Guidelines on
Operational Assessment of Polar Ships

2017

IRCLASS
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Introduction

International Maritime Organization (IMO) formally adopted the safety and environmental parts of the Polar Code at its Maritime Safety Committee meeting (on 21 Nov 2014) and Marine Environmental Protection Committee meeting (on 15 May 2015) in London, United Kingdom. IMO has developed Polar Code to promote safety and reduce the potential for environmental pollution from the increasing number of vessels operating in Polar waters. The Polar Code introduces a wide range of new regulations covering elements of design, construction, equipment and machinery, operational procedures, training, and pollution prevention.

A risk-based approach has been used to determine the scope of the Polar Code and Goal-Based Standards (GBS) have been used as the framework for regulations. GBS are comprised of at least one goal, functional requirements associated with that goal, and verification of conformity that regulations meet the functional requirements including the goals.

A list of hazards related to ship operations in polar waters were identified as a basis for developing the goals and functional requirements in the Polar Code. These hazards are listed in the Introduction of the Polar Code. They represent a minimum list of hazards for Polar Ships, other than the shipping hazards typically encountered by SOLAS ships.

Polar Code has introduced a concept of ”Operational Assessment” , under which shipowners/operators are required to undertake an operational assessment for all ships entering polar waters. The outcomes of the assessment should help define the operational limitations and capabilities of the vessel that are described in the Polar Water Operational Manual (PWOM) and referenced in the Polar Safety Certificate (PSC).The objective of this guideline is to provide guidance on performing operational assessment as required by Polar Code.

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1. General Information

1.1 Background

1.1.1 The Polar Code was developed by the International Maritime Organization (IMO) to provide for safe ship operations in polar waters and the protection of the Polar environment by addressing risks present in Polar waters not adequately mitigated by other IMO instruments. The Polar Code covers both safety and pollution prevention measures.

1.1.2 Provisions of Polar Code are made mandatory under the

a) SOLAS Convention with the addition of new chapter XIV
(IMO Resolution MSC.386(94));

b) MARPOL Convention with amendments to Annexes I, II, IV, and V
(IMO Resolution MEPC.265(68))

1.2 Overview of the Code

1.2.1 The Polar Code consists of the Introduction, part I and part II. The Introduction contains mandatory provisions applicable to both parts I and II.

1.2.2 Part I covers the safe design and operation aspects of ships in Polar Regions. Part I is subdivided into:

a) Part I-A, which contains mandatory provisions on safety measures; and

b) Part I-B containing recommendations on safety.

1.2.3 Part II considers the environmental protection of the Polar Regions. Part II is subdivided into:

a) Part II-A, which contains mandatory provisions on pollution prevention; and

b) Part II-B containing recommendations on pollution prevention.

1.2.4 The Code defines three levels of ship categories. The ship category is a reflection of the expected severity of ice conditions that the ship is anticipated to operate in. The definition in the Introduction part of the Code uses general ice descriptors based on World Metrological Organization (WMO) nomenclature.

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

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

c) Category C Ship
A ship designed to operate in open water or in ice conditions less severe than those included in Categories A and B.

1.2.5 The Polar Code is, in part, goal-based rather than purely prescriptive. This means that it describes an expected result without specifying how to achieve it. Shipowners/designers are expected to comply using a suitable combination of processes, procedures, equipment and systems which will depend on ship's required operation capabilities. Key elements of the Polar Code includes requirements for defining operational limitations and performing operational assessment.

1.3 Applicability

1.3.1 Polar Code applies to all ships carrying SOLAS certification that intend to operate in Polar Regions.

1.3.2 Part I applies to all new vessels whose keel is laid on or after 1 January 2017, and to in-service vessels from their first intermediate or renewal survey after 1 January 2018.

1.3.3 Part II applies to all vessels operating in Polar waters from 1 January 2017.

2. Operational Limitations

2.1 General

2.1.1 Polar Code introduces a concept of Operational Limitations, which are to be included on the Polar Ship Certificate (PSC).

2.1.2 It is recognized that within the Polar Regions there are significant variations in terms of hazards to shipping, primarily associated with variability of environmental conditions (such as low temperature, or the presence of sea ice) but also associated with remoteness and latitude.

2.1.3 Operational Limitations are set for each polar code ship for:

a) Ice Conditions

b) Temperature

c) Latitude

2.1.4 In addition the Polar Code requires a maximum “Expected Time to Rescue” (ETR) to be defined (and also included on the PSC).

2.1.5 Designing a ship with suitable equipment, systems and characteristics to mitigate the hazards of the extremes and remoteness of the entire polar environment would be difficult and inappropriate for ships not intended to operate in those extreme polar conditions. Since the ships will be limited in their operations based on its characteristics, writing details of the limitations on the certificate allows recording of this characteristics. For example, with respect to latitude, ships will be restricted to lower latitudes if they do not carry appropriate equipment to ascertain position (position fixing / heading).

2.1.6 As Operational Limitations are directly linked to the ship’s characteristics it is important to ensure the specification for the ship (e.g. ice class, Polar Service Temperature (PST), maximum ETR) align with where and when the ship is expected to operate in Polar Regions. This validation of the specification for the ship (or the existing ship’s characteristics) against the design operating conditions are recommended to form part of the Operational Assessment.

2.2 Ice Conditions

2.2.1 Operational limitations for ice conditions are assigned based on the ship’s ability to function safely in ice. Polar Code requires that a methodology be utilized to determine a set of operational limitations for operating in ice.

2.2.2 Guidance on such methodologies is contained within MSC.Circ.1519 – Guidance on methodologies for assessing operational capabilities and limitations in ice. Methodology for decision making support system using *“Polar Operational Limit Assessment Risk Indexing System” (POLARIS)* is annexed to this IMO circular. This circular also contains, as a footnote to paragraph 3.4, a description explaining how the link between this methodology and the Certificate should be made. It is recommended that limitations for ice conditions follow the same format as described in MSC.Circ.1519 when being proposed as outcomes of the operational assessment.

2.2.3 In addition other decision making support system may be used according to ship's intended navigation area in polar waters and paying attention to the requirements of coastal state.

a) "Arctic Ice Regime Shipping System (AIRSS)" by Canada

b) "Arctic Zone/time System" by Canada

c) "Ice Passport" by Russia

2.3 Temperature

2.3.1 Operational limitations for temperature are assigned based on the ship's ability (in terms of equipment, systems and materials) to function safely in low air temperatures. Polar Code makes a differentiation between ships that are intended to operate in low air temperatures and ships that are not.

2.3.2 Ships that are intended to operate in areas where the lowest mean daily low temperature (MDLT) is −10°C or warmer during the season of operation are not considered as operating in low air temperature. This is indicated in section 2.3 of the Polar Ship Certificate.

2.3.3 Where ships are intended to operate in areas where the lowest MDLT is colder than −10°C during the season of operation, a PST should be specified by the owner/operator, based on an examination of temperature data for the area of operation. The PST should be set a minimum of 10°C lower than the lowest MDLT for the area and season of operation identified in the operating envelope.

2.3.4 Validation of this specified temperature (or, for an existing ship, the design temperature that the ship was designed to) should form part of the operational assessment.

2.4 Latitude

2.4.1 Operational limitations for high latitudes are assigned based on the ability of the communication equipment on the ship to function effectively (transmit/receive) at high latitudes and the ship's ability to navigate/determine course heading at high latitudes.

2.4.2 Paragraph 10.3.1.1 of Part IA of the Polar Code requires equipment for effective ship-to-ship and ship-to-shore communication at all points along the intended operational route. Part IB of the Polar Code includes additional guidance on the operability of communication systems at high latitude:

> *"The theoretical limit of coverage for GEO (Geo Stationary) systems is 81.3° north or south, but instability and signal dropouts can occur at latitudes as low as 70° north or south under certain conditions. Many factors influence the quality of service offered by GEO systems, and they have different effects depending on the system design. "*

For Example:

Low Earth orbit (LEO) systems (such as, Iridium Satellite System), can be carried as supplementary communication equipment for operation close to the poles.

2.4.3 For navigation, the Polar Code requires a global navigation satellite system (GNSS) for ships operating above 80° latitude (paragraph 9.3.2.2.2 of Part IA of the Polar Code). The Polar Code Record of Equipment provides for an entry to indicate if a GNSS is provided for if operations above 80° latitude are expected.

2.4.4 Both communication and navigation rely on the functionality of the onboard equipment and it is this functionality (or lack of) that will limit high-latitude operation. As part of the operational assessment, the specification of this equipment should be reviewed and evaluated against the design operating conditions.

3. Operational Assessment

3.1 General

3.1.1 Paragraph 1.5 of the Polar Code requires an “Operational Assessment” to be carried out in order to establish procedures or Operational Limitations. As all ships will have Operational Limitations on the Polar Ship Certificate, the Operational Assessment is required for all ships. In addition, paragraph 8.2.3.3 of the Polar Code requires an assessment to be undertaken to establish appropriate survival resources following abandoning of ship.

> ***“1.5 Operational assessment***
>
> *In order to establish procedures or operational limitations, an assessment of the ship and its equipment shall be carried out, taking into consideration the following:*
>
> *.1 the anticipated range of operating and environmental conditions, such as:*
>
> > *.1 operation in low air temperature;*
> >
> > *.2 operation in ice;*
> >
> > *.3 operation in high latitude; and*
> >
> > *.4 potential for abandonment onto ice or land;*
>
> *.2 hazards, as listed in section 3 of the Introduction, as applicable; and*
>
> *.3 additional hazards, if identified.”*

3.1.2 The Operational Assessment is the methodology through which the shipowner/operator evaluates how the ship’s characteristics (either proposed or existing) in combination with the operational procedures mitigate the hazards of operating in polar waters. Operational assessment allows a review of the ship’s procedures and equipment against the expected operations and the operational environment. It is to be undertaken by the shipowner/operator in order to enable appropriate means of hazard mitigation identification and implementation in the ship specification/design.

3.1.3 The results of the operational assessment are to be submitted to IRS for review, and the operational limitations are to be approved. It should be noted that the Operational Assessment is not approved by the Flag Administration. However, because the outputs of the assessment lead to provision of procedures, equipment and Operational Limitations it is important that the Operational Assessment is performed in a structured way and that it is documented. It is anticipated that the decision making process in the Operational Assessment will be reviewed as part of Polar Code compliance.

3.1.4 The Operational Assessment is intended to cover:

a) Validation of the Operational Limitations, to be mentioned in Polar Ship Certificate

b) Establish Operational Procedures

c) Establish Survival Resources

3.1.5 Validation of the Operational Limitations

3.1.5.1 It is the responsibility of shipowner/operator to specify appropriate design features and operational procedures for the operating environment associated with their anticipated trade. Identification of the area and season of operation in polar waters and associated environmental conditions (temperature, ice conditions), is to be done to establish the ship’s required design parameters (ice class, PST, latitude and maximum expected time to rescue).

3.1.5.2 Identification done above essentially sets the applicable requirements for the Polar Code. The Operational Limitations required by the Polar Code are defined based on the anticipated environmental conditions expected by the shipowner/operator in the assessment.

3.1.6 Establish Operational Procedures

3.1.6.1 Depending on the operating environment, for mitigating polar hazards, equipment or systems, or operational procedures, or a combination of both may be provided.

3.1.6.2 The Operational Assessment is to be used by the shipowner/operator to establish what operational procedures are required (which will subsequently form part of the Polar Water Operations Manual (PWOM) content) and what equipment and systems are required (which will form part a new ship's specification or an existing ship's design features).

3.1.7 Establish Survival Resources

3.1.7.1 Chapter 8 of the Polar Code requires survival resources to be determined for abandonment onto water, land or ice. The Operational Assessment is to be used to identify which abandonment scenarios are appropriate and what equipment, systems and procedures are required.

3.1.8 The operational assessment is to output:

a) A report to describe the process undertaken and the decisions made by the shipowner/operator in terms of mitigating polar hazards through equipment and/or procedures.

b) develop the operational limitations which constitute the contents of the Polar Ship Certificate, including ice condition, temperature, high latitude and other limitations;

c) develop the operational procedures for the ship and its equipment which constitute the contents of the PWOM;

d) A list of equipment identified as means of meeting Polar Code requirements and addressing the risk of polar hazards.

e) determine the survival sources for abandonment onto ice or land

3.2 Steps for an Operational Assessment

3.2.1 Guidance on undertaking the Operational Assessment can be found in Part I-B of the Code.

"2.2 Steps for an operational assessment:

.1 identify relevant hazards from section 3 of the Introduction and other hazards based on a review of the intended operations;

.2 develop a model to analyse risks considering:

.1 development of accident scenarios;

.2 probability of events in each accident scenario; and

.3 consequence of end states in each scenario;

.3 assess risks and determine acceptability:

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

.2 assess whether risk levels are acceptable; and

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

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

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

.3 limit the circumstances in which failures may occur; or

.4 mitigate consequences of accidents; and

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

3.3 Identification of Hazards

3.3.1 Sources of hazards are identified in the Introduction to the Polar Code. The relevance of these sources of hazards is to be determined, primarily, by the environmental conditions. For example, ice accretion is a hazard source but if the ship is not likely to operate in areas subject to ice accretion then the ice accretion hazard is not relevant. Thus, relevant hazards can be filtered by considering the environmental conditions.

3.3.2 The risk level within polar waters may differ depending on the geographical location, time of the year with respect to daylight, ice-coverage, etc. Thus, the mitigating measures required to address the above specific hazards may vary within polar waters and may be different in Arctic and Antarctic waters.

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

3.4 Development of Risk Model

3.4.1 Accident Scenarios

3.4.1.1 For relevant hazards, the possible accident scenarios are to be identified, considering operational conditions, environmental conditions, cargo conditions, crew experience, capabilities of the ship and equipment.

3.4.1.2 The typical accident scenarios include, but not limited, to the following:

.1 Typical accident scenarios of the ship operating in ice zones

a) Encountering ice condition which exceeds the design operational capability, thus causing damage of the hull structure, thruster and steering gear;

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

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

d) During navigation near icebergs/glaciers, falling of ice results in damage of the ship and equipment;

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

f) Riding on the ice block or fixed ice, thus causing a reduced stability (small ships).

.2 Typical accident scenarios of the ship operating in low temperatures

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

b) Accumulation of ice/snow on the surface of the structure and equipment above the hull waterline results in a reduced stability;

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

d) Low environmental temperature at work and accommodation spaces results in loss of work ability, hypothermia and death to crew personnel;

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

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

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

.3 Typical accident scenarios of the ship operating at high latitude

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

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

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

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

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

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

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

3.4.2 Defining Risk Level

3.4.2.1 The identified hazards and their associated accident scenarios under consideration should be ranked to prioritize them and to discard scenarios judged to be of minor significance. The frequency and consequence of the scenario outcome requires assessment. Ranking is to be undertaken using available data, supported by judgment, on the scenarios. A generic risk matrix is shown below. The frequency and consequence categories used in the risk matrix have to be clearly defined. The combination of a frequency and a consequence category represents a risk level. Probability of events in each accident scenario; and consequence of end states in each scenario are to be identified.

		Consequence			
		Minor	**Significant**	**Severe**	**Catastrophic**
Frequency	**Frequent**				**High Risk**
	Reasonably Probable				
	Probable				
	Remote				
	Extremely Remote	**Low Risk**			

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

a) the design ice class;

b) performance of the equipment and system;

c) anti-cold climate measures;

d) training and experience of the crew;

e) operational experience of polar ship.

3.5 Assessment of Risk and determining acceptability

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

a) Developing operational procedure for ship and equipment system;

b) Providing the crew with the training of operating in polar waters;

c) Providing protective measures.

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

a) Developing operational limitations, for ensuring the ship is operated within the scope of the design operational capabilities;

b) Optimizing the design and arrangement of the system, improving the operational capabilities, eliminating the effect of human factors.

3.6 Operational Assessment Report

3.6.1 Operational assessment report is to consist the following:

a) Basic Information of Ship

b) Operating conditions

c) Description of Ship Operational Assessment Method

d) List of Identified Hazards and accident scenarios

e) Description of Risk Model and Risk assessment of the identified scenarios

f) Abandonment scenarios

g) Risk control measures

4. References

1. International Code For Ships Operating In Polar Waters (Polar Code)

2. MSC.Circ.1519 – Guidance on methodologies for assessing operational capabilities and limitations in ice

3. MSC-MEPC.2/Circ.12 - Revised Guidelines for Formal Safety Assessment (FSA) for rule making in IMO rule making Process

4. Standard IEC/ISO 31010 "Risk Management - Risk Assessment Techniques"