Tasneef®
Life Environmentally Optimized

# Guide for the Implementation of the Polar Code

*Effective from 1 January 2018*

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# GENERAL CONDITIONS

**Definitions:**

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.

*"IACS"* means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

*"Rules"* in these General Conditions means the documents below issued by the Society:

(i) Rules for the Classification of Ships or other special units;
(ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
(iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
(iv) Guides to carry out particular activities connected with Services;
(v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

*"Ship"* means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

**Article 1**

**1.1.** The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
(i) sets forth and develops Rules;
(ii) publishes the Register of Ships;
(iii) issues certificates, statements and reports based on its survey activities.

**1.2.** The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

**1.3.** The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

**Article 2**

**2.1.** The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

**2.2.** The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatemen t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

**2.3.** The Society exercises due care and skill:
(i) in the selection of its Surveyors
(ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

**2.4.** Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

**Article 3**

**3.1.** The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

**3.2.** No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

**3.3.** The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaw orthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structur e, material, equipment or machinery inspected or tested by the Society.

**3.4.** Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certifi cation or other activity at the time of the check.

**3.5.** The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, t he Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

**Article 4**

**4.1.** Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

**4.2.** In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

**4.3.** The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any st atutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

**Article 5**

**5.1.** In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

**5.2.** Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

**5.3.** Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

**Article 6**

**6.1.** These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

**6.2.** However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the

right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the right to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

**Article 7**

**7.1.** All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

**7.2.** Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

**7.3.** In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

**Article 8**

**8.1.** Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

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# 1 PREMISE

The International Code for Ships Operating in Polar Waters ("the Polar Code") is one of the most interesting news in the International regulatory framework in 2017.

It is the consequence of the new routes that are becoming available due to de-icing in some specific seasons in Polar areas.

Two are the main effects on the shipping market: one is strictly linked to the energy saving for cargo ships passing through the northwest passage (shorter routes), and the other related to the constant growth of cruises offering new horizons and emotions to passengers with the expedition cruises.

The Code has been developed to supplement existing IMO instruments in order to increase the safety of ships' operation and mitigate the impact on the people and environment in the remote, vulnerable and potentially harsh polar waters.

The Polar Code has been made mandatory through the new Chapter XIV of the SOLAS Convention within clearly defined Arctic and Antarctic waters and it will apply to new ships constructed on or after January 1, 2017.

In order to enforce the Polar Code the following Resolutions were adopted:

- Resolution MEPC.265(68) containing amendments to MARPOL Annexes I, II, IV and V to make use of the environment-related provisions of the International Code for Ships Operating in Polar Waters (Polar Code) and
- Resolution MSC.386(94) containing, the new chapter XIV of the SOLAS Convention, to make use of the safety related provisions of the International Code for Ships Operating in Polar Waters (Polar Code)
- Res. MSC.416(97) and Res. MSC.417(97), containing amendments to STCW, the amendments take effect on July 1, 2018.

Ships constructed before January, 1 2017 and operating in the areas defined in the Code, will be required to meet the relevant requirements of Part I-A the Polar Code by the first intermediate or renewal survey, whichever occurs first, after 1 January 2018.

The focal points of the new Code are safety measures, pollution prevention measures, manning, training and qualification of ship's personnel. At this purpose Part A of the Seafarers' Training, Certification and Watchkeeping (STCW) Code has been amended by Resolution MSC.417(97), to take into account the Polar Code.

This is the consequence of the fact that masters and crew qualifications cover a very important role in the structure of the Code.

The core of the Polar Code Certification is the operational assessment that is carried out to establish procedures or operational limitations for the single ship depending on her characteristics. The assessment determines the content of the Polar Waters Operational Manual (PWOM), a mandatory manual to be kept on board as a support to the master and crew decision-making process.

The above procedure makes the application of the Polar Code very interesting also to ships built before January 1,2017, certain modifications may make these ships eligible for Polar Code certification in restricted areas of great interest from the business point of view.

The goal of Polar Code is to provide for safe ship operation and the protection of the polar environment by addressing risks present in polar waters and not adequately mitigated by other International instruments.

# 2 STRUCTURE OF THE CODE AND MAIN PRINCIPLES

The key principles for developing the Polar Code have been the use of a risk-based approach in determining the scope and the adoption of a holistic approach in reducing identified risks following the performance of the operational assessment foreseen in section 1.5 of the Code.

In order to identify the areas of application the Polar Code provides Fig 1 and Fig 2 illustrating the Antarctic area and Arctic waters.

The structure of the code is detailed in the following:

- Part I-A of the Polar Code: safety-related provisions (Reference to SOLAS Ch. XIV/Reg.2)
  - Chapter 1 – General
  - Chapter 2 – Polar Waters Operational Manual (PWOM)
  - Chapter 3 – Ship Structure
  - Chapter 4 – Subdivision and Stability
  - Chapter 5 – Watertight and Weathertight Integrity
  - Chapter 6 – Machinery Installations
  - Chapter 7 – Fire Safety/Protection
  - Chapter 8 – Life-saving Appliances
  - Chapter 9 – Safety of Navigation
  - Chapter 10 – Communication
  - Chapter 11 – Voyage Planning
  - Chapter 12 – Manning and Training
- Part I-B provides additional guidance to achieve the goals specified in Part I-A
- Part II-A of the Polar Code: environment-related provisions (Reference to applicable Annex I – II – IV– V of MARPOL):
  - Chapter 1 – Prevention of Pollution by Oil (MARPOL Annex I)
  - Chapter 2 – Prevention of Pollution by Noxious Liquid Substances (MARPOL Annex II)
  - Chapter 4 – Prevention of Pollution by Sewage from Ships (MARPOL Annex IV)
  - Chapter 5 – Prevention of Pollution by Garbage from Ships (MARPOL Annex V)

In applying parts A of the Polar Code, consideration should be given to the additional guidance in part B of the Polar Code (not mandatory).

Ships intended for operation in Arctic and Antarctic waters constructed on or after 01/01/2017 are to comply with the requirements of the Polar Code (Part I-A and Part I-B).
The compliance to the Polar Code for "existing ships" (constructed before 1/1/2017) is regulated as follows:

- PART I-A: Ships operating in polar waters and constructed before 1 January 2017 are required to meet the relevant requirements of the Polar Code by the first intermediate or renewal survey, whichever occurs first, after 1 January 2018.
- Part II-A: in principle Part II-A applies also to existing ships; application is specified in Chapters 1, 2, 4 and 5 thereto and in the amendments to the corresponding Annexes of MARPOL where the date or the survey for implementation is indicated.

It is worth to remind that Part II-A is applicable to all ships starting from January 1, 2017 also to existing ships for which only operational requirements are foreseen.
The Code defines main thresholds for regulations based on the following conditions:

- Ships intended to operate in ice
- Ship categories
- Ships intended to operate in low air temperatures
- Ships intended to operate in areas where ice accretion is likely to occur.

The above mentioned parameters are to be evaluated in advance in order to identify the applicable requirements and ship's characteristics and/or operational limitations relevant to the operational routes.
The requirements contained in the Polar Code are not a "Go/No Go" tool but they are to be intended as a decision support tool. The decision for operating in specific ice regimes should be based on the consideration of personnel on board qualified in accordance with chapter 12 of the Polar Code, taking into account the condition and characteristics of the ship, current and forecasted environmental conditions, including type and concentration of ice, sea state and visibility; and an understanding of the anticipated ship-ice interactions.
Designers, owners, and operators of ships intended to apply for Polar Code certification should make appropriate decisions and assumptions about a ship's intended operation in a very early stage of the project and/or modification.

## 3 POLARIS SYSTEM AND ICE CLASSES

While the definition of ice classes according to International regulations and IACS Polar classes refers to an ice concentration of 100% (ten/tenths), the Polar Code concept is based on the POLARIS system where ice concentrations of less than ten tenths along the route are examined.

The application of POLARIS method is detailed in MSC.1/Circ. 1519, and its principal features may be summarized as follows:

- the use of a combination of IACS Polar Class ice classes and ice classes assigned equivalence to Finnish-Swedish Ice Class Rules under HELCOM3, which are consistent with ice class references used elsewhere in the Code;
- the use of ice type definitions generally consistent with WMO nomenclature and which can be found on international ice charts;
- consideration of different ice regimes (e.g. waters with partial ice concentrations of different ice types and development stages and ice free waters);
- consideration of ice decay – the outcome of which is a reduced risk due to a reduction in ice strength for some ice types when operating in warmer ambient temperatures; and
- an acknowledgement that ships operating under icebreaker escort have a different risk profile to ships operating independently.
- POLARIS uses a Risk Index Outcome (RIO) value to assess limitations for operation in ice.

The RIO is determined by a summation of the RIVs for each ice type present in the ice regime multiplied by its concentration (expressed in tenths):

RIO = (C1xRIV1)+(C2xRIV2)+(C3xRIV3)+…(Cn x RIVn)

Where C1…Cn are the concentrations (in tenths) of ice types within the ice regime; and

RIV1…RIVn are the corresponding Risk Index Values for each ice type applicable to the Ice Class of the ship

**Table 1: Risk Index Outcome criteria**

| **$RIO_{SHIP}$** | **Ice classes PC1-PC7** | **Ice classes below PC7 and ships not assigned an ice class** |
|---|---|---|
| RIO ≥ 0 | Normal operation | Normal operation |
| -10 ≤ RIO < 0 | Elevated operational risk | Operation subject to special consideration |
| RIO < -10 | Operation subject to special consideration | Operation subject to special consideration |

It is worth to highlight that in case of ships complying with IACS Polar classes below PC 7 (IACS Polar classes to which Category C ships belong to), the ships are not allowed to plan a route in an area where RIO ≤ 0 (even if icebreaker escort or any other mitigating measure is foreseen).

On the contrary, ships complying with IACS Polar classes PC 7 or PC 6 (IACS Polar classes to which category B belong to) are allowed to operate along a route with -10 < RIO < 0, under the "*elevated operational risk regime*" reducing the speed to 3 kts, and/or including as mitigating measure the icebreaker support. All the operational/mitigating measure shall be included in the PWOM.
For what in the above it is clear that the category A and B ships grant a much higher flexibility in the planning and management of the routes.

**Figure 1: Antarctic water**

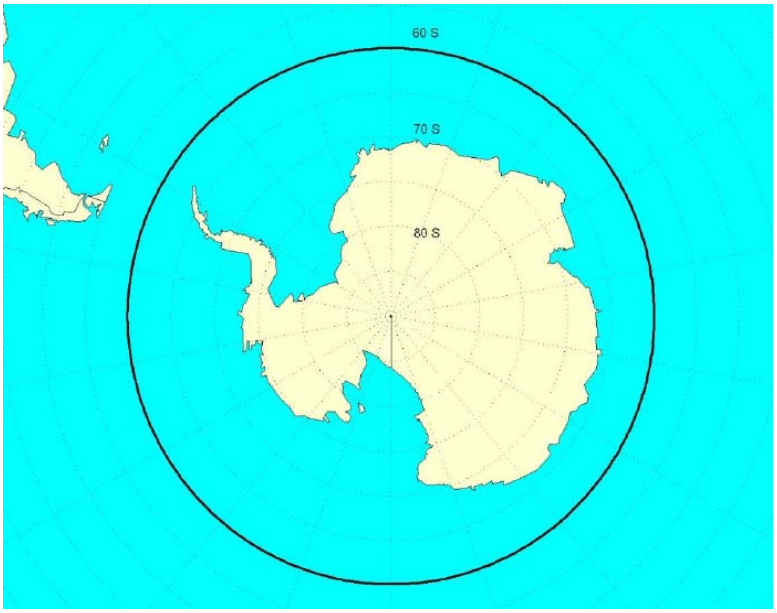



**Figure 2: Arctic water**

## 4 ICE AND POLAR CLASS CLASSIFICATION

For ships strengthened for navigation in ice Tasneef Rules for the classification of ships foresee three class notations (see APPENDIX 1):

1) "Ice Class Notation":
   - Ice Class IA Super
   - Ice Class IA
   - Ice Class IB
   - Ice Class IC
   - Ice Class ID
2) "Polar Class Notation":
   - Polar Class PC1
   - Polar Class PC2
   - Polar Class PC3
   - Polar Class PC4
   - Polar Class PC5
   - Polar Class PC6
   - Polar Class PC7

In addition, ships intended to be operated in a cold climate ove long periods may be assigned of:

3) "Winterization Notation"
   In order to grant the WINTERIZATION (temp) notation, the ship is to be assigned the additional class notation GREEN PLUS or GREEN STAR 3 DESIGN or equivalent and one of the following class notations:
   - POLAR CLASS (any of them)
   - ICE CLASS IA SUPER
   - ICE CLASS IA
   - ICE CLASS IB
   - ICE CLASS IC

## 5 SHIP'S CATEGORIES AND ICE REGIME

- Category A ship means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions.
- Category B ship means a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions.
- Category C ship means a ship designed to operate in open water or in ice conditions less severe than those included in categories A and B.

The ice regime ( in which the ships are permitted to operate according to the definitions above allow to link the ship's categories to the IACS Polar Class requirements and can be summarized as follows:

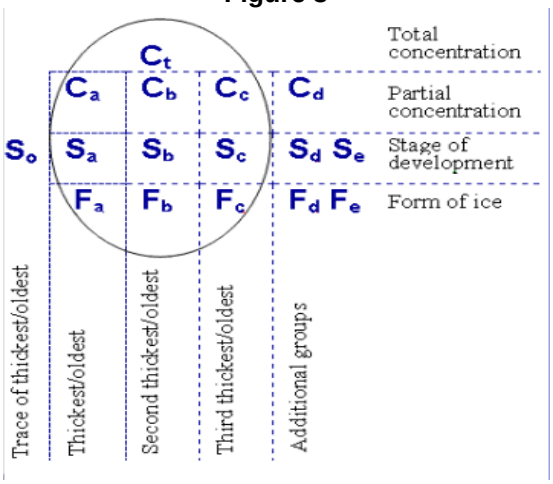
- Category A ship : IACS Polar Ice Class from PC 5 to PC 1
- Category B ship: IACS Polar Ice Class PC 7 and PC 6
- Category C ship: below IACS Polar Ice Class PC7

Ships provided with "Ice Class Notations" mentioned in the previous paragraph, upon satisfactory result of an assessment performed by Tasneef, may also be eligible to be categorized as Category B ships under the Polar Code.

Being the RIO directly connected to the Ice Classes, its value, calculated along a foreseen route for ship's operation, gives guidance on the ship's category that best fits the necessities of the operator.

In order to calculate the RIO it is necessary to refer to the available historical data of ice charts of the area where the ship is expected to operate, ice charts provide data of each area using the " ice egg system" where total concentration, partial concentration for each stage of development and form of ice are indicated.

**Figure 3**




## 6 SHIP STRUCTURE

The definition of the ship structure in terms of scantling and materials is strictly related to the expected ship's route in terms of ice regime, latitude, season, temperature and ice accretion.

Following the outcome of the operational assessment, and calculation of RIO in several expected conditions it is possible to identify the most suitable Polar Code ship's category for each project.

The goal of Chapter 3 of the Polar Code is to provide that the material and scantlings of the structure retain their structural integrity based on global and local response due to environmental loads and conditions.

In order to comply with the functional requirements contained in Chapter 3, also taking into account "low air temperature operation", IACS standards or equivalent may be applied (see App 1).

Two IACS regulatory instruments are available:

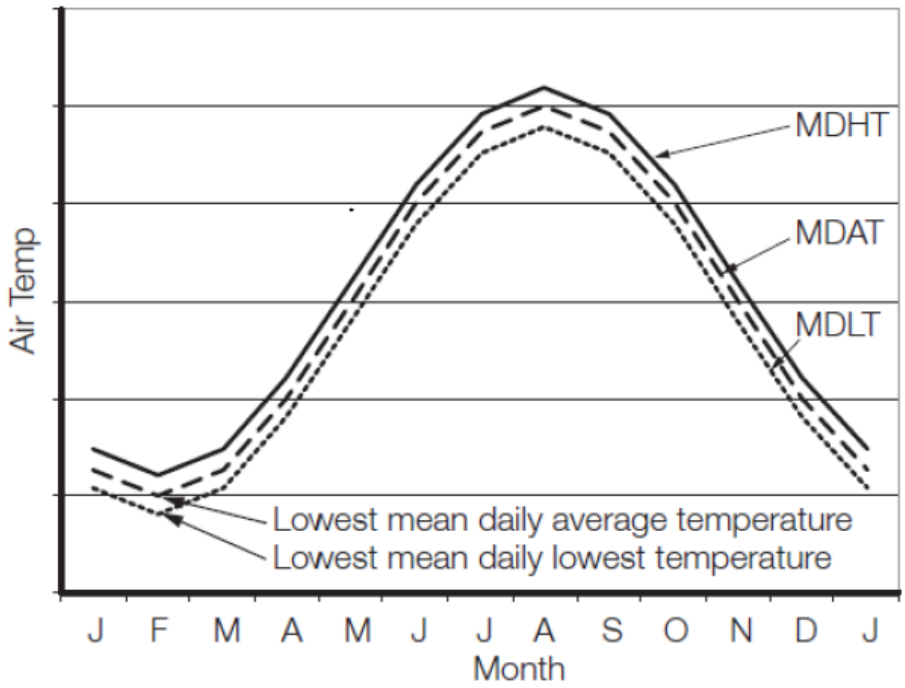
- IACS Unified Requirement UR S6 - Use of Steel Grades for Various Hull Members – Ships of 90 m in Length and Above
- IACS Unified Requirements UR I Requirements Concerning Polar Class

In case of existing ships that are intended to apply for Polar Code Certification, the upgrade to ship other than "Category C" would result of too much impact to justify the its feasibility.

## 7 AIR TEMPERATURE

In addition to the ice regimes encountered by the ship along the route, the low air temperature parameter does highly affect the ship's characteristics at the early design/modification stage.

**Figure 4**




The code defines:
MDHT – Mean Daily High Temperature
MDAT – Mean Daily Average Temperature
MDLT – Mean Daily Low Temperature

Guidance instructions for determining MDLT:

a) Determine the daily low temperature for each day for a 10 year period.
b) Determine the average of the values over the 10 year period for each day.
c) Plot the daily averages over the year.
d) Take the lowest of the averages for the season of operation.

The threshold temperatures in the code are "low air temperature" and "Polar Service Temperature" defined below.

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

*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 MDLT for the intended area and season of operation in polar waters.

For ships that operate in areas and seasons in low air temperature a PST must be identified and shall be at least 10°C below the lowest MDLT.

Operational requirements in PST deeply influence design, equipment and operational requirements of the ship to withstand the PST:

- Materials of ship structures
- Exposed machinery, electrical installations, and fire safety systems are to be suitable for operation at the PST
- Systems and equipment, survival systems and are to be fully functional at the PST
- Life-saving appliances are to be fully operative at the PST
- Fire safety systems and appliances and two-way portable radio communication equipment are to be available and effective at the PST.

For what in the above the decision to have a ship operating in "low air temperature" are to be an input provided at the very early stage of the design.

## 8 ICE ACCRETION

Ice accretion is a phenomena not only related to the "low air temperature" operation as it occurs also above -10°C, depending on the environmental conditions (presence of winds, sea water salinity, sea water temperature etc.) along the ships' route.

Ice accretion contribute are to be taken into account as affecting proper functioning and behavior of the ship under several point of view:

- Intact stability
- Watertight integrity (means for removal or prevention)

- Protection of machinery from ice accretion
- Protection of fire safety systems from ice accretion
- Escape routes, muster stations, access to survival craft (means for removal or prevention)
- Embarkation areas, survival craft, launching appliances
- Navigation and communication antenna (means for prevention)
- Operational procedures (e.g. monitoring, de-icing, removal, etc.)

This is a parameter that is common to all ships' categories.

## 9 ASSESSMENT FOR THE COMPLIANCE WITH THE CODE – OPERATIONAL ASSESSMENT -PWOM

Bearing in mind all the parameters that may affect the safety of the ship described in the above, the operational assessment is the first step towards the Polar Certification.

The operational assessment of the ship and its equipment is to be carried out by the ships' operator. The documentation required to perform the operational assessment include:

a) the anticipated range of operating and environmental conditions, such as:
   - Maps showing the expected route of the ship in operation;
   - For each area of operation, indication of the expected period (season) of operation;
   - operation in low air temperature data (temperatures statistical data in the season and area of operation);
   - operation in ice (ice charts statistical data in the area and period of operation);
   - seawater temperature statistical data for area and season of operation;
   - operation in high latitude information; and
   - potential for abandonment onto ice or land assessment;
   - Search and Rescue facilities in the area of operation (considerations on the maximum expected time of rescue)
b) assessment of the hazards, as listed in section 3 of the Introduction in the Polar Code, as applicable.
c) Assessment of the limitations for operation in ice according to MSC.1/Circ.1519 as per paragraph [3].

Section 2 in Chapter 1 Part I-B of the Code contains information for the performance of the operational assessment that are here below reported:

*"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 analyze 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. "*

The outcome of the operational assessment will contain the information both related to the specific characteristics of the ship's design and to the operational mitigation measures to be adopted as well as the procedures necessary to be put in place by the master and the crew to implement such mitigating measures. These data and information will be included in the Polar Water Operational Manual (PWOM).

The goal of the PWOM is to provide the owner, operator, master and crew with sufficient information regarding the ship's operational capabilities and limitations in order to support their decision-making process.

The PWOM is to contain at least the following information:

- voyage planning to avoid ice and/or temperatures that exceed the ship's design capabilities or limitations;
- arrangements for receiving forecasts of the environmental conditions;
- means of addressing any limitations of the hydrographic, meteorological and navigational information available;
- operation of equipment required under other chapters of this Code; and
- implementation of special measures to maintain equipment and system functionality under low temperatures, topside icing and the presence of sea ice, as applicable.
- procedures to be followed in the event of incidents in polar waters

- specific procedures to be followed in the event that conditions are encountered which exceed the ship's specific capabilities and limitations
- procedures to be followed when using icebreaker assistance, as applicable
- risk-based procedures to be followed for:
  - contacting emergency response providers for salvage, search and rescue (SAR), spill response, etc., as applicable; and
  - in the case of ships ice strengthened in accordance with chapter 3, procedures for maintaining life support and ship integrity in the event of prolonged entrapment by ice.

In few words the PWOM contains the information for the safe operation of the ship.

## 10 INTACT AND DAMAGE STABILITY

Depending on the ice regime and environmental conditions where the ship is expected to operate intact and damage stability requirements are to be properly evaluated.

All ship's categories in environmental conditions where ice accretion is likely to occur are to have the intact stability calculations demonstrating the ship's capability to operate in compliance with the additional requirements set out in the Code.

Category A and B ships, constructed on or after 1 January 2017, are required to have sufficient residual stability to sustain ice-related damages.

## 11 WATERTIGHT AND WEATHERTIGHT INTEGRITY

For all ships in principle all closing appliances and doors relevant to watertight and weathertight integrity of the ship are to be operable, the requirements of chapter 5 of the Code apply.

For ships operating in areas and during periods where ice accretion is likely to occur, means are to be provided to remove or prevent ice and snow accretion around hatches and doors.

For ships operation in low air temperature additional measures are required such as:

- prevention of freezing or excessive viscosity of liquids or
- watertight and weathertight doors, hatches and closing devices which are not within an habitable environment and require access while at sea are to be designed to be operated by personnel wearing heavy winter clothing including thick mittens.

For all ships the requirements of Chapter 6 of the code apply to grant machinery installations functionality under the anticipated environmental conditions, taking into account:

- ice accretion and/or snow accumulation;
- ice ingestion from seawater;
- freezing and increased viscosity of liquids;
- seawater intake temperature; and
- snow ingestion.

For ships intended to operate in low air temperatures additional requirements are imposed such as:

- exposed machinery and electrical installation and appliances to function at the polar service temperature
- combustion air for internal combustion engines driving essential machinery to be maintained at a temperature in compliance with the criteria provided by the engine manufacturer.

For ice strengthened in accordance with chapter 3 scantlings of propeller blades, propulsion line, steering equipment and other appendages for Category A and B ships are to comply with the requirements of relevant IACS Polar Ice Class requirements.

## 12 MACHINERY INSTALLATIONS

For all ships the requirements of Chapter 6 of the code apply to grant machinery installations functionality under the anticipated environmental conditions, taking into account:

- ice accretion and/or snow accumulation;
- ice ingestion from seawater;
- freezing and increased viscosity of liquids;
- seawater intake temperature; and
- snow ingestion.

For ships intended to operate in low air temperatures additional requirements are imposed such as:

- exposed machinery and electrical installation and appliances to function at the polar service temperature
- combustion air for internal combustion engines driving essential machinery to be maintained at a temperature in compliance with the criteria provided by the engine manufacturer.

For ice strengthened in accordance with chapter 3 scantlings of propeller blades, propulsion line, steering equipment and other appendages for Category A and B ships are to comply with the requirements of relevant IACS Polar Ice Class requirements.

## 13 FIRE SAFETY/PROTECTION

For all ships fire safety systems and appliances are effective and operable, and that means of escape remain available so that persons on board can safely and swiftly escape to the lifeboat and liferaft embarkation deck under the expected environmental conditions applying the requirements of Chapter 7 of the Code.

For ships intended to operate in low air temperature:

- all components of fire safety systems and appliances are to be designed to ensure availability and effectiveness under the polar service temperature;

- materials used in exposed fire safety systems are to be suitable for operation at the polar service temperature.

## 14 LIFE-SAVING APPLIANCES AND ARRANGEMENTS

For all ships the compliance with Chapter 6 is required so that exposed escape routes, survival craft and muster and embarkation arrangements, life-saving appliances and associated equipment are to provide safe evacuation and be functional under the possible adverse environmental conditions during the maximum expected time of rescue.
In addition focus is made to the necessity of survival equipment so that adequate thermal protection is provided for all persons on board, taking into account the intended voyage, the anticipated weather conditions (cold and wind), and the potential for immersion in polar water, as applicable.
For ships constructed on or after 1 January 2017, exposed escape routes are to be arranged so as not to hinder passage by persons wearing suitable polar clothing.
In case the operational assessment identifies a potential of abandonment onto ice or land group survival equipment stowed in easily accessible locations, as close as practical to the muster or embarkation stations are to be provided. Containers for group survival equipment are to be designed to be easily movable over the ice and be floatable; means are to be identified of ensuring that this equipment is accessible following abandonment.

## 15 SAFETY OF NAVIGATION - COMMUNICATION

Chapter 9 and 10 of the Code contain specific requirements for safe navigation and effective communication for ships and survival craft during normal operation and in emergency situations.
All ships are required to have:

- the ability to receive up-to-date information including ice information for safe navigation;
- systems for providing reference headings and position fixing suitable for the intended areas;
- means of receiving and displaying current information on ice conditions in the area of operation.

Additional equipment is may be required depending on operational conditions as detailed in Chapter 5.
For ships operating in low air temperature, additional equipment to grant communications capabilities for use in survival craft, including life-rafts, and rescue boats are required for operation during the maximum expected time of rescue. Equipment for voice communications with aircraft on 121.5 and 123.1 MHz is also mandatory.

## 16 VOYAGE PLANNING

Chapter 11 of the Code contains requirements for voyage planning along a route through polar waters for which the master is to take into account:

- the procedures required by the PWOM;
- any limitations of the hydrographic information and aids to navigation available;
- current information on the extent and type of ice and icebergs in the vicinity of the intended route;
- statistical information on ice and temperatures from former years;
- places of refuge;
- current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas;
- current information on relevant ships' routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas;
- national and international designated protected areas along the route; and
- operation in areas remote from search and rescue (SAR) capabilities.

## 17 MANNING AND TRAINING

Specific requirements for manning and training are requested for masters, chief mates and officers in charge of a navigational watch in accordance with chapter V of the STCW Convention and the STCW Code, as amended.

## 18 ADDITIONAL GUIDANCE TO PART I-A

Part I-B of the Code contain additional guidance for the implementation of the requirements.

- limitations for operating in ice
- operational assessment
- polar water operational manual
- ship structure
- machinery installations
- life-saving appliances and arrangements and survival equipment
- (safety of navigation
- communication
- voyage planning.

## 19 POLLUTION PREVENTION MEASURES – PART II-A

Part I-A contains mandatory requirements for ships eligible to the Polar code Certification
The requirements cover:

- prevention of pollution by oil structural requirements
- control of pollution by
- noxious liquid substances in bulk
- prevention of pollution by sewage from ships

- prevention of pollution by garbage from ships.

Mandatory pollution prevention measures contained in the Polar Code are above and beyond MARPOL regulations, the environmental regulations are written in a prescriptive format.

In this respect the Polar Code amends four MARPOL Annexes:

- MARPOL Annex I – Oil
- MARPOL Annex II - Noxious Liquid Substances
- MARPOL Annex IV – Sewage
- MARPOL Annex V - Garbage

The Polar Code imposes a full prohibition on any discharge into the sea of oil or oily mixtures from any ship in Polar waters.

Discharge of any Noxious Liquid Substances (NLS) is also subject to a 100% prohibition in all polar waters.

Sewage discharge limitations in Polar waters are stricter than in MARPOL Annex IV, for example, discharge of comminuted and disinfected sewage must be at least 3 nautical miles for any ice-shelf or fast ice and far from ice concentrations greater than 1/10th coverage. Non-comminuted and non-disinfected sewage is subject to further restriction, more than 12 nautical miles from any ice shelf or land-fast ice.

Food and garbage discharge limitations are imposed on ships operating in Polar waters to consider concentrations of ice in a similar way as the sewage restrictions.

## 20 POLAR CODE – CERTIFICATE AND SURVEY

**Part I-A**

The Polar Ship certificate is issued to state the compliance with requirements under Part I-A of the Polar Code. The certificate is supplemented by the Record of equipment.

Polar Ship Certificate validity, survey dates and endorsements are to be harmonized with the relevant SOLAS certificates.

**Part II-A**

No specific certificate is envisaged for ship complying with the requirement of this part of the Polar Code.

Compliance with requirements contained in the specific Chapters of Part II-A of the Polar Code is stated with the issue/endorsement of the certificate issued pursuant the corresponding Annex of MARPOL.

The existing IOPP Supplements have been amended introducing a new section dedicated to compliance with Part II-A Chapter 1 of the Polar Code.

The regime of survey is regulated as follows:

- Compliance with Part I-A of the Polar Code (Safety-related provisions)

The applicable surveys are aligned with those ones foreseen by SOLAS for ship certified in accordance with Chapter I.

The surveys are complementary to the applicable SOLAS surveys providing specific additional safety-related provisions (construction, equipment and radio) for the operation of the ship in polar waters and are reported by means of their dedicated initial and periodical check lists.

- Compliance with Part I-A of the Polar Code (Environment-related provisions)

The scope of survey is included in the established surveys already enforced by the pertinent Annexes of MARPOL and are reported by means of the existing check list that have been amended accordingly.

## 21 CONCLUSIONS

It has already been highlighted that the key principles for developing the Polar Code have been to use a risk-based approach in determining scope and to adopt a holistic approach in reducing identified risks.

In this respect Tasneef can provide full assistance to the operators for:

- verification of the parameters affecting the ship's characteristics on the basis of the intended area of operation
- evaluation of the necessary upgrades of the existing ships tailored to the intended service
- review of the operational assessment
- risk analysis and implementation of the SMS procedures
- implementation of IACS Polar Ice Class for ship-structure and machinery and systems
- review of the Polar Waters Operational Manual
- review and approval of new ships intended for Polar Water Operation
- implementation of Flag Administration requirements and National requirements.

## 1 CONSIDERATIONS ON STRUCTURAL ASPECTS

Polar Class ships are those that may be granted the Polar Class (PC1 to PC7) according to IACS UR I1, I2 and I3 as incorporated in e.g. Tasneef Rules Pt F, Ch 10. These are ships that are specifically intended for navigation in ice-infested polar waters.

For what concerns the structural aspects of the Polar Class design, more severe material steel grades and more severe scantling requirements are involved, when compared to the ships designed in the past to standards such as the Finnish-Swedish Ice Classes, as incorporated in the Class Societies rules.

## 2 MATERIAL STEEL GRADES FOR POLAR CLASS SHIPS COMPARED TO ICE CLASS SHIPS

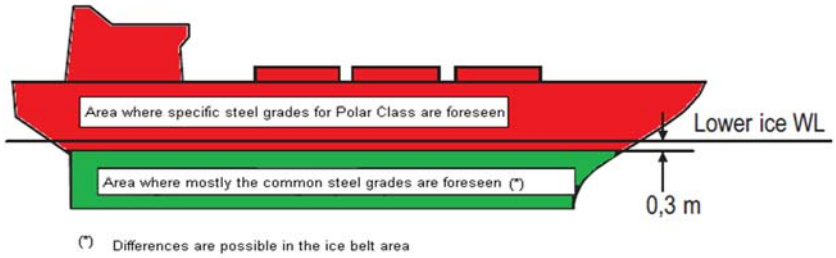
Designs according to Ice Class, even those that follow the most demanding of those, i.e (IAS) do not require foreseeing steel material grades more demanding than those of other ships.

In terms of Tasneef Rules, ships that are granted Ice Class notation according to Tasneef Rules Pt F, Ch 9, have to follow the minimum steel material grades according to Pt B, Ch 4, Sec 1, [2.4] i.e. those general for all other ships.

On the contrary, designs according to the Polar Class (Tasneef Rules Pt F, Ch 10) have specific and more demanding requirements. The affected parts of the ship are all those shown in the Fig 1.

**Figure 1**

**Steel Grade Requirements for Submerged and Weather Exposed Shell Plating**




The steel grades requirements for Polar Class for such areas, as excerpted from Tasneef Rules, can be found in the tables here below. Table 2 covers the steel grades for plating that are directly exposed to weather (outer air), while Table 3 covers all the inboard members attached to exposed plating (all of them, differently from the requirements for common ships where only those contributing to longitudinal strength are covered).

In general, as can be intuitive, the requirements for PC6 and PC7 are only slightly more demanding than those for normal ships, while for PC1 to PC5 the possible situations leading to needed improvements are more numerous.

**Table 2: Steel grades for weather exposed plating (1) (3)**

| As built thickness t, in mm | Material Class I | | | | Material Class II | | | | Material Class III | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PC1-5 | | PC6 and 7 | | PC1-5 | | PC6 and 7 | | PC1-3 | | PC4 and 5 | | PC6 and 7 | |
| | NSS | HSS | NSS | HSS | NSS | HSS | NSS | HSS | NSS | HSS | NSS | HSS | NSS | HSS |
| t ≤10 | B | AH | B | AH | B | AH | B | AH | E | EH | E | EH | B | AH |
| 10<t ≤15 | B | AH | B | AH | D | DH | B | AH | E | EH | E | EH | D | DH |
| 15< t ≤20 | D | DH | B | AH | D | DH | B | AH | E | EH | E | EH | D | DH |
| 20< t ≤25 | D | DH | B | AH | D | DH | B | AH | E | EH | E | EH | D | DH |
| 25<t ≤30 | D | DH | B | AH | E | EH **(2)** | D | DH | E | EH | E | EH | E | EH |
| 30<t ≤35 | D | DH | B | AH | E | EH | D | DH | E | EH | E | EH | E | EH |
| 35<t≤40 | D | DH | D | DH | E | EH | D | DH | F | FH | E | EH | E | EH |
| 40<t ≤45 | E | EH | D | DH | E | EH | D | DH | F | FH | E | EH | E | EH |
| 45<t ≤50 | E | EH | D | DH | E | EH | D | DH | F | FH | F | FH | E | EH |

**(1)** Includes weather exposed plating of hull structures and appendages, as well as their outboard framing members, situated above a level of 0,3 m below the lowest ice waterline.

**(2)** Grades D and DH are allowed for a single strake of side shell plating not more than 1,8 m wide from 0,3 m below the lowest ice waterline.

**(3)** "NSS" and "HSS" mean, respectively:"Normal Strength Steel" and "Higher Strength Steel".

**Appendix 1**

**Table 3: Steel grades for inboard framing members attached to weather exposed plating**

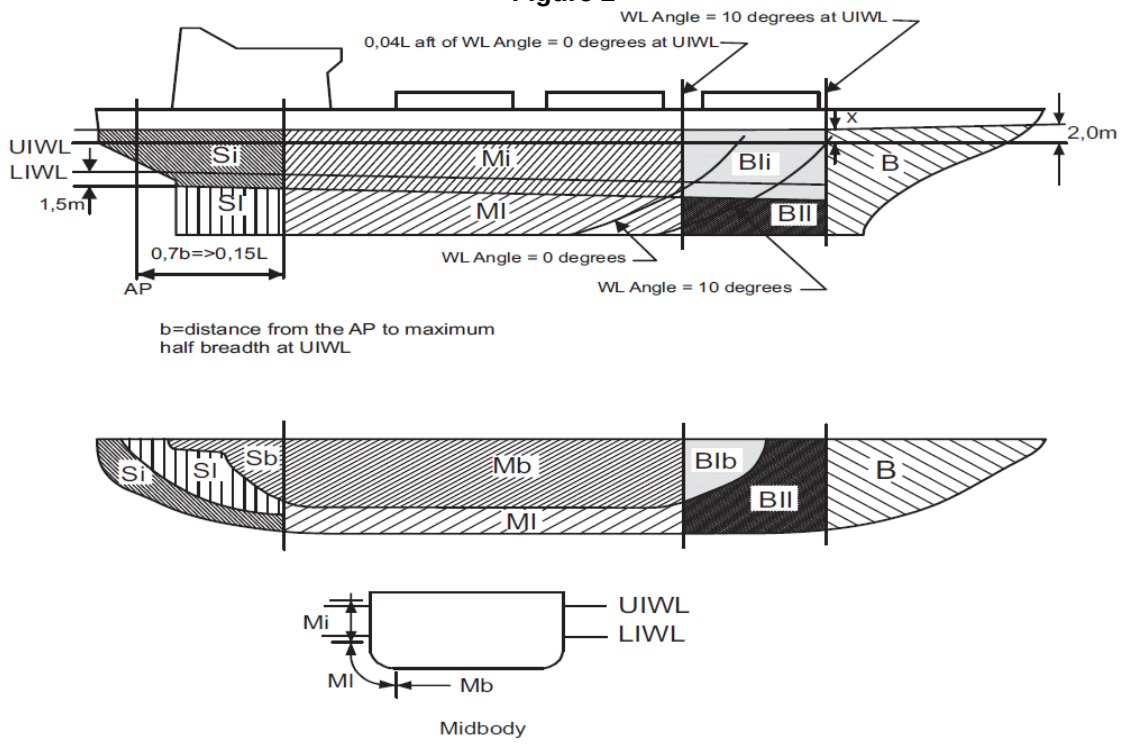
| As built thickness t, in mm | PC1 to PC5 | | PC6 and PC7 | |
|---|---|---|---|---|
| | NSS | HSS | NSS | HSS |
| t ≤ 20 | B | AH | B | AH |
| 20 <t ≤ 35 | D | DH | B | AH |
| 35 <t ≤45 | D | DH | D | DH |
| 45 <t ≤50 | E | EH | D | DH |

The most relevant outcome of this analysis is that it is rather unlikely that a ship not designed for Polar Class from the beginning may be easily upgraded, especially to classes PC1 to PC5, given the amount of steel whose grade should be changed.
Improvements in steel grades for Class III material starts to be necessary as low as 10 < t < 15 mm, while for normal ships the threshold is placed above 20 mm.
Due to these requirements about steel grades, upgrading existing ships even to PC 6 or PC7 is likely to be more demanding in terms of steel works weight than it were to upgrade to IAS ice class, even if the required scantlings are usually only slightly bigger.

## 3 POLAR CLASS SHIPS SCANTLINGS COMPARED TO ICE CLASS SHIPS

The hull of all Polar Class ships is divided into areas reflecting the magnitude of the loads that may be acting upon them. In the longitudinal direction these are: Bow (B), Bow Intermediate (BI), Midbody (M), Stern (S). The ), Bow Intermediate (BI), Midbody (M), Stern (S) are subdivided in the vertical direction in bottom (b), lower (l) and icebelt (i).
A pictorial representation of the above mentioned areas can be found in the Fig 2.

**Figure 2**




The scantling requirements coming from the application of the Polar class potentially affect a greater portion of the hull structures compared to the Ice class (affecting the bow and icebelt only, with different and generally smaller extensions).
Here below the table excerpted from the rules and covering the area factor AF can be found. This factor AF reflects the relative magnitude (compared to 1) of the load expected in that area.

**Table 4: Hull area factors (AF)**

| Hull area | | Area | Polar Class | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 |
| Bow (B) | All | B | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Bow Interme-diate (BI) | Icebelt Lower Bottom | $BI_i$ | 0,90 | 0,85 | 0,85 | 0,80 | 0,80 | 1,00 **(1)** | 1,00 **(1)** |
| | Lower | $BI_l$ | 0,70 | 0,65 | 0,65 | 0,60 | 0,55 | 0,55 | 0,50 |
| | Bottom | $BI_b$ | 0,55 | 0,50 | 0,45 | 0,40 | 0,35 | 0,30 | 0,25 |
| Midbody (M) | Icebelt | $M_i$ | 0,70 | 0,65 | 0,55 | 0,55 | 0,50 | 0,45 | 0,45 |
| | Lower | $M_l$ | 0,50 | 0,45 | 0,40 | 0,35 | 0,30 | 0,25 | 0,25 |
| | Bottom | $M_b$ | 0,30 | 0,30 | 0,25 | **(2)** | **(2)** | **(2)** | **(2)** |
| Stern (S) | Icebelt | $S_i$ | 0,75 | 0,70 | 0,65 | 0,60 | 0,50 | 0,40 | 0,35 |
| | Lower | $S_l$ | 0,45 | 0,40 | 0,35 | 0,30 | 0,25 | 0,25 | 0,25 |
| | Bottom | $S_b$ | 0,35 | 0,30 | 0,30 | 0,25 | 0,15 | **(2)** | **(2)** |

**(1)** See [4.1.3]
**(2)** Indicates that strengthening for ice loads is not necessary.

It is interesting to notice that the Midbody and Stern Lower area are subject to scantling requirements even for PC6 and PC7 ships, while such locations are outside the scantling requirements for Ice Class ships.

For PC1 to PC3 ships even the Midbody Bottom likely needs to be reinforced while the Stern Bottom has this need also for PC4 and PC5.
In the following Tab 5 are summarized the class factors that are involved in the calculation of required scantlings for Polar Class ships.

**Table 5: Class Factors**

| Polar Class | Crushing Failure Class Factor ($C_{FC}$) | Flexural Failure Class Factor($C_{FF}$) | Load Patch Dimensions Class Factor ($C_{FD}$) | Displacement Class Factor ($C_{FDIS}$) | Longitudinal Strength Class Factor ($C_{FL}$) |
|---|---|---|---|---|---|
| **PC1** | 17,69 | 68,60 | 2,01 | 250000 | 7,46 |
| **PC2** | 9,89 | 46,80 | 1,75 | 210000 | 5,46 |
| **PC3** | 6,06 | 21,17 | 1,53 | 180000 | 4,17 |
| **PC4** | 4,50 | 13,48 | 1,42 | 130000 | 3,15 |
| **PC5** | 3,10 | 9,00 | 1,31 | 70000 | 2,50 |
| **PC6** | 2,40 | 5,49 | 1,17 | 40000 | 2,37 |
| **PC7** | 1,80 | 4,06 | 1,11 | 22000 | 1,81 |

Of interest is the Load Patch Dimensions Class Factor (CFD) that is directly proportional to the required plate thickness and stiffener required section modulus and shear area.
As a PC6 Polar Class ship plating is only slightly thicker than an IAS, a PC1 Polar ship can be considered to be at least approximatively 80-90% thicker than the plating of an IAS ship: this gives a good measure of the fact that Polar class ships PC1 to PC5 are really much more demanding in terms of scantlings, thus justifying the category A that is foreseen for them by the Polar Code.

## 4 HULL GIRDER STRENGTH

Another very important difference between Ice class and Polar class ships is that the former do not require additional checks for the hull girder strength while for the latter this is foreseen.
The Longitudinal Strength class factor ($C_{FL}$), as can be seen from the table in the previous page is directly proportional to the Design Vertical ice bending moment that is to be added to vertical still water bending moment. From the numerical values of this coefficient, it can be understood that a PC1 ship has an additional bending moment due to ice

that is more than 400% greater than one of a PC7 ship.

## 5 STRUCTURAL SYNTHETIC CONCLUSIONS

PC6 and PC7 Polar class ships can be considered to be one-way equivalent to IAS and IA1 ships, indicating that a PC6 ship can be granted the IAS Ice class without further checks while the vice-versa (IAS that grants the PC6 or PC7 Polar class) is not true a priori, even if in practice it could be found true for specific cases where the IAS requirements were exceeded from the beginning both in terms of steel grades and scantlings (due to e.g. owner specific requests).

Synthetically it can be said that as an IAS Ice class may raise the plate thickness in the reinforced area by approximatively 50% compared to a ship without such notations, a PC6-7 ship can raise such thickness up to approximatively 55-65%; the area to be reinforced is likely to be as well more extended for Polar class ships compared to Ice class ships.

Steel weight increases for PC1 to PC5 are more difficult to be forecasted, and, given that almost all the hull is affected and the very sharp increase in the dimensioning factors (class factors), for the higher classes are likely to be huge and thus require from the beginning dedicated projects, being not an economic choice for conversions.