Implementation of the Polar Code – Perspectives on the Code Five Years On

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ABSTRACT

The IMO Polar Code is one of the first major pieces of maritime legislation to follow the IMO's goal-based standards framework. One of the basic principles stated by the IMO for goal-based standards is that they are "clear, demonstrable, verifiable, long-standing, implementable and achievable". This paper evaluates if this principle has been met by reviewing the Code text in the context of engineering solutions utilized in polar ship design practice. Experience of implementing the Code practically for several ship cases are used to provide a frame of reference. Challenges with implementing the Code are discussed by drawing on feedback from classification societies, administrations and designers involved in the Code's use. The means of verification of a ship's operational compliance with the Code – essentially how to ensure a level playing field for the maritime industry and a consistent level of safety is maintained – is identified as the core shortcoming.

KEY WORDS: Polar Code; Goal-Based Standards; Risk; Winterization

DEVELOPMENT OF THE POLAR CODE

The development of an international regulatory instrument for shipping in polar waters has its origins in the early 1990s, with a first draft of the "International Code of Safety for Ships Operating in Polar Waters (Code of Polar Navigation)" circulated in July 1996. Over twenty years later, the International Code for ships operating in Polar Waters (the Polar Code) entered into force on 1st January 2017 (IMO, 2014). Five years on from its entry into force, all SOLAS certificated ships operating in Polar waters must comply with the Code and carry a Polar Ship Certificate. During this implementation period several issues have arisen with regards to applying the Code's content as well as challenges with respect to interpreting how the Code is used, given that it was written using a goal-based framework. Furthermore, much has been learnt from applying regulations written as goal-based standards (GBS) that is applicable outside of polar regulations, indeed to all future regulations where GBS is used.

Between 1993 and 1998 an outside working group from the International Maritime Organization (IMO) was formed to determine the foundation approaches for regulating shipping in polar waters. These principles are still a valid basis through which to understand the context and purpose of the Polar Code. The principal approach agreed at the IMO was that requirements should not duplicate existing regulations, but supplement them, by addressing the additional hazards of operating in the Arctic region, in particular (ABS, 2016):

- Ships should have suitable ice strengthening for their intended voyages;

- Ice strengthening construction standards should be unified;
- Oil should not be carried against the outer shell;
- All crew members should be properly trained;
- Appropriate navigational equipment should be carried;
- Suitable survival equipment shall be carried for each person; and
- Consideration of vessel installed power and endurance must be made

The first regulatory text relating to operation in polar waters were the Guidelines for Operation in Arctic Waters, published by the IMO in 2002 as MSC/Circ.1056 (IMO, 2002). In 2009, the IMO stepped up efforts for a mandatory Polar Code: As with many international safety initiatives for ships, new impetus was given by a near disaster: the sinking of the *MV Explorer* in Bransfield Strait in November 2007 (Liberia Bureau of Maritime Affairs, 2009). Between 2010 and 2014 a series of working groups at the IMO developed the Polar Code text, leading to its finalisation in 2015.

GOAL BASED STANDARDS AND THE POLAR CODE

The Polar Code is one of the first international maritime regulations to be developed using a goal-based format, alongside the International Code for Ships using Gas as a Fuel (IMO, 2015). The intention to develop a rule-making framework using goal-based standards was introduced by the IMO's Maritime Safety Committee in 2000 (IMO, 2004). The goal-based standards (GBS) approach, which is often described as "rules for rules", was conceived on the recognition that the pace of IMO regulation was falling behind maritime technological development (Huss, 2007). Furthermore, the IMO acknowledged that it was not the best placed body to develop and maintain a detailed set of technical requirements for new and emerging technology.

The intention under the GBS framework is for the IMO to set high-level goals and accompanying functional requirements, while other competent bodies are left to develop the means to meet the functional requirements, either through complementary prescriptive rules or other, usually risk-based, approaches. As GBS are intended to be broad, over-arching safety, environmental and/or security standards that ships are required to meet during their lifecycle (Huss, 2007) the wait for empirical data to regulate can therefore be circumvented. In addition, GBS are intended to establish the level of safety to be achieved by the requirements of classification societies and other recognized organizations, administrations, and the IMO itself, rather than detailed prescriptive requirements which require detailed domain knowledge. The adoption of a GBS framework to IMO rule-making thus represents itself a step-change in the approach to maritime regulation.

Figure 1 presents the generic IMO Goal-based framework, (IMO, 2004) modified to include Polar Code references. In the figure a distinction is made between the standards developed by the IMO (Tiers I, II and III) and the complementing detailed requirements set by industry bodies, such as classification societies. For the Polar Code, the goal-based approach means that the Code is structured with one over-arching goal for each chapter. Each goal usually has several accompanying functional requirements, generally associated with a hazard or a collection of similar hazards. Every functional requirement is intended to have one or more regulations, which provide a (semi) prescriptive way of meeting the functional requirements. All functional requirements must be met although alternatives to the prescriptive regulations are allowed.

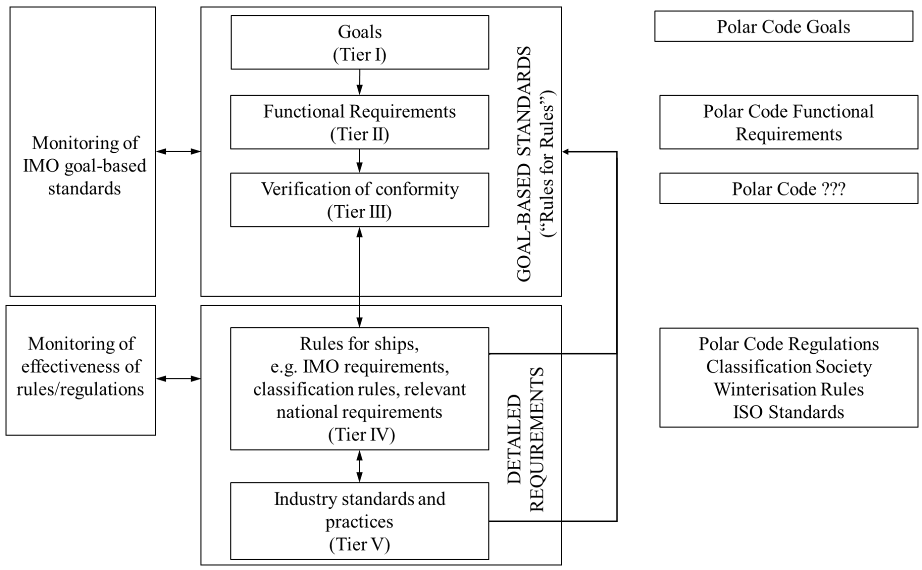

Figure 1. IMO Goal-based Standard Framework (modified from IMO, 2004)

Figure 1 illustrates that Tier I Goals and Tier II Functional Requirements are included in each Polar Code chapter. Tier I and II are supplemented by Regulations (Tier IV) in the Code. One immediately evident gap in the Polar Code is the lack of a structured process for verification of conformity (Tier III), although one could argue that the Regulations themselves are a means to verify conformity with the Functional Requirements. This lack of structured verification process becomes evident when the Code is used, as will be discussed in later.

One of the main motivations for the GBS approach was that it would allow alternatives to the prescriptive regulations in the Code, thus enabling the Code to be flexible with respect to technological advancements. However, the formal process (referenced as a footnote) for utilising alternatives to the Regulations is quite complex: The designer / owner is required to follow the IMO process for Alternative Design (MSC.1./Circ.1212) (IMO, 2002), which involves a significant amount of additional engineering and justification. However, the Tier IV Regulations in the Polar Code are often written in such a way that they allow alternative engineering / operational solutions themselves as they are still quite goal orientated. In this respect it is considered that the prescriptive requirements are sufficiently broad to avoid the alternative design route in most cases. However, this regulatory broadness has significant drawbacks itself – the vague wording leaves multiple solutions open without a means to benchmark which alternatives would comply and which would not.

IMPLEMENTATION FOCUS AREAS

The following section examines areas of the Polar Code which, through case studies, have been identified as being challenges for implementation. Polar Code text extracts are presented with recommendations for improvement. The accompanying sub-sections provides some commentary on the context and experiences from the case studies.

Case Studies for Reference

To evaluate the implementation success of the Polar Code experience from several Polar Code applications has been drawn upon. The ship cases are outlined in Table 1 and encompass a range of ship types and operational envelopes. Reference to these cases is made in the following sections where extracts of the Polar Code are evaluated against the IMO's own criteria of: Clarity of Requirements (Clear), Verification of Requirements (Verifiable) and Consistency (Implementable and Achievable). In addition, where examples are cited of approaches to compliance for equipment provision, these are referenced to the case studies by use of the case letter (see Appendix).

Table 1 – Overview of case study ships

Case	Ship Type	Ship Category	PST	High Latitudes	Max ETR	Ice Accretion
A	Icebreaker	A	-35	Yes	20	Yes
B	Bulk Carrier	B	-20	No	5	Yes
C	Expedition Cruise	A	-25	Yes	5	Yes
D	Cruise	C	No	No	5	No
E	Tanker	A	-45	Yes	5	Yes

Verifiable requirements – the status of the Operational Assessment

The concept of the Operational Assessment was introduced late in the Polar Code development: There was a need to recognise the variety of environmental conditions that a ship is designed for on the Polar Ship Certificate. As such, the Polar Ship Certificate was drafted with three separate operational limitations: ice conditions, low temperature, and high latitude, as well as a ship specific "maximum expected time to rescue" (max. ETR). To establish limitations, it was decided that an Operational Assessment should be carried out by the owner/operator but that it would not be approved by the Administration (or their delegated recognized organizations, ROs) as the Administrations recognized they did not have the competency to do so in many cases. This immediately appears unusual – a ship owner undertaking their own assessment to determine operational limitations that will then be entered on the ship's certificate. However, this is the case already during the usual ship specification process, where an owner will decide what ice class and what design temperature for the ship, based on the owner's understanding of the environment they intend to operate in. Unfortunately, once provision for the Operational Assessment became established in the Code it became somewhat of a "catch all" to avoid prescribing regulation. To speed up finalization of the Code detailed discussion on technical solutions were sometimes dropped in favour of the Operational Assessment. The rationale was that the regulations did not have to be so specific, because the Operational Assessment would capture how the risk was mitigated for each ship. One challenge is that the suitability of the limitations for the expected operational envelope is not necessarily verified and furthermore the Operational Assessment itself is not well defined, leading to differing approaches for identifying hazards and mitigating risk.

Table 2 includes the Polar Code text where the operational assessment is described. In all cases (A-E) an operational assessment was undertaken, although the format of the assessment varied. Case C followed a formal, structured risk assessment approach using HAZID / HAZOP software and guidewords. Such risk/based approaches are cross referenced as guidance in the Polar Code (IMO, 2002). Cases A and B took a similar, but more open approach, using a pre-populated set of worksheets and frequency/consequence categories. Case C used a gap analysis approach, supplemented by "brainstorming" to identify additional hazards. The Operational Assessment in Case E was undertaken by specialists from different design and operational disciplines in the company, contributing remotely - the final assessment being complied by the Operations Manager. In all cases the Operational Assessments were undertaken by the Owner/Operator (Cases A, C and D were facilitated by the classification society).

The output of the assessment (usually a report) naturally feeds into the Polar Water Operational Manual (PWOM) content, both of which are usually submitted to the administration or classification society for review, and sometimes approval. Although the Code itself is silent on the status of both documents, preference in the working group during the Code development was for the PWOM not to be approved. However, the question arises *against what criteria is the assessment reviewed and how are the decisions that are made in the assessment used as a basis for equipment provision, and verification?*

Table 2 – Polar Code Extract – Chapter 1.5, General

Text	Evaluation Comments and application experience
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.	Operational Assessment is used to establish operational limitations (which are written on the certificate, and thus an approved document issued by the administration) but the operational assessment is not approved by the administration meaning there is a verification gap. Provision of equipment is determined by the operational assessment, but as the assessment is not approved then the responsibility of determining appropriate equipment is left with the operator. As operators may use a variety of risk-based methods to assess the hazards, there is no consistency of the resultant safety level. ***Recommendation: Status of the operational assessment should be clarified. The approach (taken by some ROs) to review the outputs of the Operational Assessment should be standardized. Explicit risk-assessment criteria should be provided as a benchmark, against which deviations can be evaluated.***

There are no standard approaches in the Polar Code for what constitutes a complete Operational Assessment, or what level of risk is acceptable. This becomes further troublesome when combined with the loose phrasing in some of the Regulations (see following discussion on use of the phrase “means shall be provided”), which should be used as a benchmark reference for minimum safety levels. Again, it is left to the Administration or their ROs to evaluate the completeness of the assessment, resulting in inconsistent application and demands of the owner: For example, between the IACS members there are a range of approaches – to reviewing (Case A, Case B) or approving (Case C) the PWOM; to only checking that it exists onboard (Case E).

The loose way in which the Operational Assessment is defined and the relative vagueness in which it is linked to requirements and compliance has resulted in a broad range of approaches by Administrations and their ROs: Rigorous Operational Assessments are required by some ROs but in other cases the level of review undertaken by the ROs is minimal. The foundations of the Code would benefit greatly from a clearer description of the Operational Assessment and how it links in with limitations, equipment provision and approval / verification.

Tier IV Regulation ambiguity - means shall be provided

The intention of the goal-based approach to the Polar Code is that functional requirements (Tier II) are to be complied with and the regulations (Tier III) are an approved means to meet the functional requirements. However, in several areas of the Code, the regulations are themselves non-specific. Table 3 shows an extract from Chapter 5.3 of the Polar Code, where *means shall be provided* is used at the regulation level. This requirement can lead to a variety of *means* being proposed: In most of the case studies (A-D) the evaluation of what means were appropriate formed part of the Operational Assessment, but it is not clear from the Code that this is the intention. Furthermore, such ambiguity at the regulation level can lead to a number of potentially compliant solutions, the suitability of which is difficult to assess when there is no benchmark to compare against. For example, cases A, C and E identified heat tracing of doors as a suitable means, which is an equipment provision; whereas Case B identified operational procedures using manual methods, such as mallets and steam wands. These solutions effectively become the means of compliance, but it is not recorded on the ship's certificate. In Cases B this information is included as part of the procedures in the PWOM, but this document is not approved by the Administration. In Case D it was decided during the Operational Assessment to limit the ship to areas where ice accretion was not likely, and therefore no means were provided – this itself becomes an operational limitation but is not recorded anywhere on the certification.

Table 3 – Polar Code Extract – Chapter 5.3, Watertight and Weathertight Integrity

Text	Evaluation Comments and application experience
In order to comply with the functional r equirements of paragraph 5.2 above, the following apply: .1 for ships operating in areas and during periods where ice accretion is likely to occur, means shall be provided to remove or prevent ice and snow accretion around hatches and doors;	It is not clear which areas or when ice accretion is likely. IMO's Intact Stability Code identifies zones where ice accretion should be considered but is not referenced. ***Recommendation: As the assumption regarding operating in areas subject to ice accretion has impact on equipment provision, the PSC should be updated to include if the ship is configured to operate in areas where ice accretion is likely.*** "Means shall be provided" is used (elsewhere in the Code also) at the regulation level, but this phrase does not give clarity of requirements. Regulations are intended to provide an implementable means to meet the functional requirements and to act as a reference for alternative measures, but the wording is vague, leading to inconsistency of application. ***Recommendation: Means shall be provided should be replaced with examples of acceptable means which would act as a reference.***

Where the extract in Table 3 provides an example of one specific hazard (ice accretion) to be mitigated by suitable *means*, Table 4 presents an extract from Chapter 6.3, which addresses requirements for machinery installations. Similar to the example from Chapter 5, the lowest level of regulation (Tier IV) is nonspecific, but in this case, there are a variety of hazards listed without particular solutions to benchmark against. Again, for the case studies the Operational Assessment was used to address all the hazards, and to identify mitigation measures, however this approach not explicit. The text extract in Table 4 is a particular focus area because this one sub-item has an impact on a significant number of ship systems and equipment provision.

In addition to the ambiguity, it is unclear how the means of protection are to be recorded – this was identified as very important during the case studies: Continued compliance requires survey, and if equipment has been identified from the Operational Assessment as a means to mitigate hazards, it follows that this equipment must be onboard and must function for a Polar Ship Certificate to remain valid. Most other SOLAS certificates are accompanied by a Record of Equipment, which provides a comprehensive list of the equipment provided by the ship as required by the SOLAS prescriptive regulations. Surveyors attending onboard use this list to understand what equipment is provided to comply with the requirements as identified in the initial survey when the ship is built. The Polar Code has such a Record of Equipment, but it only lists the equipment prescriptively required by the Code. It does not, for example, list any of the equipment or winterisation means implied by the text in Table 4. The Harmonized Survey Guidelines (IMO, 2017) are intended to provide survey guidance for the Polar Code, however it is worthy to note that these guidelines simply repeat the Tier IV requirements – terms such as *checking that means are provided* are used.

To overcome the issue of verification, ships in Case Studies A and B used an additional Polar Ship Supplementary Information document (developed by Lloyd's Register (LR), the ship's classification society). This formal document, issued by LR captured all the additional equipment and other material means to meet Polar Code requirements, such as in Table 3 and Table 4. The document is appended to the Polar Ship Certificate and acts as a formal record of equipment that was identified as necessary from the Operational Assessment.

The Appendix to this paper includes the outline of a proposed Polar Ship Supplement which has been developed by reviewing the Code text and Operational Assessments undertaken in the case studies. Commentary is provided against each of the proposed entries as well as a Code cross reference. In addition, examples of the material/equipment *means* entered against each item for the case studies are identified.

Table 4 – Polar Code Extract – Chapter 6.3, Machinery Installations

Text	Evaluation Comments and application experience
.1 In order to comply with the functional requirement of paragraph 6.2.1.1 above, taking into account the anticipated environmental conditions, the following apply: .1 machinery installations and associated equipment shall be protected against the effect of ice accretion and/or snow accumulation, ice ingestion from sea water, freezing and increased viscosity of liquids, seawater intake temperature and snow ingestion;	The requirement for winterisation of machinery installations is approached by indicated that the equipment shall be protected from a number of hazards, but neither the means of protection, nor the level of protection is identified. It is implied, but not stated, that the means of protection are identified by the operator during the operational assessment. Inferring from this is that it is the operator that establishes the winterisation features and level of equipment provision. Consistent application of these requirements is therefore difficult. ***Recommendation: link between equipment provision and the operational assessment should be explicit (and by extension the criteria to identify appropriate levels of equipment of provision in the assessment should be explicit).*** Furthermore, once the equipment provision is established there is no direct mechanism for verifying that the equipment is necessary and installed on-board: The Record of Equipment which is attached to the certificate only records equipment explicitly required by the Code. ***Recommendation: Record of Equipment should be expanded or supplemented, so that the presence and material state of any equipment identified in the operational assessment as necessary to be onboard for mitigating hazards can be verified.***

CONCLUSIONS

The IMO's basic principle for goal-based standards is that they are "clear, demonstrable, verifiable, long-standing, implementable and achievable". Applying the Polar Code to several cases has identified that this principle has only partly been achieved. In all cases it should be recognized that the process of Polar Code compliance has encouraged a dialogue of safety thinking that was in some cases absent prior to the Code's introduction. In this respect it is considered that the introduction of the Polar Code has been a success.

Notwithstanding that some of the text itself is vague and difficult to interpret consistently, the main failing with the current Polar Code is the lack of a clear verification process between functional requirements, regulations and the Operational Assessment. This failing manifests in ways which leads to implementation challenges:

- The Operational Assessment's status as a regulatory tool is unclear – the assessment is used to set limitations and prescribe equipment necessary to mitigate hazards, but how these limitations and equipment are provided for, and surveyed against, is not clear.
- The rigour and depth of review of the Operational Assessment varies significantly across ROs. This leads to inconstancy in both the identification of hazards and the mitigation measures applied.
- There is no clear documentary evidence that can be used to trace or justify the outputs of the Operational Assessment to what is provided for onboard. The content of the Polar Ship Certificate and accompany Record of Equipment is insufficient and only reflects specific prescriptive requirements of the Code.
- Without a clear structure of supporting prescriptive regulations to meet the functional requirements in all cases, it is a challenge to ensure a consistent level of safety when there is no benchmark requirement to evaluate against.

These implementation challenges can also be recognized as opportunities for improvement, especially when approaching the development of other goal-based maritime regulations.

RECOMMENDATIONS

The implementation of a new regulation for sea areas where there is significant variability of environmental conditions, and using a new regulatory framework, has inevitably led to challenges. As concluded above, the most significant of these challenges is ensuring consistency of application of the regulations, given the goal-based framework which forms the basis of the Code. The following more specific recommendations are made to support an update of the Code, or for consideration for other regulatory developments following a goal-based format:

Textual amendments

The approach to goal-based standards is inconsistent in the Code. Revision of the text should ensure that functional requirements have accompanying regulations that set a measurable means of compliance, against which alternative proposals can be evaluated. In addition, a number of terms used in the Code, such as *appropriate means* and *means to be provided* should be replaced with technically viable solutions or a direct reference to the Operational Assessment as the tool to identify such means.

Operational Assessment Status

The Operational Assessment is essential to determining the equipment and procedure provisions in the Code. A clearer set of guidelines (risk evaluation methods used and approaches for determining and evaluating frequency, consequence and acceptable risk) to supplement Part I-B of the Code should be developed to ensure a consistent level of risk assessment is adopted. Furthermore, approaches should be harmonized on how the outputs of the assessment are used in verifying compliance, by documenting formally the outputs so that they are available during survey (see below). A harmonization would enable a more consistent review of the Operational Assessment by the RO and thus improve the baseline level of safety across the fleet assigned a Polar Ship Certificate.

Additional information on the Polar Ship Certificate

It has been identified that there are several decisions that are made by the owner during the Operational Assessment that limit the ship and determine equipment provision. To enable transparency, it is recommended that information be added to the Polar Ship Certificate as indicated in Table 5. The addition of these ship specific parameters would bring clarity to how the Code has been applied to the ship.

Table 5 Additional information recommended to be included on the Polar Ship Certificate

Additional Clarifying Text	Ship Specific Parameters
Ship intended to operate in areas where ice accretion is likely to occur	Yes/No
Ship intended to operate in extended periods of darkness	Yes/No
Anticipated abandonment to	Ice / Land / Water
Ship intended to be involved in icebreaker escort operations	Yes/No
Ship intending to provide icebreaking escort	Yes/No

Documentation of equipment provision determined from the Operational Assessment

The intention of the Code is that the Operational Assessment is used in many instances as a way of establishing appropriate equipment provision. This is indeed necessary when the anticipated environmental conditions are varied between ship operational areas. However, if the Operational Assessment uses risked-based approach to determine such equipment, then this equipment should become part of the ship's required inventory to retain a Polar Ship Certificate. It is therefore proposed to include a supplement to the Polar Ship Certificate that would clarify what equipment is installed and allow for consistent verification of compliance. Such a supplement has already been implemented by at least one classification society (Lloyd's Register). The table in the Appendix provides a format for such a supplement, where the first two columns would provide the basis for a template against which the Administration (or it's RO), could populatee a description of the equipment provided, when undertaking the Polar Code Initial Survey. This Supplement would then be available to any attending surveyor or Port State Control officer for reference when verifying that the ship continues to comply with the Polar Code requirements derived from the initial Operational Assessment.

Applicability to other IMO Instruments utilizing Goal-Based Standards

The Polar Code's status as one of the first IMO regulations to be developed in a goal-based standard format means there are inevitably recommendations to be carried forward for the future:

- The process of verification needs to be considered in its entirety when regulations are non-prescriptive. Where regulations are to be met by (risk) assessment processes there must be a transparent way of evaluating the processes. Although some ROs have introduced rigorous reviews of the Operational Assessment, the direction for verification should be set at the IMO level.
- Non-prescriptive or risk-based regulations diverge from a checklist approach to verification: There needs to be a structured way to document the initial decision-making process and to ensure that these decisions (e.g. selection of a certain equipment) are then carried forward to the ship itself, and are available for review to ensure that the ship remains in compliance when in service. Some ROs have already implemented additional verification measures, but these need harmonization.

- Verification should be at the forefront when developing individual functional requirements. Regulations should be tested to ensure that they answer, "does this provide a clear and verifiable requirement which can be used as a benchmark for alternative compliance".

In summary, a strong Operational Assessment is a necessary part of Tier III verification for the Polar Code, or any other regulation where risk assessments are used to identify and mitigate hazards. The Polar Code should be clearer on this aspect, and on how the outputs from the Operational Assessment are transparently converted in to surveyable (verifiable) items. Having a clear link between the Operational Assessment, equipment provision and surveyable items would lead to traceability during initial verification, continuity of survey for continued compliance by the RO and other third parties (such as Port State Control surveyors), while ensuring a consistent safety level is met across the Polar Code compliant fleet.

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APPENDIX – Proposed Polar Ship Certificate Supplementary Information

Reference	Equipment List	Rationale for inclusion (with example provision cross referenced to case studies)
Deck Equipment		
4.3.1.2	Equipment / means for removing ice from bulwarks, rails and erections	Explicit reference to equipment provision in the Code, implies there should be equipment provided for ships operating in areas during period where ice accretion is likely. Provision of equipment should be described (e.g. inventory of mallets, scrapers (Case B), steam wands Case A, E)) so that it can be surveyed for continued compliance. This should be "not applicable" if the ship is limited to operating in areas where ice accretion is unlikely (for example Case D).
5.3.1	Means for preventing ice and snow accumulation around hatches and doors	Code requires the ability to remove or prevent ice buildup, but does not indicate how: the type of means provided should be documented. Provision of equipment should be described (e.g. manual tools (Case B), steam wands (Case A, E)) so that it can be surveyed for continued compliance. This should be "not applicable" if the ship is limited to operating in areas where ice accretion is unlikely (Case D).
6.3.1.1	Means for protection of essential machinery installations from ice accretion and/or snow accumulation	Code requires machinery installations and associated equipment to be protected against polar conditions, but the extent of protection and the machinery to which it applies to is not stated. Definition of essential machinery could be implied from Classification Rule definitions, but the Operational Assessment should identify the extent of provision more precisely. The protection methods and equipment used should be described so that they can be surveyed for continued compliance (for Cases A, B and D a similar form to this Supplement has been used).
6.3.1.2	Means to protect liquids in exposed essential systems from freezing and increased viscosity	Code requires protection of liquids in exposed essential systems from freezing, but does not define acceptable approaches. These approaches (e.g. heat tracing in Case E) should be identified in the Operational Assessment and any equipment provision recorded so that they can be surveyed for continued compliance.
6.3.2.2	Means to protect engine room and machinery air intakes from snow ingestion	Code requires means to protect air intakes but the means are not defined. Means should be identified (e.g. heat tracing (Case A, C and E) or manual de-icing (Case B)) in the Operational Assessment and any equipment provision recorded so that they can be surveyed for continued compliance.
6.3.2.1	Equipment required to be certified for operation at PST	Code requires machinery installations and associated equipment to be functional at the PST but the extent of equipment is not identified. It is presumed to apply to essential machinery and, by extension this means mooring equipment as required by classification societies (SOLAS requires the ship to be classed, SOLAS Ch I, Reg.3-1 and class minimum requirements for propelled vessels include mooring equipment). Equipment provision (e.g. material specification, standstill heating (Case A, D and E)) should be described so that it can be surveyed for continued compliance.
Engine Room		
6.3.1.3	Sea chest and sea water intake arrangement to prevent ice ingestion	Code requires seawater supplies to be designed to prevent ice ingestion, taking into account the anticipated environmental conditions. Operational Assessment should be used to evaluate if these environmental conditions are expected and sea chest arrangements should be configured accordingly. Equipment provision (e.g. air and/or steam blowing (Case B), recirculation (Case A, C, E)) should be described so that it can be surveyed for continued compliance.
6.3.2.2	Means for ensuring main engine and emergency generator air supply is maintained at required temperature	Code requires arrangements to be in place for ensuring adequate air supply temperature. This may be achieved though specifying engines suitable for low air temperature (Case D), or by air-preheating and recirculation arrangements. Whichever approach is taken, it should be documented so that it can be surveyed for continued compliance.
6.3.2.1	Equipment required to be certified for operation at PST	The Code indicates that where equipment is exposed (e.g. unheated steering gear space) the equipment should be certified for that temperature. This is typically avoided by heating the spaces that equipment is located in, but where equipment is in cold spaces the approach to ensuring the equipment's continued function should be documented.
Fire Safety Systems		
7.2.1.1	Means for protecting exposed fire safety systems and appliances from ice accretion and snow accumulation	Regulations in Chapter 7 are not complimentary to the functional requirements. The extent of fire safety systems to be protected is not defined but should not be limited to the specific requirements in 7.3.1 Regulations. Equipment and protection from ice accretion (e.g. trace heating (Case A, C, E) or manual de-icing with operational procedures for monitoring ice build-up (Case B)) should be determined in operational assessment and described so that it can be surveyed for continued compliance.

7.2.1.3	Description of consideration given for use of fire safety systems and appliances wearing cold weather clothing	Code requires consideration for use of fire fighting equipment when wearing bulky cold weather clothes, but no further specific guidance is given on the extent of this, nor the bulkiness of clothing. Consequently, Operational Assessment should consider these approaches and generally identify any impacts of "bulky cold weather clothing" on operations in the PWOM (which was done in Cases A, B, C and E but concluded no particular action was required). However, any arrangement considerations should be documented to enable survey for continued compliance.
7.2.1.4	Means for removing or preventing ice and snow accretion from access of fire safety systems	Code requires the ability to remove or prevent ice buildup, but does not indicate how: the type of means provided should be documented. Provision of equipment should be described (e.g. manual tools (Case B), steam wands (Case A, E)) so that it can be surveyed for continued compliance.
7.3.3.1	Expected operating temperature for certification of extinguishing media for exposed firefighting equipment	Code requires that if portable and semi-portable extinguishers are kept in locations subject to freezing the equipment should be certified to the PST. Such equipment, if identified during the Operational Assessment, should be documented so that certification arrangements can be checked under survey. (In all cases no such portable extinguishers were stored in exposed locations, operational procedures were instead in place to ensure relocation of equipment as necessary).
7.3.1.1	Means to protect pressure / vacuum valves from ice accretion and means of access	Code requires PV valves to be protected from ice accretion. This may be by equipment provision or operational procedures. Where equipment is provided (e.g. trace heating, Case E) it should be documented so that it can be surveyed for continued compliance.
7.3.2.4	Means to clear fixed water-based fire system sea suctions from ice	Code requires similar ice clearing arrangements for fire system sea suctions as the engine sea water intakes. Equipment provision (e.g. air and/or steam blowing (Case A,C,E)) should be described so that it can be surveyed for continued compliance.
7.2.2.1	Equipment required to be certified for operation at PST	Code requires components of safety systems to be functional at the PST where they are exposed to low air temperature. Such equipment should be identified and documented, so that it can be checked under survey for compliance.
Survival equipment		
8.3.1.1	Means for removing or preventing ice and snow accretion from escape routes from muster stations to embarkation areas, survival craft and their lifting appliances	Code requires the ability to remove or prevent ice and snow accumulation but does not indicate how: the type of means provided should be documented. Provision of equipment should be described (e.g. deck heat tracing (Case A, C, E), steam wands (Case B)) so that it can be surveyed for continued compliance. This should be "not applicable" if the ship is limited to operating in areas where ice accretion is unlikely (Case D).
8.3.3.3.2	Content of Personal survival equipment	Code requires the Operational Assessment to identify appropriate personal survival resources. The guidance to the Code (Part I-B) gives examples of the content, but the content, derived from the Operational Assessment should be documented to enable survey for continued compliance. For cases with extended ETRs and remote locations the content of the survival equipment was enhanced (Case A, C).
8.3.3.3.2	Content of Group survival equipment	Code requires the Operational Assessment to identify appropriate group survival resources. The guidance to the Code (Part I-B) gives examples of the content, but the content, derived from the Operational Assessment should be documented to enable survey for continued compliance. For cases with extended ETRs and remote locations the content of the survival equipment was enhanced (Case A, C).
8.3.3.3.2	Additional survival resources	Code indicates that the Operational Assessment should be used to identify any additional survival resources needed. If the assessment identifies necessary equipment provision (e.g. heated shelter) it should be documented so that it can be surveyed for continued compliance. For cases with extended ETRs and remote locations additional survival resources – tents and on-ice accommodation – were specified (Case A, C).
8.2.3.3	Additional survival craft for abandonment	Code indicates that the Operational Assessment may identify alternative means for abandoning the ship (e.g. in the case where lifeboats, such as free-fall type are practically non deployable). In some cases SOLAS survival craft may be supplemented by other boats carried by the ship (Case A, Case C). In such cases these should be recorded as being part of the survival craft inventory and surveyed for continued compliance.
8.3.2.1	Equipment provided for means of abandonment and deployment of survival resources	Code requires means of safe evacuation in ice covered waters and/or directly on to ice. The means for doing so may be a combination of standard equipment (e.g. accommodation ladder (All Cases)) or additional equipment, such as a shipboard crane (Case A, Case C). Where the Operational Assessment identifies that such cranes be used for deploying survival resources they should be specified to function at the Polar Service Temperature and any winterisation features recorded so that it can be surveyed for continued compliance.
8.3.2.2	Lifesaving appliances and equipment requiring power independent of the ship's	Code identifies that if life saving appliances or survival resources are deployed by powered equipment then the power should be available from an emergency source. Such arrangements (e.g. crane HPU connected to emergency switchboard, Case A) should be documented and then arrangement described so that it can be surveyed for continued

	main source of power	compliance.
8.3.3.3.3.5	Description of survival craft loading for use during abandonment (all up weight of survival craft. persons, rations, survival equipment) tonnes	The Operational Assessment is used to determine additional survival resources and rations to be carried. Often the crew is required to bring such equipment and supplies into the lifeboat before abandonment. Consequently, the lifeboat (or other survival craft) require an increased capacity (or a decrease in the number of persons) (Case A, Case C). This should be documented so that it can be surveyed for continued compliance.
8.3.3.4	Emergency rations provided. Food (kJ/person/day) Water (L/person/day)	The Code requires emergency rations to be provided for the maximum expected time to rescue. The Code does not specify the energy and water requirements explicitly, which should be determined during the Operational Assessment, based on the polar service temperature (survival at lower temperatures requiring more energy). The provision of rations determined from the assessment should be recorded so that the presence of appropriate rations onboard can be confirmed. For cases with extended ETRs or remote locations rations were extended (Case A, Case C), for Case D SOLAS standard rations were considered acceptable.
1.4.3	Survival resources requiring active functionality for max ETR	Chapter 1 of the Code includes performance standards for the full functionality of survival systems and equipment at the PST and for the maximum expected time to rescue. This overarching requirement is applied to all survival resources that are identified in the Operational Assessment as being necessary for abandonment and survival. The equipment should be identified so that certification can be confirmed and the equipment's continued presence and function on board can be surveyed for compliance (Case A, C, E).
1.4.3	Equipment required to be certified for operation at PST.	
Bridge		
9.2.1	Means of receiving and displaying ice information	Code requires the ability to received ice information. The equipment used for this (e.g. internet connection with access to ice service data (all cases)) should be documented so that its presence and function on board can be surveyed for continued compliance.
9.3.2.1.3	Means to protect antennas from ice accumulation	Code requires navigation and communication antennas to be protected from ice accretion, for ships anticipating operating in areas where ice accretion is likely. It should be documented if the ship is intended to operate in such areas, to ensure consistency of verification. The means for keeping antennas ice free (e.g. heat tracing (Case A, C, E) or operation procedures using manual tools (Case B)) should be recorded so that it can be surveyed for compliance.
9.3.2.1.2	Means to maintain a clear view ahead and astern from bridge windows	Code requires a clear view ahead and astern and references SOLAS Ch.V Reg. 22.1.9.4 which indicates the view should be maintained regardless of the weather conditions. This implies equipment provision to keep the bridge windows free from ice (e.g. heated glass (Case A, D, E) or warm air blowers (Case B)). This equipment provision should be documented so that it can be surveyed for compliance.
9.3.2.1.1	Provision and arrangement of echo sounding devices	For ice strengthened ships the Code requires two independent echo sounders or one device with two separate transducers. Description of this provision already exists on the Record of Equipment but it is not clear from the form of the Record which of the two options the ship is provided with. This should be clearly stated to enable verification. Cases A, B, C and E have two separate devices.
10.3.1.1	Means of ship to ship cand ship to shore communication provided for high latitude and low temperature operations	Code requires ship-to-ship communication capabilities considering the high latitudes and low temperature. The Operational Assessment should establish if special equipment is required for high latitude functionality. If so, it should be specified here (e.g. provision IRIDIUM, Case A and C) so that it can be surveyed for compliance.
9.2.2.1	Equipment required to be certified for operation at PST	Code requires navigation equipment and systems to retain their functionality under the expected environmental conditions. In general this implies functionality at the PST. The equipment that is exposed and requires provision to function at low temperature (e.g. heat tracing) should be described so that it can be surveyed for compliance.
9.3.2.1.4.1	Protection arrangements for sensors for navigational equipment projecting below the hull from ice	The Code requires SOLAS sensors projecting from the hull to be protected against ice, but it does not state what protection is considered adequate. The approach to protecting sensors should be described to ensure consistent verification. (In no cases was this identified as an issue, however reinforced covers designed to withstand the ice load were implemented for scientific instrumentation on Case A and Case C, although the covers were flush).