No. 189 (June 2025)

Recommendation for Determining the Equivalent Level of Safety Required by the Polar Code

1. General

1.1 The IMO Polar Code requires the scantlings of hull structure and the strength of the propulsion machinery of ships of Category A to have an equivalent level of safety to that of Polar Class 1 - 5 (PC1 - PC5). This implies a minimum equivalent level of safety to that of Polar Class notation PC5 for a Category A ship.

1.2 The IMO Polar Code requires the scantlings of hull structure and the strength of the propulsion machinery of ships of Category B to have an equivalent level of safety to that of Polar Class 6-7 (PC6 - PC7). This implies a minimum equivalent level of safety to that of Polar Class notation PC7 for a Category B ship.

1.3 This document gives recommendations for determining the equivalent level of safety required by the Polar Code for assigning a Ship Category to ships not assigned with an IACS Polar Class.

2. Definitions

2.1 The following definitions are used in this document:

Polar Class	Polar Class notation assigned to ships complying with the Unified Requirements for Polar Class ships (IACS UR I)
Polar Code	The International Code for Ships operating in Polar Waters
Ship Category A	As defined by the Polar Code, means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions
Ship Category B	As defined by the Polar Code, means a ship designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions
Required Polar Class	The Polar Class level of safety required for the assignment of ship category
PST	As defined by the Polar Code, the Polar Service Temperature (PST) means a temperature specified for a ship which is intended to operate in low air temperature, which shall be set at least 10°C below the lowest mean daily low temperature for the intended area and season of operation in polar waters.
t_D	As defined in UR S6, the design temperature t_D is to be taken as the lowest mean daily average air temperature in the area of operation. The design temperature shall be no more than 13°C higher than the Polar Service Temperature of the ship.
POLARIS	Polar Operational Limit Assessment and Risk Indexing System, as described in MSC.1/Circ.1519.

Weighted areaRatio between the sub-area and the total area obtained by dividing the sub-area by the total Polar Class Hull Area under consideration.

3. Objective and application

3.1 The objective of this recommendation is to present a simplified procedure and criteria for assigning a Ship Category to ships not assigned with an IACS Polar Class but ice-strengthened in compliance with another standard the intention of which includes expected operations in the ice conditions defined for the ship category considered.

3.2 The recommended procedure in this document may also be used to evaluate ships not assigned an IACS Polar Class when using methodologies for assessing operational capabilities and limitations in ice, such as POLARIS.

3.3 The recommended procedure in this document should not be used as a basis for assignment of Polar Class notations.

3.4 The result of applying this recommended procedure to establish the equivalent level of safety should be used as part of the basis for assigning a Ship Category for issuance of the Polar Ship Certificate. It is recommended that the results be documented and retained as part of the ship's Polar Water Operational Manual.

4. Methodology

4.1 The methodology requires the identification of the *required Polar Class*. The *required Polar Class* should be used for establishing the strength and material requirements to be evaluated against. For Ship Category A the minimum *required Polar Class* is PC5. For Ship Category B the minimum required Polar Class is PC7. In cases where the evaluations of the hull and the propulsion machinery result in different categories, the ship shall be assigned the lower of the two categories to ensure that both hull and machinery are compatible with the assigned polar class.

4.2 A quantitative method for assessing the equivalent level of safety between as-built arrangements and *required Polar Class* compliant arrangements is presented.

4.3 The assessment method is based on the scantlings for ice strengthened hull structures; material grades of structures exposed to low air temperature; strength and material of the propeller blades and propulsion line strength.

5. Recommendations for evaluation of hull structure scantlings

5.1 For the assessment of ice strengthened hull structures, the comparison of scantlings should use as many areas of the hull as practical. Steel weight of the shell plating and main frames of the entire vessel should be used in assessing the compliance of the as-built structure to the *required Polar Class* scantling requirements.

Selection of Areas for Scantling Assessment

5.2 The area of comparison should be defined in order to select the representative plating and framing over the area. The overall structural arrangement, scantlings or material within the area of comparison should be uniform or with gradual changes (tapering) without abrupt discontinuities, hence representative plating and framing can be determined. If not, the area of comparison should be subdivided into multiple “sub-areas” to more accurately determine the representative structural member.

a) The boundaries of ice-strengthened areas should be determined in accordance with the Hull Areas defined in UR I2 for the *required Polar Class*. The area should be determined from the shell expansion plan as the projected area. These areas are termed Polar Class Hull Areas. (Hull Areas where no Area Factor is defined for the *required Polar Class* may be omitted).

b) The Polar Class Hull Area can be divided into sub-areas:
   (i) where the hull area under consideration is relatively large, (e.g. 30% or greater) compared to the total Polar Class Hull Area under consideration; or
   (ii) wherein the structural arrangement, scantlings or material in the Polar Class Hull Area are not uniform or without gradual changes or with abrupt discontinuities

c) Recommendations on when to divide sub-areas are as follows:
   (i) When the framing system changes, e.g., longitudinal / transverse / oblique
   (ii) When the frame spacing changes
   (iii) When the span of the frame changes abruptly, e.g., due to deck height change, presence of intermediate frame or stringer
   (iv) The change of plate thickness within the sub-area is not considered as an abrupt change if tapering is applied over a larger area which includes the sub-area.

Scantling Assessment

5.3 Shell plating within each Polar Class Hull Area should be assessed as follows:

1. The as-built gross plate thickness should be determined for each sub-area of the Polar Class Hull Area under consideration. The location for the selection of the thickness is to be at the centre of each sub-area.
2. The required minimum ‘gross’ plate thickness for the required Polar Class should be determined for respective sub-area following UR I2.4 (Shell Plate Requirements). The frame spacing, s, and material yield stress, σy, should be used.
3. The ratio of as-built plate thickness to the thickness for the required Polar Class, termed “plating ratio”, should be calculated for each respective sub-area and should not be taken greater than 1.2
4. The “plating compliance ratio” is calculated by multiplying the “plating ratio” and the “weighted area” for each sub-area.
5. The “plating compliance index” for each Polar Class Hull Area is defined as the sum of plating compliance ratios.

5.4 Framing within each Polar Class Hull Area should be assessed as follows:

1. The as-built gross sectional area of the main frame (i.e., shell stiffeners) should be determined for each Polar Class Hull Area of the vessel. The as-built gross sectional area of the main frame shall be taken as the sum of the areas of the web and flange, excluding the attached shell plating. The location for the selection of the frame to be considered should be at the centre of each sub-area.

2. The required minimum gross sectional area of the main frames for the required Polar Class should be determined for respective sub-area following UR I2.6 (transverse configurations) or UR I2.7 (longitudinal configurations). The frame spacing, s, span, type of section (bulb/angle/built-up), and material yield stress, σy, shall be used. The required minimum gross sectional area of the main frames shall be taken as the sum of the areas of the web and flange for a shell stiffener that complies with the *required Polar Class.*
3. The ratio of the as-built gross sectional area to those of the required frame, called "frame ratio", should be calculated for each respective sub-area and should not be taken greater than 1.2
4. The "frame compliance ratio" is calculated by multiplying the "frame ratio" and the "weighted area" for each sub-area.
5. The "frame compliance index" for each Polar Class Hull Area is defined as the sum of the frame compliance ratios.

Scantling Compliance Indices

5.5 For each Polar Class Hull Area a Scantling Compliance Index should be determined. The scantling compliance index for each Polar Class Hull area is defined as the average of the plating compliance index and the frame compliance index for each Polar Class Hull Area.

6. Recommendations for evaluation of material of ice strengthened hull structure and material exposed to low air temperature

6.1 For the assessment of material of ice strengthened hull structure material and material exposed to low air temperature the extent of application for evaluation is limited to identified structural members which are considered essential to the overall integrity of the ship and members which are in way of critical load transfer / impact points. The required material steel grade for these structural members can be used in assessing the compliance. The as-built structural member material grade should be compared with the *required Polar Class* material grade requirements.

6.2 In addition to material grade requirements for the required Polar Class the Polar Code also requires material grades to be sufficient for the Polar Service Temperature assigned to the ship. Where a Polar Service Temperature is assigned, the as-built structural member (as identified in Table 1) material grade should also be compared with the required material grade for the Polar Service Temperature in accordance with URS6 Use of steel grades for various hull members – ships of 90 m in length and above. See Tables 2, 3 and 4.

Selection of structural members for material grade assessment

6.3 The following structural members should be identified for assessment, where provided for:

a) All structural members if SPECIAL Category as identified in Table 1 (material class II and III)

b) All structural members of PRIMARY Category within 0.4L of amidships, as identified in Table 1 (material class II)

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c) Shell plating within the bow and bow intermediate icebelt hull areas (B, B_{Ii}) (material class II)

d) Plating materials for stem and stern frames, rudder horn, rudder, propeller nozzle, shaft brackets, ice skeg, ice knife and other appendages subject to ice impact loads (material class II)

Material grade assessment

6.4 Structural members identified in 6.3 should be assessed as follows:

1. The as-built material grade can be determined for each structural member individually. Individual structural members are considered an individual plates / strake.

2. For each structural member, based on the material class, the required material grade should be determined with the required Polar Class material grade requirements. Where a Polar Service Temperature is defined this should be used in determining the appropriate column for requirements in Tables 2, 3 and 4.

3. The as-built material grade and required material grade should be compared for each structural member individually. Where the as-built material grade is equal or greater to the required material grade for the *required Polar Class* the compliance result for the individual structural member is considered as 1. Where the as-built material grade is less than the required material grade for the required Polar Class the compliance result for the individual structural member is considered as zero.

4. The overall material compliance result is given by the sum of the compliance result for each individual structural member divided by the total number of individual structural members.

6.5 For existing vessels where the Classification Society needs to assess the material properties, for example, transfer of Class from a non-IACS member, then the original records and service history should be evaluated for equivalency in determining the acceptance by the Classification Society.

7. Recommendations for evaluation of propeller and propulsion line strength

1. Materials used in the propulsion machinery should in general fulfil the requirements in UR I3.3.

2. The pyramid strength principle as laid out in UR I3.6.1 should be fulfilled. Alternatively, a similar criterion from the vessel's original construction may be accepted, i.e. failure of one propeller blade by bending in the root area should not cause damage to any other components in the propulsion line.

3. Blade loads Ff and Fb are to be determined in accordance with I3.5.3 and assessed in accordance with I3.6.3. PC5 and PC7 are used as minimum levels for Category A and B ships, respectively. Alternatively, where is it not possible to create an FE model of the propeller blade, blade root scantlings may be evaluated by a simple cantilever beam approach for stress calculation of a blade exposed to forces Ff and Fb from I3.5.3. Fatigue evaluation of the blades is not required.

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4. The propulsion shaft line should be evaluated for a peak torque Q_r as given in UR I3.5.6.4 a), with safety factors as given in I3.6.5.2.2 and I3.6.5.2.3 for fatigue evaluation (if applicable). For propulsion plants with a significant resonance within the operational speed range, the peak torque should be specially considered. Fatigue evaluation of the shaft line components is not required, unless the components have design features with particularly high stress concentration factors (e.g. OD shafts with longitudinal slots).

5. Sufficient global strength of the structure of propulsion thrusters should be evaluated by applying forces resulting from a relevant ice pressure acting on the unit in lateral and thrust directions. UR I3 6.6 for "Azimuthing main propulsors" could be referred.

6. With reference to UR I3.2.2, for equivalency with Category A the vessel should have means provided to ensure sufficient vessel operation in the event of propeller damage. Further, vessels of Category A and Category B should have means provided to free a stuck propeller by turning it in reverse direction. “Sufficient vessel operation” is defined in paragraph 2.2.2 of UR I3.

7. Rudder actuators should comply with UR I3.13.2. PC5 and PC7 are used as minimum levels for Category A and B ships, respectively.

8. Fastening of equipment should comply with the requirements in UR I3.8. Alternatively, satisfactory historical operational experience with operations in ice may be considered.

8. Criteria for determining equivalent level of safety

8.1 For ships constructed on or after 1 January 2017 the following criteria should be met for the ship to be considered as meeting an equivalent level of safety to the *required Polar Class:*

1. Scantling Compliance Index for every Polar Class Hull Area equal or greater than 1
2. Plating compliance index and frame compliance index equal or greater than 0.8
3. Material Compliance result is equal to 1
4. Compliance with section 7 above

8.2 For ships constructed before 1 January 2017 the following criteria should be met for the ship to be considered as meeting an equivalent level of safety to the *required Polar Class:*

1. Scantling Compliance Index for every Polar Class Hull Area equal or greater than 1
2. Plating compliance index and frame compliance index equal or greater than 0.8
3. Material Compliance result is equal to 1
4. Compliance with section 7 above

8.3 For ships constructed before 1 January 2017 where the criteria in 8.2 are not met, further evaluation should be carried out, based on the following recommendations:

1. Where the Scantling compliance Index for a Polar Class Hull Area is less than 1, a risk assessment should be carried out to demonstrate an equivalent level of safety identifying risk mitigation measures incorporated into the design of the ship.

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Where a risk assessment is supplemented by further structural analysis the acceptance criteria should be specified by the Classification Society, as guidance the criteria included in URI2.17.5 may be considered.

2. Where the material compliance result is less than 1 and the ship is assigned a Polar Service Temperature, the Polar Service Temperature should be increased and the material may be re-evaluated.
3. Where the material compliance result is less than 1 and the ship is not assigned a Polar Service Temperature the material compliance result may be waived if operational limitations for temperature are imposed which limit the ship to operating in areas where the lowest mean daily low temperature is not lower than -10°C.

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Table 1 Structural Member Category and Material Class

	Material Class	
Structural member category	**Within 0.4L amidships**	**Outside 0.4L amidships**
PRIMARY: • Strength deck plating[1]	II	I
SPECIAL: • Sheer strake at strength deck[2] • Stringer plate in strength deck[2] • Continuous longitudinal hatch coamings	III	II

Notes

[1] Plating at corners of large hatch openings to be specially considered. Class III or Grade E/EH to be applied in positions where high local stresses may occur.

[2] Not to be less than Grade E/EH within 0.4L amidships in ships with length exceeding 250 metres.

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Table 2 Minimum steel grade requirements for class I material

MINIMUM STEEL GRADE FOR MATERIAL CLASS I - PC5										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	B	AH	B	AH	B	AH	D	DH	D	DH
10 < t ≤ 15	B	AH	B	AH	D	DH	D	DH	D	DH
15 < t ≤ 20	D	DH	D	DH	D	DH	D	DH	E	EH
20 < t ≤ 25	D	DH	D	DH	D	DH	D	DH	E	EH
25 < t ≤ 30	D	DH	D	DH	D	DH	E	EH	E	EH
30 < t ≤ 35	D	DH	D	DH	D	DH	E	EH	E	EH
35 < t ≤ 40	D	DH	D	DH	E	EH	E	EH	Ø	FH
40 < t ≤ 45	E	EH	E	EH	E	EH	E	EH	Ø	FH
45 < t ≤ 50	E	EH	E	EH	E	EH	Ø	FH	Ø	FH

MINIMUM STEEL GRADE FOR MATERIAL CLASS I - PC7										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	B	AH	B	AH	B	AH	D	DH	D	DH
10 < t ≤ 15	B	AH	B	AH	D	DH	D	DH	D	DH
15 < t ≤ 20	B	AH	B	AH	D	DH	D	DH	E	EH
20 < t ≤ 25	B	AH	D	DH	D	DH	D	DH	E	EH
25 < t ≤ 30	B	AH	D	DH	D	DH	E	EH	E	EH
30 < t ≤ 35	B	AH	D	DH	D	DH	E	EH	E	EH
35 < t ≤ 40	D	DH	D	DH	E	EH	E	EH	Ø	FH
40 < t ≤ 45	D	DH	D	DH	E	EH	E	EH	Ø	FH
45 < t ≤ 50	D	DH	E	EH	E	EH	Ø	FH	Ø	FH

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Table 3 Minimum steel grade requirements for class II material

MINIMUM STEEL GRADE FOR MATERIAL CLASS II – PC5										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness			MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	B	AH	B	AH	D	DH	D	DH	E	EH
10 < t ≤ 15	D	DH	D	DH	D	DH	E	EH	E	EH
15 < t ≤ 20	D	DH	D	DH	D	DH	E	EH	E	EH
20 < t ≤ 25	D	DH	D	DH	E	EH	E	EH	Ø	FH
25 < t ≤ 30	E	EH	E	EH	E	EH	E	EH	Ø	FH
30 < t ≤ 35	E	EH	E	EH	E	EH	Ø	FH	Ø	FH
35 < t ≤ 40	E	EH	E	EH	E	EH	Ø	FH	Ø	FH
40 < t ≤ 45	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø
45 < t ≤ 50	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø

MINIMUM STEEL GRADE FOR MATERIAL CLASS II - PC7										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	B	AH	B	AH	D	DH	D	DH	E	EH
10 < t ≤ 15	B	AH	D	DH	D	DH	E	EH	E	EH
15 < t ≤ 20	B	AH	D	DH	D	DH	E	EH	E	EH
20 < t ≤ 25	B	AH	D	DH	E	EH	E	EH	Ø	FH
25 < t ≤ 30	D	DH	E	EH	E	EH	E	EH	Ø	FH
30 < t ≤ 35	D	DH	E	EH	E	EH	Ø	FH	Ø	FH
35 < t ≤ 40	D	DH	E	EH	E	EH	Ø	FH	Ø	FH
40 < t ≤ 45	D	DH	E	EH	Ø	FH	Ø	FH	Ø	Ø
45 < t ≤ 50	D	DH	E	EH	Ø	FH	Ø	FH	Ø	Ø

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Table 4 Minimum steel grade requirements for class III material

MINIMUM STEEL GRADE FOR MATERIAL CLASS III - PC5										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	E	EH	E	EH	E	EH	E	EH	E	EH
10 < t ≤ 15	E	EH	E	EH	E	EH	E	EH	Ø	FH
15 < t ≤ 20	E	EH	E	EH	E	EH	E	EH	Ø	FH
20 < t ≤ 25	E	EH	E	EH	E	EH	E	FH	Ø	FH
25 < t ≤ 30	E	EH	E	EH	E	EH	Ø	FH	Ø	FH
30 < t ≤ 35	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø
35 < t ≤ 40	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø
40 < t ≤ 45	E	EH	Ø	FH	Ø	FH	Ø	Ø	Ø	Ø
45 < t ≤ 50	F	FH	Ø	FH	Ø	FH	Ø	Ø	Ø	Ø

MINIMUM STEEL GRADE FOR MATERIAL CLASS III - PC7										
PST	-24°C/-28°C		-29°C/-38°C		-39°C/-48°C		-49°C/-58°C		-59°C/-68°C	
t_D	-11°C/-15°C		-16°C/-25°C		-26°C/-35°C		-36°C/-45°C		-46°C/-55°C	
Thickness	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT
t ≤ 10	B	AH	D	DH	D	DH	E	EH	E	EH
10 < t ≤ 15	D	DH	D	DH	E	EH	E	EH	Ø	FH
15 < t ≤ 20	D	DH	D	DH	E	EH	E	EH	Ø	FH
20 < t ≤ 25	D	DH	E	EH	E	EH	E	FH	Ø	FH
25 < t ≤ 30	E	EH	E	EH	E	EH	Ø	FH	Ø	FH
30 < t ≤ 35	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø
35 < t ≤ 40	E	EH	E	EH	Ø	FH	Ø	FH	Ø	Ø
40 < t ≤ 45	E	EH	Ø	FH	Ø	FH	Ø	Ø	Ø	Ø
45 < t ≤ 50	E	EH	Ø	FH	Ø	FH	Ø	Ø	Ø	Ø

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