7.4 As ice navigation may face many unexpected difficulties and risks, the company and the ship must pay high attention and raise awareness, hope for the best and prepare for the worst when carrying out safe navigation in the ice region. The major preparations are as follows:

(1) adjust draft and trim so that the propellers are kept more than 1.5m underwater;

(2) ensure normal function of all equipment and systems (main engine sea water cooling system, boiler, windlass, etc.);

(3) ensure the integrity of watertight equipment. The bulkheads of cargo holds, oil tanks and water tanks are to be intact without leakage, and the ventilation pipes and sounding pipes are to be without damages. The piping valves of the double bottom are to be in normal condition. The hatch covers, manhole covers and watertight doors are to be watertight;

(4) prevent pipelines from rupture due to freezing;

(5) personnel are to take anti-cold measures.

Section 2 Arrangements for Receiving Forecasts of Environmental Conditions

3.2.1 General

3.2.1.1 When a ship navigates in polar waters, the master and the officer in charge of a navigational watch are to pay close attention to the environmental conditions of the planned routes. This Section sets out the means and frequency of receiving ship's environmental condition forecasts and real-time information as well as the formats of such information. The information is to include forecasts that will identify weather and ice patterns/regimes that could expose the ship to adverse conditions in the ship's navigation areas and/or intended navigation areas.

3.2.1.2 The company and the master are to evaluate changes in ice regimes and weather information in a timely manner, and if necessary, increase the information update frequency to provide enough advance notice so that the ship can take refuge or use other methods of avoiding the hazard if the conditions are forecast to exceed its capabilities.

3.2.1.3 The meteorological bureaus and/or ice region service agencies of relevant countries often issue weather forecasts, sea ice regimes and forecasts (including edge positions of ice regions and their movement forecasts, melting or forming of sea ice, etc.) by radio station, radio fax (meteorological fax images), telegraph, NAVTEX, internet, etc., and provide information such as the latest and fullest sea ice coverage real-time satellite cloud atlas and ice images. The master is to receive or hear meteorological and ice regime forecasts on time via onboard communication equipment according to the publication time provided by relevant route guidelines.

3.2.1.4 When means of receiving weather information and ice regimes onboard are limited, or the quality of the received information is not good:

(1) the company and the master can directly contact or visit website of relevant service agencies, see Appendix 2, and download the required history and latest ice image data and carry out analysis; and/or

(2) the company arranges land-based support information providers (such as meteorological pilot companies, national marine environment forecast centers) to provide effectively filtered and analyzed relevant information to the ship, reducing demands on the ship's communications systems.

3.2.2 Ice information

3.2.2.1 Receiving ice regime forecasts

Means of obtaining ice information onboard depends on the capability of the ship's communication equipment and the ice information analytical capability of the master/officer in charge of a navigational watch. Ice information may be received by onboard communication equipment, analyzed and provided by the company, provided by entrusted land-based professional service agencies. For ships rarely engaged in voyages in polar waters, given factors such as the limitations of onboard communication equipment and communication cost, providing effectively filtered information by the company and/or entrusted land-based professional service agencies is adopted. Consequently, this paragraph describes means and frequency of ice information provision based on the actual arrangement for ice regime forecast provision as well as the formats of such information.

3.2.2.2 The planning of ship's intended polar water operations is to be based on evaluation and analysis of historical data of ice and sea climate conditions in appropriate periods relating to the following aspects:

(1) navigation area;

(2) intended operation season (time in a year);

(3) availability of operation support (ice management, ice breaker escort, ice region piloting);

(4) operation synopsis: rare or periodical operation;

(5) relevant regulations of IMO, coastal states and flag states;

(6) ice region navigation system, guidelines and recommendations.

3.2.2.3 For ships operating in polar waters for long term, the company and the master are to grasp and understand the ice region features and the possibility that ice regimes are changing every year. As a result, the statistic range for ice regimes is to cover appropriate time cycle suitable for evaluating possible effects, and be updated per voyage if possible.

3.2.2.4 When evaluating data on ice charts published by different agencies, the company and the master are to pay attention to the slight variations in data representation. Symbols on charts published by the Northern American agencies, such as National Ice Center (NIC)(US) and Canadian Ice Service(CIS), use sea ice terminology definition and sea ice parameter code as well as representation standards on ice charts specified in the list of sea ice terminology published by World Meteorological Organization(WMO)(WMO No.259)(available at www.aari.nw.ru/gdsidb/XML/wmo_259.php), and use Egg Code including letters and numerical symbols.

3.2.2.5 Although Russia uses also standard terminologies of WMO, it seems that ice charts provided by Russia are different from those provided by other agencies, mainly due to round symbols used to describe pack ice dimension. The same ice regime is represented by different codes and symbols.

3.2.2.6 No matter which code is used, the company's sea service supervision manager and personnel related to ship's ice operation such as the master and the officer in charge of a navigational watch are to have training in understanding, using and correctly interpreting data marked on ice charts so as to ensure that they are familiar with the codes in forecasts of specific areas.

3.2.3 Real-time detection of ice conditions

3.2.3.1 When the ship sails near ice or operates in it, the officer in charge of a navigational watch is not only to look out carefully to avoid collision with dangerous ice such as icebergs, but also to use auxiliary equipment such as searchlights, telescopes and radars to detect dangerous ice at close distance, in particular bergy bits and old ice floes.

3.2.3.2 Radar is the most effective equipment for ice detection. However, in different sea and weather conditions, the radar's capability of detecting floating ice of different characteristics has certain limitations. In actual application, the officer in charge of a navigational watch is to differentiate carefully and avoid over-confidence. In summary, do not rely solely on radar to detect ice, particularly glacier ice. When the radar is used to identify floating ice, the operation and setting of the radar are to comply with the following requirements:

(1) When the ship sails independently, 10-centimeter S-band radar and 3-centimeter X-band radar are to be activated simultaneously. S-band radar is used to detect ice targets from a longer distance with its range set at 12 or 24 nautical miles; X-band radar is used to detect ice targets from a shorter distance with its range set at 3 or 6 nautical miles.

(2) In high pack, fast flow or smooth pack ice, X-band radar is more suitable for finding and tracking ice thanks to its stronger target identification capability.

(3) When detecting ice presence in open water, S-band radar has better sea wave suppressing effect and iceberg recognition result.

(4) During icebreaker escort, X-band and S-band radars are to be activated to show the images ahead and behind respectively at the same time.

(5) Radars set according to Table 3.2.3.2 can operate smoothly.

Table of Contrast for Radar Application **Table 3.2.3.2**

Average ship speed	Radar	Wavelength	Scan range (nautical mile)	Whether shown eccentrically
8～13 knots	X	Short wave	1～5	Yes
	S	Short wave	6	Yes
Over 14 knots	X	Short wave	3	Yes
	S	Short wave	12	Where necessary

(6) cautions for radar monitoring ice: just because there are no targets in view does not mean that there is no ice around; when ship navigates near the expected pack ice, the possibility of radar detecting ice may be greatly reduced due to the blind zone.

3.2.3.3 While recognizing the limitations of radars in application, it is recommended to use the enhanced radar, if fitted, in so much as practical. In the enhanced radar, the coastline is more clearly defined; icebergs are visible at greater distances; ice features are more easily identified.

3.2.3.4 The key points for radar image interpretations for floating ice:

(1) iceberg detection

Depending upon their size, aspect and attitude, icebergs may be detected at ranges between 4 and 15 nautical miles. Detection ranges will diminish in fog, rain, and other conditions affecting the attenuation of radar return.

Iceberg radar targets will sometimes cause a “radar shadow” on the far side, in which other targets will not show. Icebergs may not appear as clearly defined targets but the sector of the radar display directly behind the iceberg may be free of clutter. A large iceberg with a long and gently sloping aspect may not provide enough reflective surfaces to show at all on radar, so it is never to be assumed that just because there are no targets in view there are no icebergs around.

As the vessel gets closer to the iceberg, the size of the radar target reduces and may in fact disappear when very close to the iceberg. For this reason it is important to set alarm, until the point of nearest approach has passed.

(2) bergy bits detection

Pieces of ice break off, or calve, from an iceberg. The larger pieces are known as bergy bits, and the smaller pieces are known as growlers. Whereas the iceberg moves in a direction that is primarily the result of current because of its large keel area, the growlers and bergy bits are primarily wind driven, and will stream to leeward of the iceberg. While this is the general case, the effects of strong tidal currents may alter this pattern.

The differentiation of bergy bits (in waters where they are present) from open water or from a smooth first-year ice cover is relatively easy with radar, if the height of the bergy bit is sufficient. The radar display is to be checked carefully for radar shadows which may identify bergy bits with less height differential, or when the ice or water background is more cluttered.

Detection of bergy bits by radar is difficult in pack ice, especially if there is any rafting, ridging, or hummocks.

(3) growlers detection

Growlers, because of their low freeboard and smooth relief, are the most difficult form of glacial ice to detect (both visually and on radar) and, therefore, are the most hazardous form of ice. In open or bergy water with good weather conditions visual detection of growlers is possible at two or three nautical miles from the vessel. In rough weather and heavy swells, a growler may remain submerged through the passage of two or more swells passing over it, making detection by any method even more difficult. Detection (on radar or visually) can be as little as 0.5 nautical miles from the vessel, if at all. It sometimes helps to sight a growler visually then tune the radar for maximum return.

For a growler in an ice cover, it may be possible to detect it visually in clear conditions (because it is often transparent, green, or dark in appearance), but it is often not possible to discriminate it from surrounding ice clutter on marine radar. As the exact location of each growler cannot be identified for certain amongst ice floes, care must be taken to determine a safe speed through the ice-covered area when navigating by radar.

In summary, growlers are almost impossible to detect by radar. They pose an immense threat to ships. Constant visual and radar monitoring must be maintained in any area where growlers are expected.

(4) old ice floes detection

Detection of old ice floes is primarily visual, because differentiation between first-year and old ice on marine radar is not possible. Travel through old ice can be reduced by using ice analysis charts to avoid areas of high concentrations of old-ice. However, mariners must watch for old ice even in areas where it is not identified on ice charts. Old ice can be distinguished from first-year ice by more rounded and weathered surface, light blue colour, higher freeboard, and a well-defined system of melt-water channels. Visual identification is possible up to one to two nautical miles from the ship in good weather.

3.2.3.5 All possible effort must be made to minimize the chances of collision with ice in poor visibility either because of precipitation, fog or darkness, and the requirements of the regulation for preventing collisions at sea also apply. These efforts are to include:

(1) maintenance of a constant visual and radar lookout;

(2) use of searchlights at night (which may be counter-productive in fog or precipitation through reflected glare);

(3) reduction of speed and keeping navigation in a safe speed ;

(4) locating icebergs, bergy bits, and growlers on marine radar, and tracking of these targets on ARPA (Automatic Radar Plotting Aid);

(5) switching between ranges to optimize the radar for iceberg detection when navigating in pack ice.

3.2.3.6 Detecting icebergs and ice floes by sight/sound or other means

(1) Visual observation. Icebergs can be spotted at a greater distance in good visibility. At night searchlights help to spot icebergs and ice floes at a greater distance more clearly.

(2) In fog, with sunlight, icebergs are luminous white objects; without sunlight, icebergs appear to be black upon approaching. At clear moonless nights, icebergs can be spotted in one or two nautical miles as black or white objects. When there is moon and the moon is behind the observer, icebergs can be easily spotted with the help of moonlight. However, when the sky is cloudy or the moonlight appears on and off, it is rather difficult to spot icebergs.

(3) Thunderous sound when icebergs break or fall into sea after breakage can be used to identify the presence of icebergs.

(4) Ice blink (i.e. abnormal reflection of light in the sky) is a reliable indication that an ice field is in the vicinity.

(5) Abrupt moderation of the sea and swell occur when approaching an ice field from leeward.

(6) The onset of fog often indicates the presence of ice in the vicinity.

(7) If wild animals, such as walruses, seals and birds, are spotted far from the land, there may be ice in the vicinity.

(8) When the AIS signal is used to identify icebergs or ice floes, echo on the radar screen without AIS triangular symbol is a possible sign of icebergs.

(9) Water sky. Dark patches on low clouds or a dark bank on a cloud at high altitude indicate disappearance of icebergs or ice floes and are signs of open water in the immediate vicinity.

3.2.4 Hydrography, meteorology

3.2.4.1 *The master is to collect hydrographic, meteorological information from various channels, including:*

(1) *looking up relevant hydrographic, meteorological information of polar waters and knowing about seasonal climate features including current, rainfall, visibility and fog, etc.*;

(2) *receiving meteorological information by ship's communication equipment (radio station, meteorological fax, telegraph, NAVTEX, telephone and telex) during navigation, carefully signed and read by personnel in charge of a navigational watch*;

(3) *inquiring ships nearby through VHF on meteorological information in relevant sea waters during sea navigation*;

(4) *In case of abnormal meteorological changes, the personnel in charge of ship operation (the master) are to ask for additional ice and meteorological information from the national marine environment forecast center and/or meteorological pilot company*.

Section 3 Verification of Hydrographic, Meteorological and Navigational Information

3.3.1 Objective

3.3.1.1 This Section provides limitations and usage guidance of hydrographic, meteorological and navigational information of polar waters.

3.3.2 Sea chart usage

3.3.2.1 The master and the officer in charge of a navigational watch must realize many sea charts in polar waters, including paper charts, Electronic Navigational Charts (ENC) and Raster Navigational Charts (RNC), are of poor quality and have the following limitations:

(1) such charts contain areas that are inadequately surveyed;

(2) they are based on old surveys where only spot soundings were collected;

(3) data was collected only along a single track.

3.3.2.2 During polar navigation, the master is to pay attention to different projections used and the accuracy of the surveys as well as chart horizontal basis difference.

3.3.2.3 The master and the officer in charge of a navigational watch are to pay attention to data accuracy of new charts. When polar charts are used, the following precautions are to be taken:

- checking the projection and understanding its limitations;
- checking the date of the hydrographic survey and reviewing the Source Classification Diagram;
- paying attention to the range and bearing for usage and positions of transfer from chart to chart;
- checking for evidence of reconnaissance soundings;
- using the largest scale chart available;
- checking for the method of measuring distances and taking bearings; and
- updating charts and nautical publications by checking for Notices to Mariners, Notices to Shipping and any other sources for chart corrections.
- RNC is one form of ENC and generally does not add accuracy.

3.3.3 Navigation operation

3.3.3.1 Many areas covered by polar water charts may not be suitable for coastal navigation currently. The master and the officer in charge of a navigational watch are to proceed with due caution and prudent seamanship when navigating in polar zones especially in poorly charted areas or when planning voyages along new routes, and are to:

(1) cautiously and carefully plan route and course, monitor during navigation, and take into consideration the information and guidance of relevant navigational publications;

(2) familiarize themselves with the availability and accuracy of hydrographic survey information and chart information in the ship's intended operation area;

(3) constantly check GPS and radar positioning information, particularly potential chart datum difference of GPS positioning;

(4) plan the route/course through areas marked on charts and known shoals as the goal and follow the set route/course at any possible time.

3.3.3.2 The master is to cautiously plan any deviation from the planned course. For example, when navigating on the continental shelf, the master is to:

(1) activate and monitor echo detector to detect signs of any unexpected change in water depth, especially when the sea chart is not based on comprehensive survey and charting of the sea bottom; and

(2) make use of all opportunities to use independent information source and cross-reference ship's position, such as radar and satellite positioning.

3.3.3.3 The polar waters lack accurate hydrographic, meteorological and navigational information. The master is to check the information reviewed and received to make sure the hydrographic, meteorological and navigational information is updated to the latest version.

Section 4 Operation of Special Equipment

3.4.1 Objectives

3.4.1.1 This Section describes operational requirements and points to be paid attention to when the ship uses the following special equipment in its intended voyage in polar waters to ensure safe navigation. *For detailed operation procedures of each piece of equipment, please refer to the equipment operation instructions or operation instructions in SMS documents of the ship company*.

(1) navigational system: sounding devices (two sounding devices or a device with two separate independent transducers), radars, GNSS compass, 360°narrow-beam search lights;

(2) communication system: Iridium satellite system, air-borne VHF, GMDSS A4 area.

3.4.2 Sounding devices

3.4.2.1 When the ship sails in the following area, the echo-sounders onboard are to be run so as to record any rocks or shoals previously undetected to prevent grounding:

(1) when in areas of old or sparse hydrographic survey data,

(2) in areas of the high altitudes that are well surveyed, as ship traffic in the area is sparse and many of the routes will not have been sailed previously by deep-draft ships.

3.4.2.2 False echoes may be given by ice passing underneath the echo sounder or by the wash when backing or ramming in ice. Consequently, in heavy concentrations of ice cover, the echo sounder may record multiple returns so that it is impossible to distinguish which one represents the actual depth beneath the keel. When soundings are lost in this manner, it may help to stop the ship in the ice until a stable echo can be discerned amongst the random spurious echoes.

3.4.3 Radars

3.4.3.1 Weather conditions may cause ducting, which is the bending of the radar beam because of a decline in moisture content in the atmosphere. This effect may shorten or lengthen target detection ranges, depending on the severity and direction of the bending.

3.4.4 GNSS compasses

3.4.4.1 Before entering waters of high altitudes, the master is to confirm that the GNSS compass works properly.

3.4.4.2 When using the GNSS compass, the master is to frequently cross-check with electric gyrocompass and pay attention to the accuracy of the satellite positioning at the same time.

3.4.5 Search lights

3.4.5.1 Ships are to be equipped with narrow-beam search lights to provide lighting over an arc of 360 degress under icing effect in polar waters.

3.4.5.2 Searchlights are to be turned on to aid in visibility during night navigation or in poor visibility or with icebreaker support to ensure safe navigation.

3.4.6 Iridium satellite system

3.4.6.1 Due to poor coverage of the maritime satellites at the Antarctic pole and the Arctic pole, normal communication cannot be maintained in high-altitude waters. Iridium system is the satellite communication system that can achieve communication in the polar areas currently.

3.4.7 121.5 and 123.1 MHz air-borne VHF

3.4.7.1 During rescue operations, the ship can have two-way on-site voice communications with aircraft on 121.5 and 123.1 MHz by VHF.

3.4.8 Electronic charts

3.4.8.1 The master is to note that as the horizontal datum on which the electronic chart is based is different, there may be positioning difference on the electronic chart; the master is always to cross-reference positions plotted on electronic charts with the largest possible scale paper charts of the same area, and update the latest electronic chart data periodically. Where USB ports are provided, ICE CHART data may be imported as reference to guarantee safe navigation.

Section 5 Procedures to Maintain Equipment and System Functionality

3.5.1 Objectives

3.5.1.1 This Section specifies anti-freezing, anti-cold climate operation measures to ensure that when the ship:

(1) sails in water with ice, the seawater system is prevented from suctioning brash ice;

(2) sails in area and season where icing is possible, the icing effects on the ship's stability and equipment functions are prevented or mitigated;

(3) sails in low-temperature areas and seasons, the low-temperature effects on the functions of systems and equipment are prevented or eliminated.

3.5.1.2 Onboard personnel of all levels are to take anti-freezing, anti-cold climate measures or equivalents for their responsible scope, equipment and systems in advance according to meteorological forecasts and ice conditions to ensure safe navigation.

3.5.2 Icing prevention and de-icing

3.5.2.1 When the temperature drops to 0℃ or lower, the crew are to check icing conditions of key systems and equipment according to the cycles specified in Table 3.5.2.1 below and remove ice in a timely manner so as to maintain their intended functions and ensure that the icing conditions do not exceed the maximum icing density 【XX】 in the stability information. The frequency may be increased where necessary.

Table 3.5.2.1

No.	Area and equipment	Measures	Cycle
1	**Deck area**		
1.1	Deck and pipings	Remove ice and snow; avoid quick accumulation of ice and snow onboard due to seawater splashing and adverse weather to ensure crew safety during activity and ship stability	periodically
1.2	Access	● When it is rainy or snowy, check and remove ice and snow accumulation; apply antifreeze (glycol) on the deck plating in case of ice. ● Clear deck drain scuppers by steam, compressed air and/or antifreeze. ● When the temperature drops to the anticipated icing temperature and icing occurs, activate heating devices for passageways (activation at 5℃), and arrange safety ropes where necessary	every day
1.3	Evacuation passages	Check and maintain passages free of obstacles and snow and ice accumulation and ensure clear marks	once/day
1.4	Emergency exits	Check seals, hinges, latches and locks and apply antifreeze	before the temperature drops to 0℃
		Check and maintain the entrance and exit free of litters. Remove snow and ice accumulation with shovel, wood stick, steam and/or compressed air	once/day
		Use antifreeze in advance	every month
1.5	External emergency lights	Check to be free of ice and snow and readily operable	below 0℃, every day
2	**Machinery installations and systems**		
2.1	Deck machinery	Monitor metrological forecasts. When the forecast temperature is close to the minimum anticipated temperature (MAT), operate with no load and activate oil heater of the hydraulic system	periodically
2.2	Fire-fighting appliances	De-ice door gaskets	every month
		Remove ice and snow accumulation on the appliances by means of steam or compressed air so that the appliances are readily operable	every month
		Drain the fire hoses and dry them immediately after use or store them in frost-free positions	while in use
		Drain the fire main; check all fire dampers exposed to the open deck and carry out functional test; check and remove ice and snow accumulation on all external fire-fighting appliances	0℃ or below, every day
		Portable fire extinguishers of the windlass control station are stored in the operation room	-15℃ or lower
2.3	Tanks	Check the piping system and ventilation conditions	before loading/ unloading
2.4	External alarms	Check all external alarms	below 0℃, every day
2.5	Helicopter deck	Drain the foam monitor; apply antifreeze on the helicopter deck	after operation
		Apply antifreeze on deck boundary lights and reflectors	every month
		Check and verify that heat tracing of the drain scupper is in the working condition	every day
		Check and remove litter, ice and snow accumulation	before landing

No.	Area and equipment	Measures	Cycle
3	**Safety system**		
3.1	Survival crafts/ launching station	Check and arrange de-icing equipment near the launching station. The equipment is to be readily available	below 0℃
		Remove ice and snow accumulation on the securing appliances of the box for storage of lifejackets and immersion suits	every day
		Apply antifreeze on deck plating (for example, glycol/water mixture or salt)	below 0℃
		Check ice and snow accumulation on the launching station of the lifeboats and remove ice and snow on the deck, grating, rails, rope ladders, box for lifejackets and immersion suits	every day
3.2	Lifeboats and rescue boats	Activate the lifeboat heater inside the lifeboat	below 0℃
		Check the hook, latch and hinge and apply antifreeze	every day
		Check radios with batteries	twice every day
		Check lifeboats	twice every day
		Check the performance of the engine heater, lifeboat heating fan and battery charger	every day
		Operate the lifeboat engine up to the operation temperature	every day
		Check the fuel oil of the lifeboat engine is turned into churn or wax	every day
		Check viscosity of the lifeboat engine fuel oil and hydraulic (activation) oil, and change oil suitable for PST	before PST
3.3	Launching appliances of lifeboats and rescue boats	Check the hook, latch and hydraulic release joint and apply antifreeze	every day
		Check ice and snow accumulation on the brake wire and block and apply grease to lubricate where necessary	every day
		Check ice and snow accumulation on the launching appliances of the lifeboat. The winch is to be kept free of ice and snow and in operation	every day
		Check the hook, latch and hydraulic release joint and apply antifreeze	every month
		Check and remove ice and snow accumulation on the launching appliances of the rescue boat	three times every day
		Remove ice on the quick-release hook of the rescue boat and apply antifreeze	every month
3.4	Liferafts	Check and remove ice and snow accumulation on latches/hydraulic release joints	every day
		Apply antifreeze	every month
3.5	Escape slide and liferaft station	The muster and embarkation station is provided with readily available de-icing equipment. Remove ice and snow on deck rails, rafts and launching appliances	below 0℃
		Apply antifreeze on deck plating to prevent ice and snow accumulation	
		Check ice and snow accumulation of the liferaft launching station	twice every day
4	**Personnel safety equipment**		
4.1	Immersion suits	Check the humidity of the immersion suits stored in the muster station and dry these suits	every day
4.2	Lifejackets	Keep the non-moist condition when in the storage box	after usage

3.5.2.2 When the crew are de-icing, safety measures are to be taken, including:

(1) personnel are to wear cold protective clothing and antiskid shoes;

(2) personnel are to avoid working under adverse weather and the working hours are to be shortened;

(3) when removing ice from structures above (mast or covering), use some cushion to avoid the deck below from being broken through, such as wooden cargo pallets or canvas cushion.

(4) when working on the deck, take care to avoid ice fallen from rigging and mast and wear safety helmet.

3.5.2.3 When the icing condition onboard is uncontrollable or reach the maximum icing density to guarantee ship's stability, the master is to take the emergency measures specified in Chapter 4 of the Guidelines in a timely manner.

3.5.3 Operation of seawater systems

3.5.3.1 When the ship navigates in waters where the seawater temperature is lower than 0℃, the top priority is to keep an effective cooling system. As the ingestion of strainers of seawater filters causes the flow to slow down, ice rapidly forms inside the strainers. As a result, all seawater filters must be cleaned.

3.5.3.2 The personnel on duty in the engine room are to be familiar with the position of seawater inlets as well as measures to prevent blockage of the seawater chest by ice. When the ship navigates in ice areas, lower seawater inlets are to be used.

3.5.3.3 The chief engineer is to ensure the heating installations for the cooling water seawater chest are in their best working efficiency. The steam heating system of the seawater chest is to be inspected regularly to confirm its good working order when the ship is navigating in waters with ice. Before the ship operating in ice or in low water temperatures, steam hoses are to be connected to the seawater inlets.

3.5.3.4 When the ship is provided with a recycling cooling system, and before the ship enters waters below 0℃, the chief engineer is to have the cooling water volume checked and the conditions of all valves and pumps verified. Before the ship enters the ice area, the chief engineer is to run the system.

3.5.3.5 When the ship sails in waters with a lot of brash ice, the personnel on duty in the engine room is to closely monitor the working condition and seawater inlet pressure of the seawater pump and clean the filters in case of abnormality.

3.5.4 Procedures for low temperature operations

3.5.4.1 When the air temperature drops to 0℃ or lower, the crew are to maintain and monitor key safety systems and equipment in accordance with Table 3.5.4.1 below to make sure that their functionality under low temperature is maintained.

(*The contents in Table 3.5.4.1 are for examples only. The format may be referenced. In practice such table is to be developed according to the actual conditions of the systems and equipment onboard as well as cold protective design. For details the ship's cold protective manual may be referenced*.)

Table 3.5.4.1

No.	equipment and systems	Measures to monitor and maintain	Timing
1	**Cargo handling and fuel bunkering systems**		
1.1	Ventilation of cargo tanks and fuel tanks	Overhaul the ventilation valves. Add canvas covering/ activate steam heating to prevent ventilation pipes affected by ice accumulation and check that canvas covering will not reduce the operation effectiveness of ventilation valves	before the temperature drops below 0℃
		Dismantle canvas covering. Check whether the pressure/ vacuum breaker is ingested with ice and whether deck drain scuppers are free of ingestion	before handling cargoes or bunkering fuel
		Check the pressure/vacuum breaker and add antifreeze and deck water seal to maintain circulation and prevent icing	before the temperature drops below 0℃
1.2	Transfer pipings	Cautiously inspect the integrity of pipings to guarantee the tightness	before use
		Drain the lines and keep the drain valve open. Keep the filling valve open	after operation
		Check the condensation point of the cargo/fuel carried to make sure whether the lines are blocked	after operation
1.3	Transfer and diving pumps	The engines and shafts of the pumps on the open deck are to be protected by canvas covering so as to avoid delays caused by de-icing	when not in use
1.4	Tank heating coils	Drain the lines and dry them by blowing air. Close the steam transfer pipes from the mains to avoid dead ends	when not in use
1.5	Tank operation	Add coverings above the tank measurement and sampling points as well as the pressure gauges on pipes to avoid ice accumulation	operate below 0℃
		Any oil/water trays are to be kept dry and the drain valve is to remain open so as to avoid icing	
2	**Ballast system and ballast tanks**		
2.1	Hydraulic ballast valve	Operate the valve to avoid icing/blockage due to ice	frequently
		Change low-temperature performance hydraulic oil	prolong the operation duration under PST
2.2	Ventilation pipes of ballast tanks	Use coverings to protect and monitor strictly. Dismantle the coverings before ballasting operations and de-ice	frequently
2.3	Ballast water	For systems with heating, measure water density in the ballast tank and change ballast water with high salinity	before entering cold climate
		Where the free surface calculation results of the ship's stability allows, the ballast water level is maintained at or lower than the sea level and avoid using high seawater suctions	when the ship sails under ballast
		Where the ballast water level is higher than the ship's waterline, operate the ballast water heating or bubbling system, where provided	before entering areas below 0℃
		Where the ship's stability and icebelt's depth permit, the lowest seawater suctions may be used. Regularly lower and refill ballast water to avoid icing of ballast water surface (*when not provided with ballast water heating installations*)	when the ship sails under ballast
3	**Deck operation and equipment**		

No.	equipment and systems	Measures to monitor and maintain	Timing
3.1.	Cofferdams, void spaces, chain lockers	Gauge the water level inside such spaces. Drain the water, if any, and gauge regularly to ensure these spaces are free of water. Protect the sounding pipes and vents in such spaces	before entering cold climate and when in cold climate
3.2	Cranes	Operate and test with no load (*ships operated under low temperature, e.g. offshore supply vessel*). Heating installations are provided in the operation room	before entering areas below 0℃
3.3	Hydraulic system and hydraulic pumps	The hydraulic driving system keeps the hydraulic oil circulating and ensure that the hydraulic system is maintained at the specified working temperature	below 0℃
		Machinery parts, such as winches, are to be lubricated regularly. Check the suitability of the temperature range/ viscosity of the oil specified by manufacturers	-10℃ or lower
		Hydraulic oil may be treated with additives	-10℃ or lower
		Change hydraulic oil of more suitable grade	close to PST
		The hydraulic system use PST-resistant hydraulic oil and operate with no load for at least 30 mins	before operation
3.4	Windlasses and winches	The control box and the operating stick are protected by cover	-10℃ or lower
		Check and confirm that they are in operable condition and have time to remove ice accumulation	sufficient time before arriving the anchoring position
		Use the windlass to move the mooring chain to confirm that it is not frozen in the chain pipe	
		Check and close the chain locker, flushing pipe and chain pipe	
3.5	Mooring chains and fibre ropes	Stored in spaces below the deck or protected by cover	below 0℃
3.6	Deck scuppers	The rubber side of the scupper plug is applied with petroleum jelly to prevent the plug from seizure during draining	below 0℃
3.7	Deck air system	Close the deck main air valve and empty the transfer line, especially the ends. Where it is necessary to supply air to the deck, use the air desiccant	below 0℃
4	**Machinery equipment**		
4.1	Engine room/machinery spaces	The engine room is prepared for the intended conditions and special consideration is to be given to the manning of the engine room	before entering cold climate
		Prepare additional heating equipment and take care not to form excessive condensate so as to eliminate the risks of personnel slippery or dripping to the electrical equipment	before entering cold climate
4.2	Fuel oil system	Run all the heating systems of the fuel oil tanks, sludge tanks, sludge overfill tanks and main engine circulation, sediment, service tanks. The fuel oil temperature is to be maintained at least 5℃ above the minimum transfer temperature specified by the fuel oil specification	below 0℃
		Replace HFO with MDO. Fill the fuel oil pipes with diesel oil instead of fuel oil to avoid oil freezing in the fuel oil pipe	close to PST

No.	equipment and systems	Measures to monitor and maintain	Timing
4.3	Tube oil system	Drain the oil in the system or change the tube oil to avoid free water or oil-water emulsification contamination	below 0℃
		Closely monitor the temperature of tube cooling water tank. When the temperature is close to 0℃, appropriate additives may be added or temporarily drain the tank	frequently
		Keep close monitoring to ensure that the stern tube seal is oil-tight	during ice breaking operation
4.4	Ventilation system	Turn on only one ventilator in the engine room to maintain appropriate ambient temperature in the machinery spaces	operating when in the cold areas
		Fans in spaces such as rudder room may stop operation and shut off fans to maintain appropriate ambient temperature	
		Regularly move the pneumatic and manual fans to ensure proper operation and avoid freezing/seizure	
4.5	Heating systems of pipes and machinery	Activate heat tracing and use it according to the calculated current, load and voltage specified in the instructions. Pay special attention to the applicability when using tracing band in dangerous areas	navigating in cold areas
4.6	Power generators	Monitor the fuel oil temperature of the diesel oil or gasoline power generators. Where the temperature is close to fuel oil cloud point, arrange local temporary heating	navigating in cold areas
4.7	Emergency power generators	Where electrical heating installation is provided, test regularly to ensure its effective operation. The external fans and fan door of the emergency power generator room remain closed. A notice indicating the condition of the fans and fan door is to be posted inside the emergency power generator room. The cooling water of the emergency power generator is to contain appropriate amount of antifreeze at all times	navigating in cold areas
4.8	Emergency battery and battery room	Provide indoor heater according to the exposed location to protect power supply to the emergency battery and communication equipment from the impacts of extreme low temperature. Plastic cover is to be used as a precaution	navigating in cold areas
4.9	Compressed air	Use dryer to avoid the general and/or instrument air system damaged by ice, causing air provision failure of the onboard instrument	below 0℃
4.10	Steering gear	The engine for the steering gear is to be readily operable to keep the oil warm	below 0℃
		Run the cabin heater used for the steering platform to ensure that the equipment is maintained at appropriate temperature	
4.11	Lubrication and oil	All equipment is to use lub oil and grease suitable for the intended temperature	below -10℃
4.12	Use of fuel oil	Focus on the applicability of the fuel oil condensation point for the operation condition to ensure suitable fuel oil grade recommended or suggested by the main engine manufacturer. If there are no diesel oil grades suitable for the auxiliary equipment under the intended temperature, mixed fuel oil may be used. Diesel oil may be mixed with kerosene to reduce the condensation point. Note that as kerosene increases in percentage, the lubrication performance of the mixed fuel oil will decrease. As a result, make sure that the flashpoint of the final mixed oil comply with the limits specified by IMO	areas below 0℃

No.	equipment and systems	Measures to monitor and maintain	Timing
5	**Life-saving appliances**		
5.1	Liferafts and hydrostatic pressure releaser	Run the heating installation to ensure the inside does not freeze, unless provided with approved test under PST	below -30℃
		Check the manual inflation pump placed in the warm spaces near the liferafts	
5.2	Launching appliances of survival crafts	Check that the brake release safety pin is moveable and can be pulled out	
5.3	Lifeboats	Regularly check the damaged condition of the lifeboat gel coat, paying special attention to the cracking between the gel coat and the fibre structure so that once cracking is detected, repair can be made in warm and dry climate and avoid icing and freezing after entering water in the cold climate, leading to severe damage of the boat structure	before entering cold climate
		Regularly check and maintain heat tracing device at the closed lifeboat door (such as installation) to ensure it is in its normal condition	below -30℃
		Successfully start the boat engine. All relevant personnel are familiar with the starting operation procedure of the boat engine under extreme cold conditions	below -30℃
		Add the starting frequency of the boat engine	below -30℃
		Where a cold starting pot is installed, add suitable cold starting oil according to the manufacturer's instructions. The oil is stored inside the boat	below -30℃
		Use bottom shell or space heater for lifeboat oil, if installed	below -30℃
		Ensure to use the suitable low-temperature diesel oil or gasoline grade to prevent waxing of the boat fuel oil system and avoid stating failure of the boat engine and increase reliability. When fuel oil grade is changed, change the oil inside the lifeboat oil box and fuel oil pipes and run the boat engine with the new fuel to ensure proper flushing and bunkering of the system	below -30℃
		Where the cooling water system of the lifeboat carries the water and can recycle the water, antifreeze is to be used to provide protection. If the system does not carry water, check there are no obstacles or contamination preventing the system from draining the water naturally	below 0℃
		The sprinkling system of the lifeboat, including the pump, is to be drained of water completely to avoid freezing of the sprinkling pump and avoid restraining the boat engine from starting due to seizure of the propeller shaft	below 0℃
5.4	Auxiliary life-saving appliances	As the immersion suit is so designed that the feet are not protected against the cold and the suit does not grip well, when wearing the immersion suit, personnel are to be careful not to slip or fall	When evacuated onto ice
		Lifebuoys are to be maintained so that they are not frozen at their stowed position and can be freely moved and used	below 0℃
		The release pins of lifebuoys/smoke buoys at bridge wings are to be greased to ensure that they are readily operable	below 0℃
		The EPIRBs are to be kept ice-free	below 0℃

No.	equipment and systems	Measures to monitor and maintain	Timing
5.5	Breathing apparatus	Compressed air/oxygen breathing or emergency apparatus are to be dealt with care. The main dangers include freezing of steam due to exhaled air from the user, which in turn causes freezing of the air intake and outtake valves as well as premature emptying of the cylinder or system malfunction. The low-temperature (below -4℃) impacts on the user's lungs are that delayed rescue operation cause freezing damages to the lung tissues	below 0℃
		When the air cylinders are refilled, check the air moisture provided by the compressor. The dew point of the breathing air is not to be warmer than -65℉	
5.6	Eye-wash stations	Temporarily close the eye-wash stations on the open deck and use the ones in the accommodation spaces	below 0℃
5.7	Safety helmets	Check and use safety helmets whose safety operation temperature ranges are specified by the manufacturer, and suitable warm helmet linings are to be provided	during operation in cold areas
6	**Fire-fighting systems and equipment**	**Fire-fighting equipment, apparatus, system and medium are to be protected from freezing and impacts of the anticipated lowest temperature of the voyage. Measures are to be taken to prevent clogging of the nozzles, pipes and valves of any fire-fighting system by impurities, corrosion or ice accumulation. The fire mains are to be provided with additional layer against freezing, drained or heat traced so as to avoid freezing**	**below 0**℃
6.1	Portable fire extinguishers	Refer to the information provided by the manufacturer. Check the performance limits under the operation temperature. For unprotected foam extinguishers, add glycol	before entering areas lower than -10℃
6.2	Fixed foam fire-fighting system	Drain the foam pipelines on the deck so that they are readily usable	below -20℃
		Hoses suitable for the operation temperature	
6.3	Monitors, hydrant valves and moving parts	Lubricate and use canvas covers to protect them. Regularly check that they are moveable	below 0℃
6.4	Water curtain, sprinkling and misting systems	Drain the pipelines	below 0℃
6.5	Foam storage cabinet	Heat so that the temperature of such space is above 0℃. Temporary heaters may be used	below 0℃
6.6	Fire hose box	The lock catch, lock, door hook and hinge are to be kept ice-free. The water spray nozzle and the connector are to be greased and kept dry. All hoses are to be drained completely to avoid damage and facilitate fast deployment	below 0℃

Chapter 4 Risk Management

Section 1 General

4.1.1 Objectives

4.1.1.1 This Chapter describes the potential high risks faced by ships sailing in polar waters, providing guidance to the master and the crew carrying out voyage planning and operation so that they can raise risk awareness, recognize operation hazards, evaluate risks (especially risks not covered in the Guidelines), and take cautious operation measures and as a result the ship can sail and operate within its design operation capability.

4.1.1.2 This Chapter also describes potential risks faced by ships in polar waters in emergency, providing emergency guidelines to the master and the crew so as to improve the effectiveness of the emergency response.

4.1.2 Environmental information

4.1.2.1 When navigating in polar waters, the ship may be subject to dangerous ice regimes affecting ship's structural capability and maneuverability, including multi-year ice much harder than the first-year ice, thick ice ridges and very hard glacier ice. Ice collision is the primary reason for hull damages. The force of impact varies as the square of the speed. Thus the faster the speed is, the higher the possibility of severe damage is. Moreover, compared with bow colliding with ice, ice colliding with ship's sides has the same impacts. When the ship sails in fast speed, ice colliding with the hull caused by huge waves will also cause severe damages at ship's sides. Therefore, the master is to be aware that when sailing at fast speed, ice collision is very dangerous.

4.1.2.2 Pack ice is put under pressure when tides, currents, or on-shore breezes blow ice onto the shore. Pack ice that has been under pressure for some time will deform. When the ship is in pack ice under pressure, there is a risk of becoming beset, which increased greatly in the presence of old or glacial ice. Consequently, the master is to fully understand that no matter how long the ship stays in ice, as the ice pressure around the ship increases, there will be risk of freezing, icing or squeezing. Once a ship becomes trapped, it goes wherever the ice goes, leading to higher risk of ship grounding on shoal.

4.1.2.3 When the ship is berthing in the ice, the mooring system may be subject to the high load impacts of ice floes, which may cause anchor dragging and/or anchor, mooring chain and windlass damages. Therefore, the master is to be fully aware of the significant hazards of berthing in ice areas.

4.1.2.4 When the ship is sailing in open water near the edge of the pack ice, particularly in bad weather, the edge may fall apart, causing damages to the ship, and may collide with the hull above the structurally-strengthened area (icebelt), causing severe damages.

4.1.2.5 When the ship sails and operates in cold climate, there may be a decrease in the ship's stability, freezing of tanks and pipes, failure of navigational equipment and a decrease in the crew's performance. As a result, the master, the officer in charge of a navigational watch and the chief engineer are to fully understand that when many systems and their parts are under temperature close to or lower than their design limit temperature, their performance will fall rapidly, leading to decrease in the ship's safety.

4.1.2.6 When the ship is navigating in polar waters, considerations are to be given to the impacts of strong wind and huge wave on the ship and cargoes, especially in the Antarctic westerly water where the impacts of ice floes on ships are to be paid attention to.

4.1.3 Supervision and inspection

4.1.3.1 When sailing in polar waters, the master and officer in charge of a navigational watch are to have a healthy mindset, be patient, operate cautiously and do not underestimate the potential energy of the ice on the ship at any time, avoid dangerous ice areas exceeding the ship's ice capability and choose to sail in open waters as much as practicable.

4.1.3.2 During voyage planning, the company and/or the master are to avoid known potential high-risk areas as much as practicable, i.e. waters containing multi-year ice, ice ridges and glacier ice, and avoid areas where special operations need to be considered. Where the voyage planning identifies and includes navigation in high-risk areas, the company and/or the master are to establish, implement and record the relevant emergency plans.

4.1.3.3 When the ship sails near ice or operates in it, the master/officer in charge of a navigational watch is to calculate a Risk Index Overall value (RIO) of the ice field the ship is in or intended to pass according to Appendix 2 Polar Operational Limit Assessment Risk Indexing System (POLARIS). Where the ship is located in an ice field where high-risk operations are required or anticipated or special operations need to be considered, care or extra care is to be taken during operation.

4.1.3.4 Where the weather forecast reports the temperature in the navigation area is close to or lower than the ship's PST, officers responsible for equipment and systems onboard are to increase the frequency to monitor and test equipment and system operation conditions and take appropriate measures.

4.1.3.5 Before a ship enters an ice field, the master is to take the following operation measures:

(1) Evaluating the necessity to change course based on the latest available ice and meteorological information and Masters are advised to adjust their course accordingly if changes are recommended during the passage by the relevant reporting system.

(2) Extra lookouts must be posted and the bridge watch may be increased, depending on the visibility.

(3) Transiting the ice field in daylight as far as possible. If the vessel is equipped with sufficient high-powered searchlights, transiting in dark is also possible.

(4) Reducing speed to a minimum to receive the initial impact of the ice.

(5) The vessel is to be at right angles to the edge of the pack ice at entry at low speed and the point of entering the ice must be in an area of the lowest ice concentration.

(6) The engine room personnel are to be briefed fully that it may be necessary to go full astern at any time.

(7) The ship is to be ballasted down to ice draft to protect the bulbous bow, rudder, or propeller.

(8) The ship is to be fitted with an internal cooling system for use in the event that the main engine cooling water intake becomes clogged with slush ice.

4.1.3.6 When the ship sails in ice, the master and the chief engineer must arrange the inspection and preparation of equipment and systems to ensure that:

(1) the propulsion plant and steering gear of any ship intending to operate in ice must be reliable and must be capable of a fast response to maneuvering orders;

(2) the navigational and communication equipment must be equally reliable and particular attention is to be paid to maintaining radar at peak performance;

(3) light and partly loaded ships are to be ballasted as deeply as possible, but excessive trim by the stern is not recommended, to avoid decrease in maneuverability and increases in the possibility of ice damage;

(4) engine room suction strainers are to be able to be removed easily and to be kept clear of ice and snow;

(5) good searchlights are to be available to aid in visibility during night navigation;

(6) the ship is to avoid contact with ice ridges or passage through pressured pack ice;

(7) bear in mind maneuverability performance of the ship (see 1.3 of Chapter 1). If possible course changes are to be carried out in an area of open water or in relatively light ice so as to reduce the power needed for turning in ice and avoid contact with ice on the ship's side or stern causing damages due to underestimation of the swing of the ship.

4.1.3.7 If it is not possible to turn in an open water area, the Master must decide what type of turning maneuver will be appropriate. When ice conditions are such that the vessel's progress is marginal, the effect of the drag of the rudder being turned may be sufficient to halt the vessel's progress completely. If the vessel must make a sharp turn, the star maneuver will have to be performed. Masters will have to weigh the dangers of backing in ice. Care must be taken while backing on each ram that the propeller and rudder are not forced into unbroken ice astern.

4.1.3.8 Backing in ice can easily damage the rudder and propeller. Although "double-acting" ice strengthened vessels with controllable pitch can move astern, however, the ship is to move with rudder amidship at dead slow astern in ice.

Section 2 Risk Mitigation in Limiting Environmental Condition

4.2.1 Measures to be considered in adverse ice conditions

4.2.1.1 The officer in charge of a navigational watch is to evaluate the risk of operating in an ice field at all times (see 4.1.3.3), and take the following precautious measures once high-risk operations are anticipated:

(1) notify the master to give orders at the bridge;

(2) reduce speed and sail within the speed limits;

The maximum speed is not to exceed the safety speed determined and calibrated by the following methods:

- *Speed limits recommended by the Ice Class Rules:*

Ice class	***Recommended speed limit***	***Ice class***	***Recommended speed limit***
PC1	*11 knot*	*PC3-PC5*	*5 knot*
PC2	*8 knot*	*PC6 and lower*	*3 knot*

- *Where the ship is provided with ice load measurement and monitoring system, the system may be used to calibrate the recommended speed limits above.*

- *Where the ship has real-ship sea trials in ice areas and/or has numerical calculation method, these results may be used to calibrate the recommended speed limits above.*

(3) Evaluate the ship's maneuverability in ice in advance. Where low speed may impair the ship's maneuverability, such operation is to be avoided. In such case, icebreaker escort is to be applied for in a timely manner.

(4) Arrange extra lookouts in the bow region or other appropriate locations when approaching icebergs, during night navigation or in poor visibility and double watches at the bridge for navigation and steering.

(5) A frequent check is to be made for any signs of the track closing behind the ship to avoid being trapped.

4.2.1.2 Once there are operations requiring special consideration, the master and the officer in charge of a navigational watch are to take the following precautious measures:

(1) report to the company in addition to measures specified in 2.1.3;

(2) speed is to be reduced until the vessel can be stopped within the distance of visibility. The vessel must stop when necessary. If the vessel is stopped, the propeller(s) are to be kept turning at low revolutions to prevent ice from building up around the stern.

(3) when the ship is in ice under pressure, where there are no other routes, the ship must stop in the ice until the pressure in pack ice is gone;

(4) calculate and evaluate the ship risk index of the icebreaker escort, apply and wait for ice breaking and piloting;

(5) evaluate and/or change course based on meteorological and ice conditions and change tendency provided by the land-based support.

4.2.1.3 Where the ship may contact hazardous ice when in the ice area, the boatswain or carpenter is to gauge the liquid level of compartments and tanks below the hull's waterline at least once an hour according to the master's requirements. For easily accessible compartments, check the leakage and deformation of hull's shell plating and inner members. When in doubt, increase the frequency of gauging and inspection.

4.2.1.4 When the ship is navigating in an ice field containing glacier ice, the ship will face additional risks. Under any circumstances the master and the officer in charge of a navigational watch are to ensure that the ship is far away from glacier ice and pack ice of all forms and take the following measures:

(1) arrange the master, officer in charge of a navigational watch and chief engineer who have been trained to identify and avoid glacier ice and know the consequences of collision with glacier ice, and arrange for an ice navigator when necessary;

(2) when sailing in waters where there may be glacier ice, the officer in charge of a navigational watch is to carefully detect and closely monitor and avoid glacier ice according to the hazardous ice detection methods specified in 2.3, Chapter 2;

(3) where glacier ice is detected in the route, the ship is to maintain a safe distance in addition to the risk index result. It is to be noted that the underwater portion of glacier ice is larger and the safe distance is to be greater than three times the height of the glacier ice above the water and records are to be made in the logbook.

4.2.1.5 The master is to make all possible effort to minimize the chances of collision with ice when in or near ice-covered waters or in poor visibility either because of precipitation, fog or darkness, and the requirements of the regulation for preventing collisions at sea also apply. These efforts are to include:

(1) maintenance of a constant visual and radar lookout;

(2) use of searchlights at night (which may be counter-productive in fog or precipitation through reflected glare);

(3) reduction of speed before entering any ice field in poor visibility and not increasing speed before the threat has been determined;

(4) reduction of speed in any ice situation where the ratio of glacial and old ice to first-year ice indicates a significant increase in the chance of collision with hazardous ice;

(5) location of icebergs, bergy bits, and growlers on marine radar, and tracking of these targets on ARPA (Automatic Radar Plotting Aid);

(6) switching between ranges to optimize the radar for iceberg detection when navigating in pack ice;

(7) when following the icebreaker, the ship is to maintain the required minimum distance by radar and maintain VHF radio contact and constant monitoring of the radar distance between vessels. If the icebreaker suddenly slows or its position is lost on the radar screen, a collision may occur.

4.2.2 Measures to be considered in adverse temperature conditions

4.2.2.1 Where the temperature in the navigation area is close to or lower than the ship's PST, the master is to take the corresponding measures to limit operations and/or lower risks according to the weather conditions in conjunction with the monitoring and testing of the ship as well as the operation of the equipment and systems onboard:

No.	*Operation category*	*Operation limitations*	*Measures to lower risks (examples)*	*Remarks*
1	*Navigation independently in ice*	*Avoid ramming ice*	*Apply for icebreaker escorting in a timely manner*	*Control of ice-accumulation risk onboard is implemented according to Section 5 of Chapter 3*
2	*Navigation in open waters*		*Temporary heating of spaces such as the steering room, the navigation bridge; reduce speed or change course*	
3	*Cargo loading/ unloading operation*	*Suspend crane/cargo lifting operation*	*Run the hydraulic system twice every day to warm hydraulic oil without load; or replace hydraulic oil*	
4	*Liquefied cargo in bulk/fuel oil bunkering operation*	*Suspend operation*	*Drain the pipe and keep the drainage valve open*	
5	*Ballast water operation*		*Check the water density and increase salinity or when the stability or ice draft allows, use low seawater suctions and change the ballast water inside the tanks frequently*	
6	*Personnel working in the open*	*stop*	*Immersion suits*	
7	……			

The table above is for example only. The contents may vary greatly for different ship categories, types, ice classes, equipment and systems provided onboard and the PST and anti-cold characteristics determined by the design. The contents of this paragraph are to be developed based on the designed operation conditions corresponding to the ship's anti-cold characteristics.

Section 3 Emergency Response

4.3.1 General

4.3.1.1 The polar areas are remote and weather conditions are unfavorable and changeable. The ship may be subject to low temperature, sea ice and other hazards when sailing in polar waters. As it is difficult to establish land-based SAR facilities in polar areas and the communication capability is limited, the emergency response will be relatively delayed, affecting emergency response to the ship and escalating the incident.

4.3.1.2 The emergency response in polar waters specified by this Section is supplementary to the existing ship's emergency response procedures applicable to non-polar ships.

4.3.1.3 The company and the master are to carry out risk evaluation of the intended voyage in polar waters and develop necessary contingency plans.

4.3.1.4 Before the ship enters polar waters or at the initial stage of the navigation, the master is to organize emergency exercises, drills and training and be familiar with the specific contingency plans, emergency response procedures to improve the crew's response; the master is also to check the crew's familiarity with the equipment and emergency procedures.

4.3.1.5 After emergency incidents, the master is to initiate relevant specific contingency plans (see Section 4 Coordinating emergency response) according to the dangerousness of the emergency situations and the impacts of the incidents, organize the crew to implement the emergency deployment so as to avoid or reduce financial loss, environmental pollution, personnel injuries and social impacts to the greatest extent.

4.3.1.6 In case of incidents such as structural damages, hull damages and flooding, emergency towage, stranding and grounding in ice, hull listing, collision, spilled oil pollution, loss of control (including engine failure, rudder failure, loss of power), fire and explosion, personnel falling into water, personnel injuries, cargo movement/spill, ship abandonment, helicopter operation, the master is to initiate contingency plans immediately, take effective measures, control the development of such incidents, organize the crew to carry out emergency SAR work and report to the personnel on duty in the company as required.

4.3.1.7 The personnel on duty in the company are to notify the company's emergency response group immediately, initiate the emergency procedures as applicable and report to the superior as required.

4.3.2 Damage control (*mainly applicable to ships of categories A and B*)

4.3.2.1 Before the ship enters polar waters and engaged in voyages in ice, the master is to evaluate additional resource demands for damage control onboard so as to carry out temporary repairs for minor damages of the hull or take precautions measures to prevent damages or worsening of flooding and guarantee that the ship can sails to locations where substantial repairs can be carried out.

4.3.2.2 Additional resource for damage control generally includes the following:

(1) portable gas welding and cutting equipment and relevant materials and spares, including steel plates, welding consumables, acetylene and oxygen, etc.;

(2) a portable electrical diving pump the capacity of which is 100 ton/h and one set of hoses suitable for PST;

(3) where the ship is provided with propellers fitted with removable blades, spare blades and the appliances to remove and change the blades;

(4) crew equipped with repair skills.

4.3.2.3 In case of damage incidents, the master is to close the watertight doors of relevant compartments and check stability and adjust floating condition according to the contingency plans. The master is also to arrange temporary repairs provided that the personnel safety can be guaranteed.

4.3.2.4 Where oil or other pollutant spillage is involved in the damage incidents, the master is to take the following measures provided that the ship and personnel safety can be guaranteed:

(1) the pollutants in the damaged tanks are to be transferred to other tanks onboard (s*pecific tank name, listed as per the actual conditions of the ship, illustration may be included*) *and/or measures to enter tanks and spaces during external SAR*;

(2) in case of pollution accidents, implement according to SOPEP (*SOPEP is to consider measures that taking into account characteristics of polar waters such as remoteness, ice, low-temperature environment, wildlife protection, etc*.).

4.3.2.5 The master is carry out damage control exercises every week. Each exercise is to select different emergency scenario to simulate different damage conditions that may occur during polar water operations (*list the specific exercise scenario according to the ship type, structural arrangement and operation modes, etc*.).

4.3.3 Firefighting

4.3.3.1 Before the ship enters polar waters, the master is to arrange the development or adjustment of deployment table, taking into consideration the impacts of the low-temperature environment on the effectiveness of emergency response to fire and explosion. *Additional tasks are to be determined according to the routine anti-cold and anti-icing measures of the fire-fighting equipment and systems, including*:

(1) *open the isolation valve of the fire mains and close the drainage valve*;

(2) *the fire pump is to include temporary heating of the space where the emergency fire pump is located; change to low seawater suctions*;

(3) *carriage of spare hoses or hoses stowed indoors*;

(4) *carriage of de-icing tools*;

(5) *inspect heating arrangements for the fixed fire-fighting system and carry temporary heating appliances*.

4.3.3.2 Each fire drill is to comply with the elements specified by SOLAS plus the elements of low temperature and icing environment.

4.3.4 Escape and evacuation

4.3.4.1 Where the ship is engaged in voyages in polar waters far away from SAR facilities, the company and the master are to evaluate the provision of life-saving resources onboard. The life-saving resources include Personal Survival Kit (PSK) and/or Group Survival Kit (GSK) provided as follows (where applicable):

PSK		GSK (for abandonment onto ice or land)		Remarks
Item	Number	Item	Number	
Protective clothing (hat, gloves, socks, face and neck protection, etc.)	1 set/person	tents	1/6 persons	
Thermal protective aid	1/person	Thermal protective aids	1/2 persons	Not necessary if PSK is provided
Skin protection cream(sunscreen)	1/person	Sleeping bags	1/2 persons	
Sunglasses	1/person	Foaming sleeping mats	1/2 persons	
Whistle	1/person	Shovels	2	
Drinking mug	1/person	Sanitation	several	toilet paper
Penknife	1/person	Stove and fuel	sufficient for maximum number of persons ashore and maximum anticipated time of rescue	At least 5 days
Polar survival guidance	1/person	Emergency food		
Emergency food	1/person	Flashlights	1/tent	
Carrying bag	1/person	Waterproof and windproof matches	1/tent	
		Signal mirror	1/tent	
		Water containers & water purification tablets	1/tent	
		GSK container	several	waterproof and floatable

4.3.4.2 When the ship is engaged in voyages in waters far away from SAR facilities, the master is to develop or adjust contingency deployment table, taking into consideration factors of evacuation onto ice or land and/or in low-temperature environment and adding contingency tasks, such as:

(1) *carriage of PSK and GSK* (*where personnel are evacuated to lifeboats, the impacts of carriage of PSK and GSK on the lifeboat loads are to be considered*);

(2) *de-icing of survival crafts*;

(3) *carriage and operation of positioning and communication equipment of survival crafts and rescue boats*;

(4) *carriage of lifeboat goods that are stowed on the ship to prevent from being frozen, such as fresh water*;

(5) *carriage and operation of heating devices for lifeboat cabins*;

(6) *carriage and operation of antifreeze for fuel oil of the boat engine*;

(7) *special arrangement for ice evacuation*.

4.3.4.3 When the ship is engaged in voyages in waters far away from SAR facilities, the ship-abandonment drill is to consider scenarios of evacuation to water, ice/land, or a combination thereof. Each ship-abandonment drill is to include the following, where applicable:

(1) passenger control in cold environment;

(2) check that all personnel are properly dressed;

(3) the crew wear immersion suits or heat-insulation suits;

(4) testing the emergency lighting for mustering and abandonment;

(5) instructions for life-saving and survival equipment as well as for survival in the sea and/or on the ice;

(6) application procedures for the alarms and communication equipment of survival crafts and rescue boats.

4.3.4.4 Given the dangerousness of lowering rescue boats in waters near polar caps, the master is to carry out rescue boat exercises as much as practicable where necessary.

4.3.4.5 The usage training and drills of the life-saving equipment onboard are to include the usage of PSK and/or GSK. Each training and drill can cover part of the equipment and appliances, but all equipment and appliances must be covered within two months (for cargo ships)/one month (for passenger ships), and each crew member is to be provided with the following training:

(1) emergency treatment of cold shock, too low body temperature and other emergency treatment procedures;

(2) special precautions for using life-saving appliances on ice or in ice-covered waters under adverse weather and sea conditions.

4.3.4.6 When an evacuation is required in waters with ice, the master is to organize an orderly and safe evacuation considering the actual ice and meteorological conditions. The methods are as follows:

(1) if there are adverse ice conditions at locations where the ship abandonment is carried out and the survival crafts cannot be lowered, use helicopter to lower personnel onto safe ice or land; or if the ship condition permits, personnel are evacuated onto safe ice by rope ladder, gangway in an orderly manner and wait for rescue;

(2) if the location where the ship abandonment is carried out has sufficient open water for survival crafts to be lowered, survival crafts may be lowered to evacuate personnel. However, launching survival crafts by throwing them overboard is to be avoided in case that the crafts are damaged by the ice.

4.3.4.7 Due to the limits of battery life of the communication equipment/installations, after the ship abandonment, commanders of survival crafts and rescue boats are to coordinate with each other and muster survival crafts as much as practicable or make them close to each other. When several survival crafts are very close to each other, keep no more than two alarms or positioning devices (EPIRB) in operation so as to save battery life of the communication equipment, prolong the duration for sending alarms or EPIRB and avoid interference with lateral equipment.

4.3.5 Freeing a Ship Beset

4.3.5.1 When a ship is beset by ice, the master is to report to the company immediately and take the following measures to free the ship:

(1) Go ahead and astern at full power while alternating the helm from port to starboard, which has the effect of levering the ice aside. Care must be taken when going astern to ensure that no ice goes through the propeller(s), or if the vessel frees itself that it does not make sternway into any heavy ice. In vessels with twin propellers, they are to be alternated with one ahead and one astern for a few minutes, then each changed to the opposite direction, slewing the stern from side to side to create a wider opening in the ice astern.

(2) Alternate filling and emptying of the fore and after peak tanks is effective in changing the trim for the bow to get a better angle of attack on the ice ahead, or for the propellers to be given a better grip by greater submersion. It can also be effective in extracting from a ridge, by raising the bow so that the ship slides backwards as the bow is raised.

(3) Alternate the ballast to port and to starboard to list the ship and change the underwater shape. This method is only to be done with knowledge of the possible consequences of an exaggerated list if the ship comes free quickly.

4.3.5.2 Propellers and rudders are to be kept turning when the ship is trapped in ice no matter when it is taking freeing measures or waiting for the icebreaker or for the weather to turn fine so that the waterway behind the stern is not closed by ice. Meanwhile, the master is to pay attention to the adverse impacts of the lateral wind on the ship.

4.3.5.3 When self-freeing the ship, the master is to keep in contact with the company, evaluate and report the effects and progress of self-freeing and apply for external assistance in a timely manner.

4.3.5.4 Where the ship cannot free itself, the master is to follow the Procedures for maintaining life support and ship integrity while waiting for external assistance; see Section 5 of this Chapter.

4.3.6 Treatment of severe icing

4.3.6.1 When the ship is experiencing icing exceeding or almost exceeding the maximum icing allowance, the master is to take the following control measures:

(1) take anti-icing and de-icing measures (see contents in Table 3.5.2) to reduce ice accumulation so that the ship's icing condition does not exceed the maximum designed icing allowance;

(2) when icing is anticipated to be too severe to control or remove, the ship is to sail to sheltered or warm areas as much as practicable;

(3) where it is impossible to find shelters or sail to warm areas, the ship is to run with the bow heading sea and slow down as much as practicable so as to reduce immersion of the deck by wave.

4.3.7 Navigation measures in heavy seas

4.3.7.1 When the ships sails in heavy seas, the following measures are to be taken:

(1) change course and speed, use brake and rudder to keep the course in head wind at 15 degrees right or left of the wind (current, wave) direction and minimize roll angle or avoid synchronous rolling as much as practicable; the ship may be maneuvered to sail in head or following seas, broach and surf-ride;

(2) intensify inspection to ensure that the main engine, auxiliary engine, rudder can function;

(3) where the stability is not satisfactory and the rolling period is long, the double bottom is to be sufficiently ballasted if applicable to improve the stability; however, the impacts of the free surface are to be minimized as much as practicable;

(4) intensify inspection of bonding of deck equipment and cargoes. For articles that may be moved or collapsed due to insufficient bondage, effective measures must be taken to eliminate safety hazards;

(5) guarantee the watertightness of the closing appliances of all openings on the deck. Check the drainage pump, pipings and bypass valve to ensure that they are in good working order. Check and clean the bilge tank so that the water can be drained in a timely manner. Check the scuppers of each deck to ensure good drainage.

Section 4 Coordination with Emergency Response Services

4.4.1 Ship emergency response

When sailing in polar waters, the ship is generally to follow the existing emergency response procedures in the safety management system of the company and ship. In general, when the ship is intended to navigate in polar waters or has voyage plans, both the company and the ship are to carry out appropriate risk evaluations, develop or supplement contingency plans. Under any circumstance, this Section is to describe the following operational procedures, including but not limited to:

(1) *voyage preparation, including complying mandatory warnings of laws and regulations of coastal States of polar waters*;

(2) *during navigation in polar waters, in case of emergency, the communication channel and means between the ship and the company, as well as the designated agencies and means of contact for the company and the master to acquire services such as consultancy on ice conditions, meteorology, route selection, icebreaker escort, ERS, etc*.;

(3) *list and update the selectable salvage facilities and their service categories in different areas of the intended routes*.

4.4.2 Salvage

When sailing in polar waters, the ship is generally to follow the existing salvage operation procedures in the safety management system of the company and ship. This Section may consider the following supplementary procedures:

(1) *when developing voyage plans, identify and verify the salvage service arrangement based on risk evaluations*;

(2) *describe operation for the company and the ship that are salvaged in emergency*;

(3) *list and update the selectable salvage facilities and their service categories in different areas of the intended routes*.

4.4.3 Search and rescue

When sailing in polar waters, the ship is generally to follow the existing SAR service procedures in the safety management system of the company and ship. This Section may consider the following supplementary procedures:

(1) *when developing voyage plans, identify the SAR coordination center available on the route*;

(2) *verify and update the contact information and procedures of the SAR coordination center*;

(3) *list and update the contactable SAR coordination centers and their relevant facilities, if any*.

See Figures 4.4.3a and 4.4.3b for the SAR coordination centers and their SAR areas in Arctic and Antarctic waters respectively.

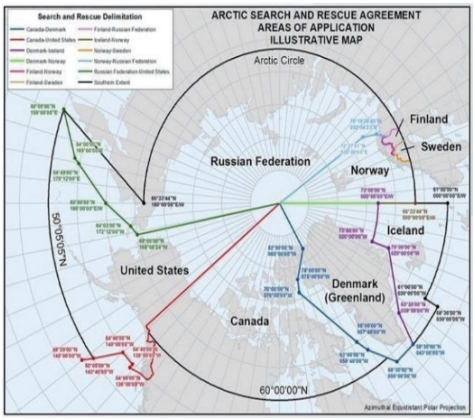


Figure 4.4.3a SAR coordination area in Arctic area

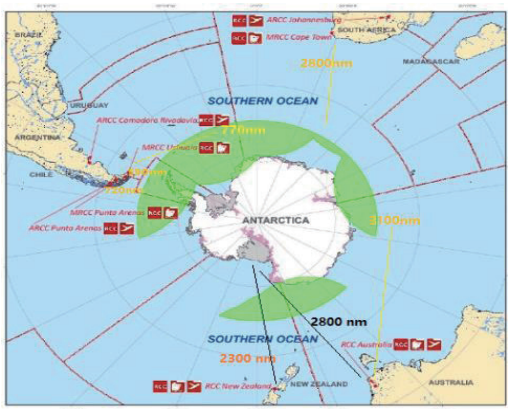


Figure4.4.3b SAR coordination area in Antarctic area

4.4.4 Removing spilled oil

When sailing in polar waters, the ship is generally to follow the existing oil spillage response procedures in the safety management system of the company and ship and implement the requirements of the SOPEP. If the SOPEP has already contained polar water factors, then this paragraph may refer to the SOPEP for details; otherwise, list and update the available oil spillage response agencies and their means of contact in different areas of the intended routes.

Section 5 Procedures for Maintaining Life Support and Ship Integrity in the event of Prolonged Entrapment by Ice

For ships intended to navigate and operate in remote polar waters far away from SAR facilities all year round, ship design is to consider the salvage risks such as prolonged besetment by ice and the ship is to be provided with special equipment and systems that can eliminate the safety and environmental risks due to the ship's prolonged besetment by ice, such as:

(1) *adding additional equipment power supplied by emergency switchboard to satisfy demands for lighting, heating, ventilation, fresh water and food supply during the longest duration waiting for salvage*;

(2) *anti-icing of the drainage system*;

(3) *isolation parts of the HVAC system*;

4.5.1 System configuration

To list specific systems based on the actual conditions of the ship.

4.5.2 System operation

To describe system operation procedures based on the actual conditions of the system.

Chapter 5 Joint Operation

Section 1 General Provisions

5.1.1 Escort arrangements

5.1.1.1 In voyage planning, companies and masters are to give considerations to the necessity of escorting operations or assistance of icebreakers and reflect them in the scheme and the specialized emergency plans. Considerations are to be given to the following elements in escort arrangements:

(1) laws and regulations and procedures for compulsory escorting regulations of coastal states;

(2) operational capacity and restrictions in ice zone for ships;

(3) uncertainties in information on ice conditions of expected or real-time routes.

5.1.1.2 Before the ship enters the polar waters, the shipping company and master are to contact the company or institution offering escorting services by icebreakers and make detailed arrangements to ensure that icebreaker services are available according to the voyage plan or when necessary.

5.1.2 Requirements for or provision of icebreaker escorting services by coastal states

5.1.2.1 In the Arctic waters, Russia and Canada fulfill the obligation of managing icebound waters by coastal states in their claimed waters under jurisdiction to provide regular icebreaker services for navigation of merchant ships. In the Antarctic waters, icebreakers only serve state research stations seasonally. For merchant ships in need of regular icebreaker escorting services, the search and rescue center is to coordinate icebreakers performing tasks around the Antarctic waters to provide the corresponding service only when the ship gives out such a demand in emergency search and rescue.

5.1.2.2 Icebreaker pilotage and assistance services for ships in the Northeast passage of Russian Northern Sea Route are to comply with relevant provisions of *The Regulations for Navigation on the Seaways of the Northern Sea Route* by Russian federation. When icebreaker service is needed, the company and master are to submit their demands in advance to Administration of Northern Sea Route (ANSR) or Western Sea Transportation Headquarters (Murmansk)/ Eastern Sea Transportation Headquarters (Haishenwai). After the consent by the headquarters, the ship is notified and the icebreaker operation company is arranged to provide paid icebreaker service. Please refer to the Regulation for details.

5.1.2.3 The ship in navigating in Northwest passage may request icebreaker assistance service of ECAREG CANADA or Ice Zone Operation Center. Since Canada is not able to provide comprehensive business icebreaker assistance service and the amount of icebreaker in Canadian Coast Guard is limited, the ship is to contact in advance and comply with the report system when icebreaker service is needed. Improper procedures in ship report may lead to difficulty or serious delay of icebreaker service. Please refer to the Ice Navigation in Canadian Waters and relevant provisions for details.

This section may also list specific provisions for application for icebreaker escort in laws and regulations and procedures of coastal states.

Section 2 Navigational Operation under Escort

5.2.1 Communication

5.2.1.1 The master is to contact icebreaker escorting institution in time and provide information including operational capabilities and maneuverability of ships in ice as required.

5.2.1.2 The master or officer in charge of a navigational watch is to establish very high frequency (VHF), formulate communication of channels, tune in and arrive at the meeting place with icebreaker in time.

5.2.1.3 The command and information of VHF among ships include but not limited to the following:

Command (Information)	Actions to be taken according to the command
All ship, please attention.	Need to send command or information to all ships in the fleet
Ice break boat will begin.	Expression to begin the navigation
Your position number is…… in fleet.	The position of the piloted ship in the fleet
Keep several cables between vessel	Keep a certain distance
Keep speed at … knots	Keep a certain speed
I'm ahead now, follow me.	Follow the icebreaker and keep the corresponding speed and distance
My vessel is now turn portside (starboardside), heading is ……	The icebreaker notifies the piloted ship to turn
Add (reduce) distance to ……cables	Adjust the distance as required
Reduce (add) speed to ……knots	Control the speed as required
It happened ……, please reduce your speed.	The icebreaker notifies speed reduction and takes actions to ensure safety
My vessel was trapped by ice.	The icebreaker stops
Keep the vessel stop.	Should back up quickly, turn left or right as the circumstances may require, and stop the vessel
Standby at present position.	Standby at present position.
Stop engine until ……	Stop engine until the new command
reverse engine full (half, slow) ahead /astern	Manipulate the main engine according to the command
full (half, slow) ahead or astern	The main engine full (half、slow) ahead or astern
Please go on.	Move forward along the route
Please turn port/starboardside	Make turns as required and remain 20 to 25 meters away from the periphery ice zone of routes
Make fast / let go the tug line	Implement the command
Please keep vessel with icebreaker in the fleet	Implement the command as required
Be care, the tug line was broken.	The piloted ship should be full astern and get away from icebreaker
The pilot was break off.	The icebreaker notifies the reason and follow-up actions
The pilot was over, please go on voyage.	The pilot was over

At the same time, the ship must master information including sound, visual and radiotelephony signals to contact the icebreaker listed in the following Table:

Letter	Icebreaker	Ship
WM	Icebreaker support is now starting, use special icebreaker signals and maintain continuous watch of sound, visual and radiotelephony signals	
A.-	Go ahead, proceed along ice channel	I am going ahead
G--	I am going ahead, follow me	I am going ahead, I will follow you
J.---	Do not follow me (proceed along ice channel)	I will not follow you (I will proceed along ice channel)
P.--	Slow down	I am slowing down
N-.	Stop your engines	I am stopping my engines
H….	Reverse your engines	I am reversing my engines
L.-..	You should stop your vessel instantly	I am stopping my vessel
4….-	Stop. I am icebound	Stop. I am icebound
Q--.-	Shorten the distance between vessels	I am shortening the distance between vessels
B-…	Increase the distance between vessels	I am increasing the distance between vessels
Y-.--	Be ready to take (or cast off) tow line	I am ready to take (or cast off) tow line
5…..	Attention	Attention
WO	Icebreaker support is finished. Proceed to your destination	

5.2.2 Escorting operation and monitoring

5.2.2.1 In the process of icebreaker escorting, the master is to always stand in the bridge room. While following the instructions of the icebreaker master, the master is also to consider the ship's operation capabilities and restrictions, keep risk assessment of limitations for operation in ice, navigate with caution and watch out.

5.2.2.2 In escorting, the ship is to pay attention to the following items:

(1) the master is to ensure compliance with the instructions of the icebreaker;

(2) the master and officer in charge of a navigational watch are to be aware of ice maneuvering performance, implement instructions of icebreaker master, maintain the position within the ice convoy, speed and/or distance to any other ship in the ice convoy, closely monitor the trash ice and changes round the ship and trend of the previous ship, and keep a safe distance;

(3) 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;

(4) 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

(5) for the ship's contact and extrusion with ice, the master is to arrange a carpenter to measure level of compartment and tank below hull waterline at least once an hour, monitor the hull structure and immediately report to the icebreaker of any damage;

(6) if the ship must go astern, considerations are to be given to the damage of ice to propeller and rudder. Cautions are also to be given in manipulating bi-direction icebreakers and controllable pitch ships.

Section 3 Navigational Operation within Ice Convoy

5.3.1 Position within the ice convoy

5.3.1.1 Ice convoy navigation refers to icebreaker service institutions make arrangements based on the number of ships applying for icebreaker escorting in a certain period to resolve the shortage of icebreakers and improve the escorting efficiency.

5.3.1.2 The ship's position within the ice convoy is to be determined by the icebreaker based on the ship's size, ice navigation and maneuvering capability within the ice convoy.

5.3.2 Ice convoy navigation manipulation and monitoring

5.3.2.1 In ice convoy navigation, the ship is to comply with the precautions of escorting navigation operations in Section 2, including communication contact, navigation speed control, safe distance and structure monitoring.

5.3.2.2 In case of changes with ice conditions in the ship's ice convoy navigation or navigational problems of the ship or the previous ship, the master is to immediately report to the icebreaker and request the adjustment of the ship's position to follow ships with stronger navigation capabilities in ice zones.

Appendix① 1 Polar Operational Limit Assessment Risk Indexing System and Examples

0. General

0.1 The Polar Operational Limit Assessment Risk Indexing System (POLARIS) has been developed incorporating 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.

0.2 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.

0.3 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.

0.4 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 HELCOM②, 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.

1 Polar Operational Limit Assessment Risk Indexing System

1.1 Risk Index Values

1.1.1 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.

① Paragraphs 1 and 2 of this Appendix are derived from the Appendix of MSC.1Circ.1519.
② Refer to the Appendix to HELCOM Recommendation 25/7, Safety of Winter Navigation in the Baltic Sea Area, available at www.helcom.fi.

1.1.2 Ice types in POLARIS generally conform to WMO nomenclature used on ice charts with the 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.

1.1.3 Risk Index values have been developed in Table 1.1.3a and Table 1.1.3b. Table 1.1.3a 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 1.1.3a 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 1.1.3b may be used.

Risk Index **Table 1.1.3a**

Category	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	Medium First Year Ice less than 1 m. thick	Thick First year Ice	Second Year Ice	Light Multi Year Ice, less than 2.5 m thick	Heavy Multi Year Ice
A	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
B	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
	B1*	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
	B1	3	2	2	2	1	0	-1	-2	-3	-4	-5	-5
C	B2	3	2	2	1	0	-1	-2	-3	-4	-5	-6	-6
	B3	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8
	No ice class	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

Risk Index Value (RIV) – Melting ice regime **Table 1.1.3b**

Category	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	Medium First Year Ice less than 1 m. thick	Thick First year Ice	Second Year Ice	Light Multi Year Ice,less than 2.5 m. thick	Heavy Multi Yearlce
A	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
B	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
	B1*	3	2	2	2	2	1	1	0	-1	-3	-4	-4
	B1	3	2	2	2	1	1	0	-1	-2	-4	-5	-5
C	B2	3	2	2	1	0	-1	-1	-2	-3	-5	-6	-6
	B3	3	2	1	0	-1	-2	-2	-3	-4	-6	-7	-8
	No ice class	3	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-8

1.2 Risk Index Outcome

1.2.1 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 1.3.1 and 1.4.1. 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.

1.2.2 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):

$$RIO = (C_1 \times RIV_1) + (C_2 \times RIV_2) + (C_3 \times RIV_3) + \ldots\ldots + (C_n \times RIV_n)$$

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.

1.3 Evaluation of the Risk Index Outcome for independent operations

1.3.1 Operational limitations for ships operating independently are determined based on the criteria in Table 1.3.1, 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.

1.3.2 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 1.3.1 equals these three levels of operation.

Risk Index Outcome criteria Table 1.3.1

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 1.4 **See 1.5

1.4 Elevated Operational Risk

1.4.1 Ships operating in an elevated risk ice regime, based on the RIO outcome, should limit the speed to the values indicated in Table 1.4.1. 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 1.4.1

Ice Class	Recommended Speed Limit
PC1	11 knots
PC2	8 knots
PC3-PC5	5 knots
Below PC5	3 knots

1.4.2 Ships equipped with ice load measurement and monitoring systems can utilize these systems to calibrate recommended speeds included in Table 1.4.1.

1.4.3 Ships having undergone full scale ice trials and/or calculation-based methodologies can utilize these results to calibrate recommended speeds included in Table 1.4.1.

1.4.4 Recommended speed limits for elevated operational risk conditions should be included in the PWOM.

1.4.5 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.

1.5 Operations Subject to Special Consideration

1.5.1 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.

1.5.2 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.

1.5.3 For voyage planning purposes, ice regimes where the RIO identifies Operations Subject to Special Consideration should be avoided.

1.6 Risk Index Outcome for ships under icebreaker escort

1.6.1 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.

1.6.2 The icebreaker itself should calculate its own RIO along the intended route.

1.6.3 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.

1.6.4 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.

1.7 Operation in Ice Regimes Containing Glacial Ice

1.7.1 The presence of glacial ice represents additional risks to the ship. Areas containing glacial ice should be approached with caution.

1.7.2 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.

1.7.3 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.

2 Identification of Sea Ice Symbols

POLARIS is the tool for the master to determine the risk assessment of limitations for operation in ice to match the ice class with the actual ice condition, considering factors including ice types, thickness and quantity. Ice condition assessment adopts the ice chart and observation standards made by WMO, namely the egg-shape coding in Figure 1 below.

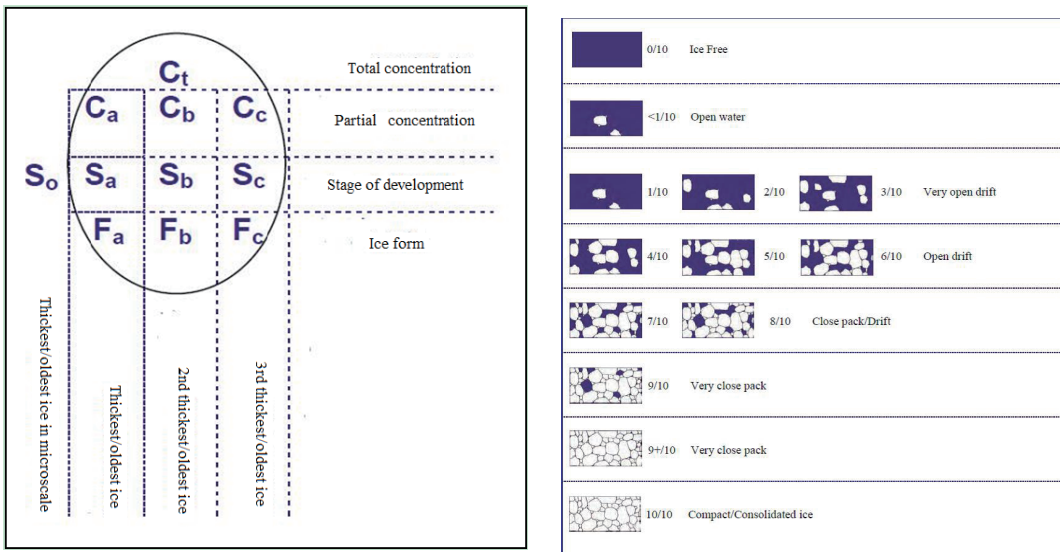


Figure 1 Diagram of EGG Code Figure 2 Diagram of Ice Concentration

(Ice Navigation in Canadian Waters (2012)) (Canadian Coast Guard)

(1) Symbols of C_a, C_b and C_c and F_a, F_b, and F_c in Figure 1 correspond to S_a, S_b and S_c respectively.

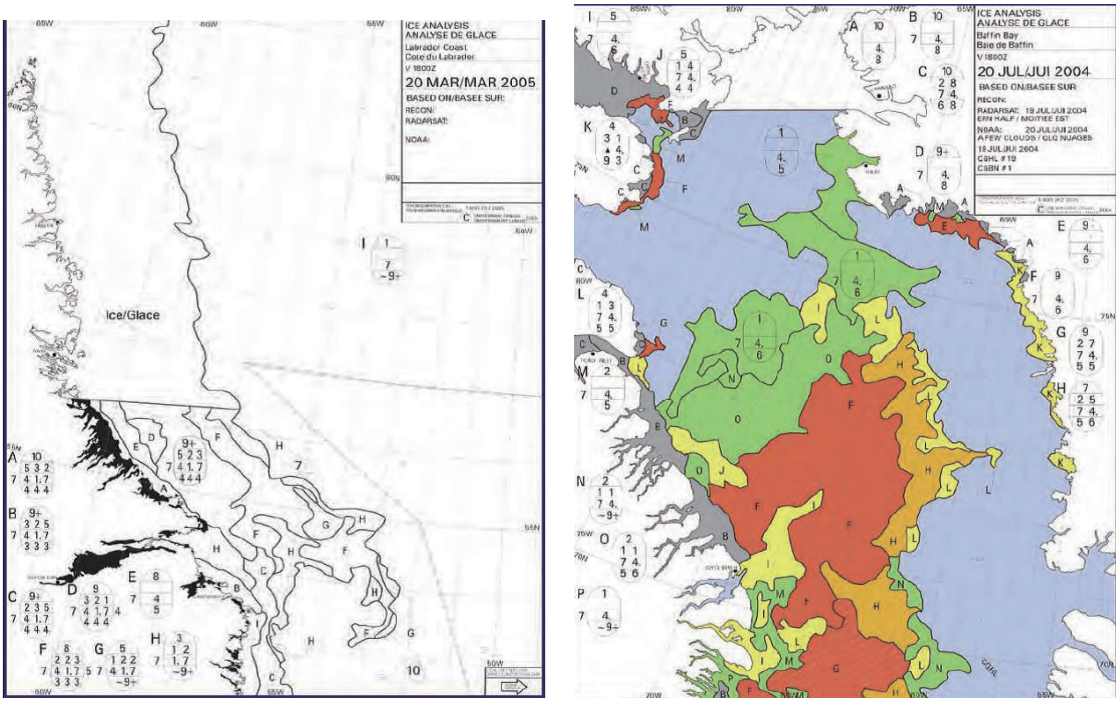
(2) Ice concentration C_t, C_a, C_b and C_c are expressed in a ten-point system in Figure 2.

(3) The codes for ice growth stages S_a, S_b and S_c and ice forms F_a, F_b, and F_c are listed in Table 1 below:

Code for ice formation stage and form **Table 1**

Ice formation stage	Color	Code	Ice form	Code
New Ice		1	Pancake Ice	0
Nilas		2	Small Ice Cake	1
Young Ice		3	Ice Cake	2
Grey Ice		4	Small Floe	3
Grey-White Ice		5	Medium Floe	4
First-Year Ice		6	Big Floe	5
First-Year Thin Ice		7	Vast Floe	6
Stage 1 First-Year Thin Ice		8	Giant Floe	7
Stage 2 First-Year Thin Ice		9	Fast Ice	8
First-Year Medium Ice		1*	Floe berg, bergy bit	9
First-Year Thick Ice		4*	Unidentified ice	X
Old Ice		7*		
Second-year Ice		8*		
Multi-Year Ice		8*		
Ice of land origin (Glacier ice)		▲		
Unidentified ice	? ? ?	X		
Open water		-		

(4) Examples of ice chart



Black and white ice chart Colorful ice chart

3 Application examples of POLARIS

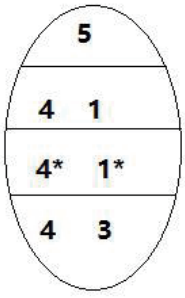
Ice regime and Risk Index Outcome (RIO) are computed as follows (*take ice class PC7 as an example*):

Ice zone example 1

(1) Ice zone is determined based on the ice "egg" provided by relevant international service providers in ice regions. For example:



Ice regime 1



Ice zone 1
First-Year Thick Ice 4/10,
First-Year Medium Ice 1/10,
Ice-free Waters 5/10

(2) Use the RIO provided by POLARIS to calculate by the following formula:

$$RIO = (C_1 \times RIV_1) + (C_2 \times RIV_2) + \ldots\ldots + (C_n \times RIV_n) = 4 \times (-2) + 1 \times (-1) + 5 \times 3 = 6$$

Where:
$C_1 \ldots C_n$ are the concentrations of ice types within the ice regime, including ice-free waters, namely 4, 1 and 5;

and $RIV_1 \ldots RIV_n$ are the corresponding Risk Index Values for each ice type. Risk Indexes of PC7 in First-Year Thick Ice, First-Year Medium Ice and Ice-free Waters in Table 1.3 of POLARIS are -2, -1 and 3 respectively.

(3) If the RIO is above 0 according to Table 1.1 of POLARIS, this suggests that the ship can operate normally in this ice zone.

Ice zone example 2

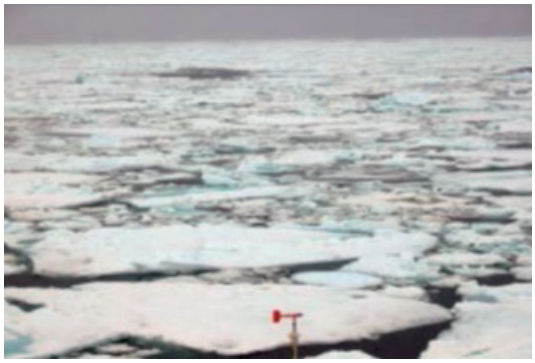


Ice zone 2

Ice zone 2
1/10 Second-Year Ice, 8/10 Thick First Year Ice, 1/10 Open Water

RIO= -8 based on the above calculation suggests the elevated risk of the ship in operating in this ice condition.

Ice zone example 3



Ice zone 3

Ice zone 3
2/10 Medium thick multi-year ice, 7/10 Thick First Year Ice, 1/10 Open water

RIO= -17 based on the above calculation suggests operations subject to special consideration of the ship in this ice condition.

Appendix 2 Channels to acquire ice information

1. This Appendix is to provide the master with relevant channels to acquire ice information in navigating in polar areas to facilitate the voyage planning.

2. Relevant state ice zone service institutions listed in Figure 2.1 below can offer the latest and most comprehensive ice information, including detailed climate condition, water depth measurement, ice data set and ice chart.

Figure 2.1 List of State Ice Zone Services

Region	Ice information service	Contact information
Canada The Arctic Pole	Canadian Ice Service	373 Sussex Drive Block E, Third Floor, Ottawa, Ontario, K1A 0H3 Canada
	● Latest ice conditions available	www.ice-glaces.ec.gc.ca/WsvPageDsp.cfm?ID=1&Lang=eng
	● Sea Ice Climatic Atlas	http://ec.gc.ca/glaces-ice/default.asp?lang=En&n=090AF7D6-1
	● Icebreaking services	www.ccg-gcc.gc.ca/eng/CCG/Ice_Home
Greenland	Danish Meteorological Institute	3910 Kangerlussuag, Greenland Phone +299-84-1022 www.dmi.dk/dmi/en/gronland/iskort.htm
Norway	Norwegian Meteorological Institute (DNMI)	PO Box 43, Blindern 0313 Oslo, Norway Phone +47-22-963000 Fax +47-22-963050 email：emet.inst@met.no www.met.no/english/index.html
	Norwegian Polar Institute Polar Environmental centre	N-9296 Tromsø, Norway (Norsk Polarinstitutt, Polarmiljøsenteret, 9296 Tromsø) Phone +47-77-750500 Fax +47-77-750501 email: postmottak@npolar.no www.npolar.no/en/
Sweden	Swedish Maritime Administration	601 78NorrkopingSweden www.sjofartsverket.se/en/ Phone +46 771 63 00 00 Fax +46 11 10 19 49 email: ulf.gullne@sjofartsverket.se

Region	Ice information service	Contact information
Finland	Finnish Transport Agency/ Winter Navigation Unit	PO Box 185FI-00101 HelsinkiFinland http://portal.liikennevirasto.fi/sivu/www/e/professionals/winter_navigation Phone +358 295 343 327 Phone + 358 295 343 325 Fax + 358 202 48 4360 email: winternavigation@fta.fi
	The Finnish Meteorological Institute	P.O.BOX 503FI-00101 HelsinkiFINLAND www.itameriportaali.fi/en_GB/ Phone: +358 295 391 000 email: ice@fimr.fi
Iceland	Icelandic Meteorological Office	Bustaoavegur 7-9, 108 Reykjavik, Iceland Phone +354-522 6000 Fax +354-522-6001 http://en.vedur.is/sea-ice/sea-ice-reports/
Russia The Arctic Pole	Federal Agency of Sea and River Transport Administration of the Northern Sea Route	109012, Moscow, Ul.Rozhdestvenka, 1,building 1 Phone +7 495-626-1100, +7 495-626-1064, email: MonkoNA@morflot.ru
	Arctic and Antarctic Research Institute	38 Bering Street, St. Petersburg, 199397, Russia Phone +7-812-352-1520 Fax +7-812-352-2688 email: service@aari.nw.ru aaricoop@aari.nw.ru www.aari.nw.ru/index_en.html
The United States	National Ice Center	Federal Building # 4, 4231 Suitland Road, Washington D.C. 20395, USA Phone +1-301-394-3100 www.natice.noaa.gov
China	National Marine Environmental Forecasting Center, China	www.nmefc.gov.cn provides numerical forecasts of Arctic sea ice, weather and sea wave and security services for forecasts in 24, 72 and 120 hours. Phone: +8610-62173595 Fax: +8610-62173620 E-mail: nmefcpolar@163.com

3. At present, Canada and the US carry out the iceberg tracing and monitoring in the Arctic regions. The company and master can get the Arctic iceberg information from the institutions listed in Figure 3.1

Figure 3.1 List of Arctic Iceberg Monitoring Service

Region	Iceberg monitoring service	Contact information
North of 50^0N	Canadian Ice Service Iceberg monitoring service	373 Sussex Drive Block E, Third Floor, Ottawa, Ontario, K1A 0H3 Canada www.ice-glaces.ec.gc.ca/WsvPageDsp.cfm?ID=1&Lang=eng
South of 50^0N in the Northern Hemisphere	International Ice Patrol	1082 Shennecosselt Road, Connecticut 06340, USA Phone +1-860-441-2626 Fax +1-860-441-2773 email iipcomms@uscg.mil www.uscg-iip.org/

Appendix 3 The Arctic Northeast Route Control Code

Appendix 2 of Russia's Rules of Navigation on the Water Area of the Northern Sea Route provides the following Navigation Restrictions on the Water Area of the Northern Sea Route based on ice class:

1. Ice zone free strengthening class ship and RS Ice1 – Ice3 ship, navigation period from July to November 15.

Ice class of the ship	Mode of ice navigation	Kara Sea		Laptev Sea		East Siberian Sea		Chukchi Sea
		south-western part	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) Oil tankers, gas carriers, gas carriers, and 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.

2) For ships without ice strengthening it is allowed to independently navigate in the water area of the Northern Sea Route only in open water.

2. RS Arc4-Arc9 ice class ship, navigation period from July to November

Category of ice strengthening of ship	Mode of ice navigation	Kara Sea		Laptev Sea		East Siberian Sea		Chukchi Sea
		south-western part	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
Arc4	Ind	– + +	– + +	– – +	– – +	– – +	– – +	– + +
	IA	+ + +	+ + +	– + +	– + +	– + +	– + +	– + +
Arc5	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	– + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc6	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc7	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc8	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc9	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +

3. RS Arc4-Arc9 ice class ship, navigation period from November to December and from January to June

Category of ice strengthening of ship	Mode of ice navigation	Kara Sea		Laptev Sea		East Siberian Sea		Chukchi Sea
		south-western part	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
Arc4	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Arc5	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– – +	– – +	– – +	– – +	– – +	– – +	– – +
Arc6	Ind	– – +	– – +	– – +	– – +	– – +	– – +	– – +
	IA	– + +	– + +	– – +	– – +	– – +	– – +	– + +
Arc7	Ind	+ + +	– + +	– – +	– – +	– – +	– – +	– + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc8	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Arc9	Ind	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +

4. Icebreaker6-Icebreaker8 ship, navigation period from January to June and December

Category of ice strengthening of ship	Mode of ice navigation	Kara Sea		Laptev Sea		East Siberian Sea		Chukchi② Sea
		south-western part	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
Icebreaker6	Ind	– + +	– + +	– – +	– – +	– – +	– – +	– + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Icebreaker7	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +
Icebreaker8	Ind	+ + +	+ + +	– + +	– + +	– + +	– + +	+ + +
	IA	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +	+ + +

Notes: ① Ice strengthening of ship Icebreaker9 ship is not limited to independent navigation in the water area of the Northern Sea Route.

② Ice strengthening of ship Icebreaker6-8 ship is permitted to independently navigate from July to November.

H: heavy ice conditions (in compliance with the official information of Roshydromet)

M: medium ice conditions (in compliance with the official information of Roshydromet)

L: light ice conditions (in compliance with the official information of Roshydromet)

+: navigation of ship is permitted

–: navigation of ship is prohibited

Appendix 4 Shipping Safety Control Zones in the Canadian Arctic Waters

The Canadian Arctic Waters are divided into 16 Safety Control Zones with the most serious ice condition in Zone 1 and the least serious ice condition in Zone 16 (see Figure 1), which provides the dates when ships of various ice capabilities may enter various zones (see Table 1).

If a Canadian 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 (Table 1), 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.

Please refer to the picture on the right for classification of shipping safety control zones.

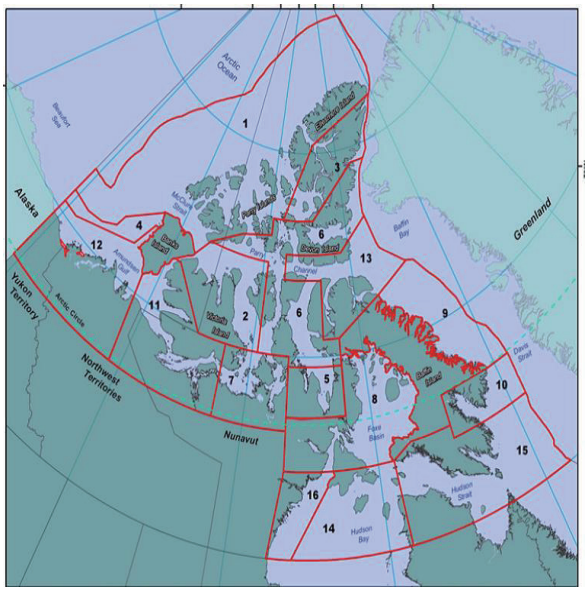


Table 1: Date of entering shipping safety control zones

Item	Col. I Category	Col. II Zone 1	Col. III Zone 2	Col. IV Zone 3	Col. V Zone 4	Col. VI Zone 5	Col. VII Zone 6	Col. VIII Zone 7	Col. IX Zone 8	Col. X Zone 9	Col. XI Zone 10	Col. XII Zone 11	Col. XIII Zone 12	Col. XIV Zone 13	Col. XV Zone 14	Col. XVI Zone 15	Col. XVII 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

Source: Arctic Waters Pollution Prevention Act Schedule VIII

Appendix 5 List of References

Serial number	Name of document
1	International Code for Ships Operating in Polar Waters (IMO MEPC.264(68))
2	Guidances on Arctic Navigation in the Northeast Route (2014) (Maritime Safety Administration of the People's Republic of China)
3	Rules of Navigation on the Water Area of the Northern Sea Route (2013) (Northern Sea Route Administration)
4	Ice Navigation in Canadian Waters (2012) (Canadian Coast Guard)
5	Offshore Vessel Operations in Ice and/or Severe Sub-zero Temperatures in Arctic and Sub-Arctic Regions (2014) (OCIMF)
6	Rules for Classification of Sea-going Steel Ships (CCS), PART EIGHT, Chapter 23
7	Guidelines for Polar Ships (2016) (CCS)
8	Statistical Data on Temperature in Polar and Sub-polar Regions (IMO/DSC1/INF.12)
9	A Tiered Risk Assessment Approach to Polar Operations Safety and the Mandatory Polar Code (IMO/DE54/INF.2)
10	Guidance on Methodologies for Assessing Operational Capabilities and Limitations in Ice (IMO/MSC.1/1519)
11	Guidelines for Ships Operating in Polar Waters (IMO A.1024 (26))
12	Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE) (Canada)
13	Sailing Directions (Pilots) (NP10/NP9/NP/11/NP23/NP12)
14	Antarctic Treaty (1959)
15	Enhanced Contingency Planning Guidance for Passenger Ships Operating in Areas Remote from SAR Facilities (IMO MSC.1/Circ.1184)
16	Guidelines on Voyage Planning for Passenger Ships Operating in Remote Areas (IMO Res. A.999(25))
17	Guidelines for Owners/Operators on Preparing Emergency Towing Procedures (MSC.1/Circ.1255)
18	International Medical Guide for Ships (WHO02)
19	Cold-proof Manual or Atlas
20	Atlas of Sea Ice Along Polar Voyages (written by Wei Lixin, Sun Hulin and Ren Beiqi in 2016)
21	Sea Ice Nomenclature Code (WMO No.259)
22	Guidelines for Voyage Planning (IMO Res. A.893(21))