Amendments to "Rules for the Classification of Workboats"

RFS/011/AMN/02

Effective from 1/5/2023

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SECTION 1 FIELD OF APPLICATION OF THE RULES, SERVICE NOTATION AND GENERAL

1 Field of application of the Rules

1.1

1.1.1 *(1/5/2023)*

These Rules apply for the purpose of classification of vessels with steel, reinforced plastic, aluminium alloy or high density polyethylene (HDPE) hull - including catamarans and rigid inflatable boats (RIBs) - in commercial use, other than those in use for recreational, sport and pleasure, having a load line length between 4 m and 24 m, with a maximum speed of 45 knots and carrying no more than 12 passengers.

The application of these Rules to vessels with reinforced plastic hull or aluminium alloy hull having different load line length or speed may be considered by the Society on a case-by-case basis, depending on their specific operation and construction characteristics.

These rules deal with HDPE ships having slender hull shapes, having a length not greater than 24 m and having an operating profile extended up to "moderate environment"; HDPE ships having different features will be specially considered on a case by case basis.

Where necessary, in the various parts of these Rules, specific conditions relevant to the field of application of the requirements are given.

The requirements for assignment of special service notations will be established by Tasneef case by case on the basis of the requirements of Part E of the Rules for the Classification of Ships.

For the purpose of the assignment of special class notations, the requirements of Part F of the Rules for the Classification of Ships are to be complied with, as far as practicable, at Tasneef discretion, in relation to the navigation and service notations, vessel size and hull material.

2 Service Notation

2.1

2.1.1 *(1/7/2021)*

The vessels complying with the classification requirements of these Rules are assigned with the service notation **WORKBOAT**, that may be completed by the following additional service features:

- **Crew Transfer Vessel - CTV**: when the workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when the workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat is designed as multi-purpose workboat for offshore works and transport. Normally a multicat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when the workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel - SGSV**: when the workboat is designed for the purpose of research, seismic survey and mapping at seas.
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when the workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

3 Navigation and design category

3.1 Navigation Notations

3.1.1 *(1/7/2021)*

Every classed workboat is to be assigned one navigation notation.

3.1.2 *(1/7/2021)*

The navigation notation **unrestricted navigation** is assigned to a ship intended to operate in any area and any period of the year.

3.1.3 *(1/7/2021)*

The navigation notation "**NAV 150**" is assigned to ships intended to operate only within 150 nautical miles from a safe haven.

3.1.4 *(1/7/2021)*

The navigation notation "**NAV 60**" is assigned to ships intended to operate only within 60 nautical miles from a safe haven.

3.1.5 *(1/7/2021)*

The navigation notation "**NAV 30**" is assigned to ships intended to operate only within 30 nautical miles from a safe haven.

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Part A
Classification and Surveys

Chapter 4

SURVEYS OF SHIPS WITH HIGH DENSITY POLYETHYLENE (HDPE) HULL

SECTION 1 FIELD OF APPLICATION AND SURVEYS

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1 Field of application

1.1

1.1.1 *(1/5/2023)*

The requirements of this Chapter apply to ships with high density polyethylene (HDPE) wooden hull.

For the purpose of classification and surveys, the requirements of Part A of the Rules are to be complied with, taking account of the modifications and additions specified in [2], [3] and [4], as far as the frequency and the technical requirements relevant to surveys are concerned.

2 Periodical surveys and relevant frequency, anticipations and postponements

2.1 Surveys in general

2.1.1 *(1/5/2023)*

For all periodical surveys, the requirements of Part A, Chapter 2, Section 2 of the Rules are to be fulfilled. However, in the case of ships more than 15 years old, the frequency of the Bottom survey is subject to special consideration.

3 First Classification Surveys

3.1 First Classification Surveys of ships built under Tasneef supervision

3.1.1 *(1/5/2023)*

The eligibility for class is evaluated on the basis of the substantial compliance with the applicable Tasneef Rules, with the examination of main drawings and documents and following the outcome of a First Classification Survey specifically carried out with an extension adequate to the individual cases.

Before the supervision of the first construction, an inspection of the shipyard is performed in order to verify that it is provided with adequate equipment in relation to the materials used and to the type of manufacture.

In addition, storage premises of the HDPE sheets, welding consumables shall be so equipped and arranged that the material supplier's directions for storage and handling are followed.

3.2 First Classification Surveys of ships built without Tasneef supervision

3.2.1 *(1/5/2023)*

The eligibility for class is evaluated on the basis of the substantial compliance with the applicable Tasneef Rules, with the examination of main drawings and documents and following the outcome of a First Classification Survey specifically carried out with an extension adequate to the individual cases. Where appropriate, within reasonable limits, a proven service record of satisfactory performance may be used as a criterion of equivalence. Special consideration will be given to ships of recent construction. For the purpose of classification, it may be required that adequate data for the evaluation of materials, machinery and arrangements in general are made available; such adequate data may consist of the details of specific rules and requirements originally applied but, where appropriate, tests and checks, to be established in the individual cases, may also be required.

4 Periodical hull surveys

4.1 Annual surveys

4.1.1 *(1/5/2023)*

Visual inspection to be performed on the areas exposed to weather, sun light for surface cracking, particular attention is to be given to welded connections.

4.2 Class renewal survey (hull) and bottom survey in dry condition

4.2.1 *(1/5/2023)*

In addition to the requirements for the Annual surveys given in [4.1], all external surface is to check due to the cracks. To this end, the ship is to be made available for the bottom survey in dry condition before the application of any coating, so as to allow a careful visual inspection.

SECTION 1 DESIGN PRINCIPLES

1 Design principles

1.1 Applications

1.1.1 *(1/5/2023)*

~~The requirements of Pt B, Ch 1 and Ch 2 apply to glass reinforced plastic vessels and the requirements of Pt B, Ch 1 and Ch 3 apply to alluminium vessels.~~

For reinforced plastic vessels, the requirements of Ch 1 and Ch 2 apply.

For aluminium alloy hull vessels, the requirements of Ch 1 and Ch 3 apply.

For steel hull displacement vessels, the requirements in Pt B, Ch 8 of the Rules for the Classification of Ships apply. However, for steel hull displacement vessels having operative characteristics corresponding to the construction feature "light ship" (i.e. restricted navigation, length not greater than 50 m and speed greater than 15 knots), the requirements in Ch 3 of the Rules for the Classification of High Speed Craft may be applied instead of those in Pt B, Ch 8 of the Rules for the Classification of Ships.

For steel hull planing vessels, the requirements in Ch 3 of the Rules for the Classification of High Speed Craft apply.

Craft with V^3 10 $L^{0,5}$ will be individually considered by Tasneef that, in general, may accept scantling according to ISO 12215-5 with safety factor increased of 25%.

1.1.2 Direct calculations

Tasneef may require direct calculations to be carried out, if deemed necessary.

Such calculations are to be carried out based on structural modelling, loading and checking criteria accepted by Tasneef.

1.1.3 Units

Unless otherwise specified, the following units are used in the Rules:

- thickness of plating, in mm,
- section modulus of stiffeners, in cm^3,
- shear area of stiffeners, in cm^2,
- span and spacing of stiffeners, in m,
- stresses, in N/mm^2,
- concentrated loads, in kN,
- distributed loads, in kN/m or kN/m^2.

1.1.4 Definitions and symbols

The definitions of the following terms and symbols are applicable throughout this Chapter and its Appendices and are not, as a rule, repeated in the different paragraphs. Definitions applicable only to certain paragraphs are specified therein.

"Moulded base line": The line parallel to the summer load waterline, crossing the upper side of keel plate or the top of skeg at the middle of length **L**.

"Hull": The hull is the outer boundary of the enclosed spaces of the vessel, except for the deckhouses, as defined below.

"Chine": For hulls that do not have a clearly identified chine, the chine is the hull point at which the tangent to the hull is inclined 50° to the horizontal.

"Bottom": The bottom is the part of the hull between the keel and the chines.

"Main deck": The main deck is the uppermost complete deck of the hull. It may be stepped.

"Side": The side is the part of the hull between the chine and the main deck.

"Castle": A castle is a superstructure extending from side to side of the vessel or with the side plating not being inboard of the shell plating more than 4% of the local breadth. In general, such a superstructure fitted on the weather deck of the vessel is considered as "constituting a step of the strength deck" when it extends within 0,4 **L** amidships for at least 0,15 **L**. Other castles are considered as "not constituting a step of the strength deck".

"Deckhouse": The deckhouse is a decked structure located above the main deck, with lateral walls inboard of the side of more than 4 per cent of the local breadth. Structure located on the main deck and whose walls are not in the same longitudinal plane as the under side shell may be regarded as a deckhouse.

"Cross-deck": For twin-hull vessel, the cross-deck is the structure connecting the two hulls.

"Fore end": Hull region forward of 0,9 **L** from the aft perpendicular.

"Deadrise angle α_d": For hulls that do not have a clearly identified deadrise angle, α_d is the angle between the horizontal and a straight line joining the keel and the chine. For catamarans with non-symmetrical hulls (where inner and outer deadrise angles are different), α_d is the lesser angle.

"Aft end": Hull region abaft of 0,1 **L** from the aft perpendicular.

"Midship area": Hull region between 0,3 **L** and 0,7 **L** from the aft perpendicular.

L : Rule length, in m, equal to $\mathbf{L}_{WL}$ where $\mathbf{L}_{WL}$ is the waterline measured with the vessel at rest in calm water.

FP : forward perpendicular, i.e. the perpendicular at the intersection of the waterline at draught **T** and the foreside of the stem

AP : aft perpendicular, i.e. the perpendicular located at a distance **L** abaft of the forward perpendicular

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SECTION 2 DESIGN LOADS AND HULL SCANTLINGS

1 Design loads

1.1 Application

1.1.1 The requirements in Ch 2, Sec 3, [2], Ch 2, Sec 3, [3] and Ch 1, Sec 3, [4] apply.

2 Hull scantlings

2.1

2.1.1 This Article stipulates requirements for the scantlings of hull structures (plating, stiffeners, primary supporting members). The loads acting on such structures are to be calculated in accordance with Ch 2, Sec 2, [5].

In general, for vessels with speed **V** > 45 knots, the scantlings of transverse structures are to be verified also by direct calculations carried out in accordance with Ch 2, Sec 2, [5].

For all other vessels, Tasneef may, at its discretion and as an alter-native to the requirements of this Article, accept scantlings for transverse structures of the hull based on direct calculations in accordance with Ch 2, Sec 2, [5].

2.2 Definitions and symbols

2.2.1 "**Rule bracket**" - A bracket with arms equal to **l**/8, **l** being the span of the connected stiffener. Where the bracket connects two different types of stiffeners (frame and beam, bulkhead web and longitudinal stiffener, etc.), the value of **l** is to be that of the member with the greater span, or according to criteria specified by Tasneef.

t : thickness, in mm, of plating and deck panels;

Z : section modulus, in cm³, of stiffeners and primary supporting members;

s : spacing of stiffeners, in m, measured along the plating;

l : overall span of stiffeners, in m, i.e. the distance between the supporting elements at the ends of the stiffeners (see Fig 4);

S : conventional scantling span of primary supporting members, in m, to be taken as given in the examples in Fig 5. Special consideration is to be given to conditions different from those shown. In no case is **S** to be less than 1,1 S_0, S_0 being the distance between the internal ends of the conventional brackets as indicated in Fig 5 or, if there are no brackets, between the ends of the members;

b : actual surface width of the load bearing on primary supporting members; for usual arrangements **b** = 0,5 · (l_1 + l_2), where l_1 and l_2 are the spans of stiffeners supported by the primary supporting member;

p : design pressure, in kN/m², calculated as defined in Ch 1, Sec 3, [4];

σ_{am} : permissible normal stress, in N/mm²;

τ_{am} : permissible shear stress, in N/mm²;

K : material factor defined in Sec 1, [1.6];

e : σ_p / σ_{bl}, ratio between permissible and actual hull girder longitudinal bending stresses (see [2.4]);

σ_p : maximum admissible stress, in N/mm², as defined in [2.4.1];

σ_{bl} : longitudinal bending stress, in N/mm², as defined in [2.4.1];

μ : $\left(1,1 - 0,5 \cdot \left(\frac{s}{l}\right)\right)^{0,5}$

, which is not to be taken greater than 1,0.

2.3 Minimum thicknesses

2.3.1 In general, the thicknesses of plating, stiffeners and primary supporting members are to be not less than the minimum values.

Lesser thicknesses may be accepted provided that their adequacy in relation to strength against buckling and collapse is demonstrated to the satisfaction of Tasneef. Adequate provision is also to be made to limit corrosion.

Table 1

Element	Minimum thickness (mm)
Shell plating: - Bottom shell plating - Side shell plating	$1,35 \cdot L^{1/3} \geq 2,5$ $1,15 \cdot L^{1/3} \geq 2,5$
Deck plating	2,5
Bulkhead plating	2,5
Deckhouse side shell plating	2,5

2.4 Overall strength

2.4.1 Longitudinal strength

In general, the scantlings resulting from local strength calculations in this Article are such as to ensure adequate longitudinal strength of the hull girder for the vessel.

Specific longitudinal strength calculations are required for each of the following cases:

- vessel whose hull geometry suggests significant bending moments in still water with the vessel at rest;
- vessel with large openings on the strength deck

Longitudinal strength calculations are, as a rule, to be carried out for the hull transverse section where the bending moment is maximum.

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These formulae are valid for stiffeners whose web is perpendicular to the plating, or forms an angle to the plating of less than 15°.

In the case of stiffeners whose web forms an angle $\alpha >$ 15° to the perpendicular to the plating, the required modulus and shear area may be obtained from the same formulae, dividing the values of **Z** and $\mathbf{A}_t$ by cos α .

The section modulus of ordinary stiffeners is to be calculated in association with an effective width of plating equal to the spacing of the stiffeners, without exceeding 20 per cent of the span.

The web thickness is to be not less than:

- 1/15 of the depth, for flat bars;
- 1/35 of the depth, for other sections

and the thickness of the face plate is to be not less than 1/20 of its width.

The ends of ordinary stiffeners are, in general, to be connected by means of Rule brackets to effective supporting structures.

Ends without brackets are accepted at the penetrations of primary supporting members or bulkheads by continuous stiffeners, provided that there is sufficient effective welding section between the two elements. Where this condition does not occur, bars may be accepted instead of the brackets, at the discretion of Tasneef

In general, the resistant weld section $\mathbf{A}_w$, in cm², connecting the ordinary stiffeners to the web of primary members, is not to be less than:

$$\mathbf{A}_w = \phi \cdot \mathbf{p} \cdot \mathbf{s} \cdot \mathbf{l} \cdot \mathbf{K} \cdot 10^{-3}$$

where:

ϕ : coefficient as indicated in Tab 4

p : design pressure, in kN/m², acting on the secondary stiffeners, defined in [2.7.2] to [2.7.6] for various hull regions

s : spacing of ordinary stiffeners, in m

l : span of ordinary stiffeners, in m

K : greater material factor of ordinary stiffener and primary member, defined in Sec 1, [1.6].

For aluminium alloys, when calculating the resistant connecting weld section, the fillet weld length $\mathbf{d}_e$, in mm, is to be determined as follows (see case 1 and 2 in Tab 4):

- case 1: $\mathbf{d}_e = \mathbf{d} - 20$ where **d**, in mm, is the length of the weld
- case 2: for extruded T stiffeners, the lesser of $\mathbf{d}_e = \mathbf{b} - 20$ and $\mathbf{d}_e = 4 \cdot \mathbf{t}$, where **b**, in mm, is the flange width of the ordinary stiffener and **t**, in mm, is the web thickness of the primary member.

Table 3

Type of stiffener	m
Continuous longitudinal stiffeners without Rule brackets at the ends of span	12
Longitudinal and transverse stiffeners with Rule brackets at the ends of span	19
Longitudinal and transverse stiffeners with Rule brackets at one end of span	15
Non-continuous longitudinal stiffeners and transverse stiffeners without Rule brackets at the ends of span	8

Table 4

Case	Weld	ϕ
1	Parallel to the reaction on primary member	200
2	Perpendicular to the reaction on primary member	160

2.7.2 Bottom and bilge stiffeners *(1/5/2023)*

Both single and double bottoms are generally to be longitudinally framed.

The section modulus, shear area and welding section required for bottom and bilge stiffeners are given by the formulae in [2.7.1], assuming:

a) **p** = impact pressure $\mathbf{p}_{sl}$ if occurring on the bottom as defined in Ch 2, Sec 2, [4.3], where $\sigma_{am} = 70/\mathbf{K}$ N/mm²
τ_{am} = ~~90~~45/**K** N/mm²;

b) **p** = sea pressure $\mathbf{p}_s$ defined in Ch 2, Sec 2, [4.5], where:

- stiffeners contributing to the longitudinal strength:
  $\sigma_{am} = 70 \cdot \mathbf{C}_A/\mathbf{K}$ N/mm²
  $\tau_{am} = 45/\mathbf{K}$ N/mm²;
- stiffeners not contributing to the longitudinal strength:
  $\sigma_{am} = 70/\mathbf{K}$ N/mm²
  $\tau_{am} = 45/\mathbf{K}$ N/mm²;

where $\mathbf{C}_A$ is given by Tab 5 as a function of the distance **x**, in m, from the calculation point of section modulus to the after perpendicular.

Table 5

x/L	C_A
$\mathbf{x}/\mathbf{L} < 0,1$	1
$0,1 \le \mathbf{x}/\mathbf{L} \le 0,3$	$1 + 0,5 \cdot \left(0,3 - \frac{1}{\mathbf{e}}\right) \cdot \left(10 \cdot \frac{\mathbf{x}}{\mathbf{L}} - 1\right)$
$0,3 < \mathbf{x}/\mathbf{L} < 0,7$	$1,3 - \frac{1}{\mathbf{e}}$
$0,7 \le \mathbf{x}/\mathbf{L} \le 0,9$	$1 - 0,5 \cdot \left(0,3 - \frac{1}{\mathbf{e}}\right) \cdot \left(10 \cdot \frac{\mathbf{x}}{\mathbf{L}} - 9\right)$
$\mathbf{x}/\mathbf{L} > 0,9$	1

Note 1: The value of C_A is to be taken less than or equal to 1.

Bottom longitudinals are preferably continuous through the transverse elements. Where they are interrupted at a transverse watertight bulkhead, continuous brackets are to be positioned through the bulkhead so as to connect the ends of longitudinals.

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Part B
Hull and Stability

CHAPTER 5
HIGH DENSITY POLYETHYLENE HULLS

SECTION 1 DESIGN PRINCIPLES AND STABILITY

1 Application

1.1

1.1.1 *(1/5/2023)*

The requirements in Ch 1, Sec 1 and Ch 4, Sec 1 apply.

SECTION 2 MATERIALS, CONNECTIONS AND STRUCTURE DESIGN PRINCIPLES

1 Materials and connections

1.1 General requirements

1.1.1 (1/5/2023)

Materials to be used in hull and equipment construction, in delivery condition, are to comply with these requirements or with specific requirements applicable: they are to be tested in compliance with the applicable provisions. Quality and testing requirements for materials covered here are outlined in the relevant Tasneef Rules.

Welding processes are to be approved for which they are intended and with limits and conditions as stated in the applicable in the relevant Tasneef Rules.

1.2 HDPE hull structures

1.2.1 (1/5/2023)

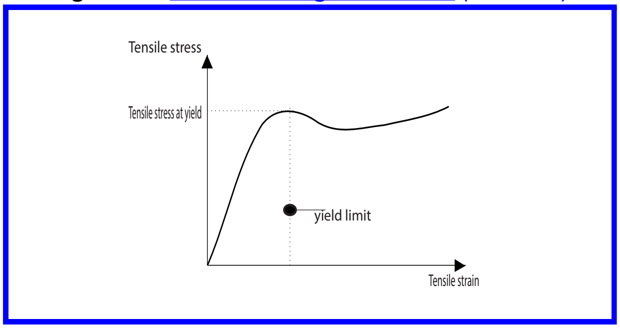
HDPE is a thermoplastic material made up of long-chain of molecules (polymer) consisting of a series of small repeating molecular units (monomers).

HDPE is characterized by a good impact resistance, light weight, and very low moisture absorption.

HDPE members used for the construction of the hull are not to be of a recycled manufacturing.

Taking into account the non-linearity of the HDPE behavior as shown on Fig 1, the main mechanical characteristics to be considered in the present Section are to be defined by the manufacturer and verified by mechanical tests at the yield limit of the material.

Figure 1 : Stress / elongation curve (1/5/2023)



When the mechanical properties of HDPE have not been defined by the manufacture yet, the minimum values at the yield limit are given below, subject to the subsequent confirmation by mechanical tests.

Table 1 (1/5/2023)

Mechanical properties	Value
Density g/cm³(acc. to ISO 1183-2)	0.946
Elasticity (Young) modulus at yield (MPa)	E = 950
Shear modulus at yield (MPa)	300
Tensile stress at yield (MPa)	R_{eh} = 22
Tensile stress at Breaking (MPa)	R_m = 30
Tensile elongation at yield (%)	13
Shear stress at yield (MPa)	τ_{eh} = 14
Poisson's coefficient	0.45
Long term service temperature (°C)	80

Minimum mechanical characteristics of HDPE is to be verified by testing with the recognized standards e.g. ASTM/ISO or alternatively national standard may be applied, subject to the agreement of Tasneef

1.2.2 (1/5/2023)

Water absorption of HDPE sheets are to be determined in accordance with ASTM D570-98 or ISO 62:2008 and it is to be in range 0.01 to 0.017 % (24 hrs).

1.2.3 Welded connections (1/5/2023)

A welding booklet, including the weld scantling such as throat thickness and design of joint, is to be submitted to the Society for examination. The welding booklet is not required if the structure drawings submitted to the Society contain the necessary relevant data defining the weld scantling.

The structures of the hull will be in general connected with welded joints as follows.

Butt weld: As a rule, butt welding is to be used for plate and stiffener butts and is mandatory for heavily stressed butts such as those of the bottom, keel, side shell, sheerstrake and strength deck plating, and bulkheads (in particular bulkheads located in areas where vibrations occur). As a rule, the structural butt joints are to be full penetration welds, performed from both sides.

Fillet welds: As a rule, double continuous fillet welds are to be provided. The total throat thickness weld is not to be less than the thinner plate of the assembly.

Other throat thickness may be considered on a case-by-case basis by the Society.

1.2.4 Non Destructive Testing (NDT) of welding *(1/5/2023)*

The non-destructive testing, their extent and their result acceptance criteria are to be defined by the shipyard are to be submitted to the Society for information.

1.2.5 Welding procedure and Welder certification *(1/5/2023)*

Welding procedure relating to joints between structural reinforcements and panels and panels between them, reference is to be made to specific procedure to be prepared by the yard is to be made available to attending surveyor before production of the hull. Based on the procedures welders must be certified according to UNI EN 13067 or other recognized standards.

2 Structure design principles

2.1 Protection against high temperature

2.1.1 *(1/5/2023)*

The Shipyard shall take all the precautions to protect the material against temperatures higher than long term service temperature at the construction stage.

The reason is that HDPE mechanical properties (e.g. tensile stress at yield) degrade dramatically with the increase of the temperature.

Examples of the possible precautions to be taken are:

a) The engine room is to be fitted with a mechanical ventilation system having a rate capable of keeping the temperature lower than the long-term service temperature.

b) A system for the washing/cooling of the deck and of the structures particularly exposed to the sun.

2.2 Rounding-off

2.2.1 *(1/5/2023)*

Values for thickness as obtained from formulae are to be rounded off to the nearest standard value, without such a reduction exceeding 3 per cent.

SECTION 3 DESIGN LOADS AND HULL SCANTLING

1 Application

1.1

1.1.1 *(1/5/2023)*

The requirements in Ch 2, Sec 2, [2], [3] and [4] apply taking into account the local load point location defined in Ch 2, Sec 2, [4.2.2] (Load points).

For the purpose of defining the value of the parameter "S", as specified in Ch 2, Sec 2, [2.1], the type of service to be adopted is to be in all cases "pilot", except when the unit is intended for rescue operations for which the relevant type of service is to be selected.

The operational area to be considered for the service of the units is not to be more extended than that corresponding to "Moderate environment service".

For limit operating conditions allowed for by design parameters, see Ch 2, Sec 2, [2.4].

2 Hull scantlings

2.1 Introduction

2.1.1 *(1/5/2023)*

This Article stipulates requirements for the scantlings of hull structures (plating, stiffeners, primary supporting members) made, totally or partly, of high-density polyethylene (HDPE) for building based on HDPE sheets. The loads acting on such structures are to be calculated in accordance with the provisions of [1].

In general, HDPE is not to be used for hull structures of ships more than 24 m in length.

In specific cases the designer may decide to use HDPE for hull structures of ships up to 65 m in length, provided that the following additional requirements are fulfilled:

a) Hull girder yielding strength is checked according to [3.2].

b) Buckling strength is checked according to [3.3].

c) Overall stiffness of the hull girder is checked according to [3.4].

For transverse structures of the hull, Tasneef may, at its discretion, and as an alternative to the requirements of this Chapter, accept scantlings based on direct calculations.

2.1.2 **Equivalence** *(1/5/2023)*

Structural checks of the hull scantlings may be also carried out in compliance with the provisions of ISO 12215-5 for metallic materials. The design category is not to be greater than C and the safety coefficient to be adopted for the definition of the design stresses is 1.5.

2.1.3 **General material approach** *(1/5/2023)*

The scantling formulae will use the yield characteristics of the HDPE (stresses and moduli). The main mechanical characteristics at yield to be defined by the HDPE supplier are the:

- E: tensile modulus of elasticity
- R_{eh}: minimum tensile stress at yield
- τ_{eh}: minimum shear stress at yield
- R_m: minimum tensile stress at breaking
- Long term service temperature
- Elongation.

The minimum mechanical characteristics of HDPE are given in Sec 2, Tab 1. Particular attention is to be taken to avoid the use of HDPE where temperatures may be higher than long term service temperature.

2.1.4 **Hull structure scantling analysis** *(1/5/2023)*

The hull structure scantling analysis is to be carried out according to the requirements for aluminum in Ch 3, Sec 2, [2.6] to [2.8], [2.10] and [2.11] as applicable, with the modifications described in [2.1.5] to [2.1.8]. Reference is also made to the description of aluminum strength characteristics in Ch 3, Sec 1, [1.6]

2.1.5 **Modifications to be adopted with respect to the strength approach for aluminum, when HDPE is used - General** *(1/5/2023)*

In general, the following modifications are to be adopted in the definitions:

E : tensile modulus of elasticity for HDPE in MPa (see [2.1.5] to [2.1.8])

$R_{p02} = R_{eh}$

where R_{eh} is the value for HDPE (see [2.1.5] to [2.1.8]).

2.1.6 **Modifications to be adopted with respect to the strength approach for aluminum, when HDPE is used - Plating** *(1/5/2023)*

For the plate formulae (see Ch 3, Sec 2, [2.6], [2.10.2] and [2.11.1]), in case of impact pressure p_{sl} or of plating of sub-division bulkheads:

$\sigma_{am} = R_{eh}/1.45$ (in lieu of 95/K) MPa

while in case of quasi-static pressure (external or internal):

$\sigma_{am} = R_{eh}/1.60$ (in lieu of 85/K) MPa.

In general, the HDPE structures are not suitable for the carriage of vehicles (concentrated loads), therefore the formulae for plating under wheeled loads in Ch 3, Sec 2, [2.6.7] cannot be applied.

The bending deflection, due to design pressure p, of a HDPE panel between stiffeners is not to be greater than about 2.5% of the stiffener spacing. The total deflection, in mm, of a HDPE panel, fixed on its edges, is given by the formula:

$$f = \frac{\mu_2}{384} \cdot \frac{p \cdot s^4}{[EI]}$$

where:

[EI]: rigidity of the HDPE panel, for 1 mm width, in $N*mm^2/mm$

μ2: 1, for l > 2s

$$1 - 2,1\left(1 - \frac{l}{2s}\right)^2 \quad \text{for } s < l < 2s$$

0,475, for l ≤ s

2.1.7 Modifications to be adopted with respect to the strength approach for aluminum, when HDPE is used - Ordinary stiffeners *(1/5/2023)*

For the ordinary stiffeners (see Ch 3, Sec 2, [2.7], [2.10.3] and [2.11.2]):

σ_{am} = (R_{eh} * C_A) / 1.95 MPa, for ordinary stiffeners contributing to the longitudinal strength (in lieu of 70*C_A/K):

or

σ_{am} = R_{eh} / 1.95 MPa, for ordinary stiffeners not contributing to the longitudinal strength (in lieu of 70 / K)

or

σ_{am} = R_{eh} / 1.60 MPa, for ordinary stiffeners of cross-deck bottom and internal sides of twin-hull craft, when subject to impact pressure (in lieu of 85 / K)

or

σ_{am} = R_{eh} / 1.45 MPa, for ordinary stiffeners of subdivision bulkheads (in lieu of 95 / K)

and

τ_{am} = τ_{eh} / 1.2 where τ_{eh} is the value minimum shear stress at yield for HDPE, see [2.1.1], in lieu of 45/K, in general

or

τ_{am} = τ_{eh} / 1.05 where τ_{eh} is the value minimum shear stress at yield for HDPE, see [2.1.1], in lieu of 55/K, for ordinary stiffeners of subdivision bulkheads.

2.1.8 Modifications to be adopted with respect to the strength approach for aluminum, when HDPE is used - Primary supporting *(1/5/2023)*

For the primary supporting members (see Ch 3, Sec 2, [2.8], [2.10.4] and [2.11.3])

σ_{am} = (R_{eh} * CA) / 1.95 MPa, for primary supporting members contributing to the longitudinal strength (in lieu of 70*CA/K):

or

σ_{am} = R_{eh} / 1.95 MPa, for primary supporting members not contributing to the longitudinal strength (in lieu of 70 / K)

or

σ_{am} = R_{eh} / 1.60 MPa, for primary supporting members of cross-deck bottom and internal sides of twin-hull craft, when subject to impact pressure (in lieu of 85 / K)

or

σ_{am} = R_{eh} / 1.45 MPa, for primary supporting members of subdivision bulkheads (in lieu of 95 / K)

and

τ_{am} = τ_{eh} / 1.20 MPa where τ_{eh} is the value minimum shear stress at yield for HDPE, see [2.1.1], in lieu of 45/K, in general

or

τ_{am} = τ_{eh} / 1.05 MPa where τ_{eh} is the value minimum shear stress at yield for HDPE, see [2.1.1], in lieu of 55/K, for primary supporting members of subdivision bulkheads.

The multipliers in Ch 3, Sec 2, [2.11] for the collision bulkheads are to be applied if the collision bulkhead is built with HDPE plates, ordinary stiffeners and primary supporting members.

2.1.9 Minimum ordinary stiffener section modulus *(1/5/2023)*

As a rule, the minimum section modulus of hull and deck secondary stiffeners is not to be less than 15 cm^3.

2.1.10 Pillars *(1/5/2023)*

Pillars in HDPE are in general not allowed. Specific cases may be considered by the society based on strength and stiffness under compression.

3 Check for overall loads

3.1 Transverse section strength characteristics

3.1.1 *(1/5/2023)*

The calculation of the hull girder strength characteristics (section moduli at deck and at bottom) is to be carried out as defined in Ch 3, Sec 2, [2.4], considering all the longitudinal continuous structural elements of the hull.

The value of the hull girder bending longitudinal stress σ_{bl} is to be calculated according to the formulae in Ch 3, Sec 2, [2.4.1].

3.2 Yielding checks for overall loads

3.2.1 *(1/5/2023)*

Hull girder yielding strength is checked for the total (still water plus wave) overall loads in Ch 1, Sec 3, [3].

The value of the hull girder bending longitudinal stress σ_{bl} is not to exceed the value of 70% of R_{eh} (see [2.1.1]) in any point of the transverse section.

The value of the shear stress due to hull girder total shear force is not to exceed the value of 70% of τ_{eh}, the shear stress at yield for the HDPE (see [2.1.1]).

3.3 Buckling checks for overall loads

3.3.1 *(1/5/2023)*

Hull girder buckling strength is checked for the total (still water plus wave) overall loads in Ch 2, Sec 2, [3].

The value of the hull girder bending longitudinal stress and shear stress in the plating are not to exceed the critical longitudinal and shear buckling stresses as calculated in Ch

3, Sec 2, [2.5] with the following modifications to the formulae:

E: tensile young modulus of the HDPE (see [2.1.3]).

$R_{p0.2}$: to be taken equal to the value of R_{eh} tensile stress at yield of HDPE (see [2.1.3]).

Alternative methods to calculate the critical buckling tensile and shear stresses in the plating may be considered by the society.

The formulae in Ch 3, Sec 2, [2.5.4] a) and b) cannot be used for the axially loaded stiffeners built in HDPE.

The critical buckling tensile stress in the stiffeners will be specially considered by the society, based on E and R_{eh}, the tensile stress at yield of HDPE (see [2.1.3]).

3.4 Overall stiffness check

3.4.1 *(1/5/2023)*

The hull girder overall stiffness is checked for the total (still water plus wave) overall loads in Ch 2, Sec 2, [3].

The overall stiffness of the hull girder is to be checked to avoid excessive values of hull girder deflection that would impair the operability of the ship structure and plants. To this purpose, the maximum vertical deflection under the total hull girder loads is not to exceed, in general, the value of L/150 at any frame along the hull.

SECTION 4 HULL OUTFITTING

1 Application

1.1

1.1.1 *(1/5/2023)*

The requirements in Ch 1, Sec 2 apply.

SECTION 5 RUDDERS, EQUIPMENT AND TESTING

1 Rudders

1.1 Application

1.1.1 *(1/5/2023)*

The requirements in Pt B, Ch 10, Sec 1 of the Rules apply.

2 Equipment

2.1 Application

2.1.1 *(1/5/2023)*

The requirements in Pt B, Ch 10, Sec 4 of the Rules apply.

3 Testing

3.1 Application

3.1.1 *(1/5/2023)*

The requirements in Pt B, Ch 12, Sec 3 of the Rules apply.