

# S6 Use of steel grades for various hull members - ships of 90 m in length and above

(1978)  
(Rev.1  
1980)  
(Rev.2  
1996)  
(Rev.3  
May  
2002)  
Rev.4  
July  
2003)  
(Rev.5  
Sept  
2007)

## S6.1 Ships in normal world wide service

Materials in the various strength members are not to be of lower grade than those corresponding to the material classes I, II and III as given in Table 1, depending on the categories of structural members (SECONDARY, PRIMARY and SPECIAL), and grades specified in Table 1 to Table 6. General requirements are given in Table 1, while additional minimum requirements for ships with length exceeding 150 m and 250 m, bulk carriers subject to the requirements of SOLAS regulation XII/6.5.3, and ships with ice strengthening are given in Table 2 to Table 5. The material grade requirements for hull members of each class depending on the thickness are defined in Table 6.

**Table 1 – Application of Material Classes and Grades**

Structural member category	Material class	
	Within 0.4L amidships	Outside 0.4L amidships
<p>SECONDARY:</p> <p>A1. Longitudinal bulkhead strakes, other than that belonging to the Primary category</p> <p>A2. Deck Plating exposed to weather, other than that belonging to the Primary or Special category</p> <p>A3. Side plating</p>	†	A/AH
<p>PRIMARY:</p> <p>B1. Bottom plating, including keel plate</p> <p>B2. Strength deck plating, excluding that belonging to the Special category</p> <p>B3. Continuous longitudinal members above strength deck, excluding hatch coamings</p> <p>B4. Uppermost strake in longitudinal bulkhead</p> <p>B5. Vertical strake (hatch side girder) and uppermost sloped strake in top wing tank</p>	‡	A/AH
<p>SPECIAL:</p> <p>C1. Sheer strake at strength deck [1], [8]</p> <p>C2. Stringer plate in strength deck [1], [8]</p> <p>C3. Deck strake at longitudinal bulkhead [2], [8]</p> <p>C4. Strength deck plating at outboard corners of cargo hatch openings in container carriers and other ships with similar hatch openings configuration [3]</p> <p>C5. Strength deck plating at corners of cargo hatch openings in bulk carriers, ore carriers, combination carriers and other ships with similar hatch openings configuration [4]</p> <p>C6. Bilge strake [5], [6], [8]</p> <p>C7. Longitudinal hatch coamings of length greater than 0.15 L [7]</p> <p>C8. End brackets and deck house transition of longitudinal cargo hatch coamings [7]</p>	‡‡‡	‡‡ (†-outside 0.6L amidships)

### Notes:

- Changes introduced in Rev.5 are to be uniformly implemented by IACS Members and Associates from 1 July 2008.

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Notes:

- [1] — ~~Not to be less than grade E/EH within 0.4L amidships in ships with length exceeding 250 metres.~~
- [2] — ~~Excluding deck plating in way of inner skin bulkhead of double hull ships.~~
- [3] — ~~Not to be less than class III within the length of the cargo region.~~
- [4] — ~~Not to be less than class III with 0.6L amidships and class II within the remaining length of the cargo region.~~
- [5] — ~~May be of class II in ships with a double bottom over the full breadth and with length less than 150 metres.~~
- [6] — ~~Not to be less than grade D/DH within 0.4L amidships in ships with length exceeding 250 metres.~~
- [7] — ~~Not to be less than grade D/DH.~~
- [8] — ~~Single strakes required to be of class III or of grade E/EH and within 0.4L amidships are to have breadths not less than  $800+5xL$  mm, need not be greater than 1800 mm, unless limited by the geometry of the ship's design.~~

~~The material grade requirements for hull members of each class depending on thickness are defined in Table 2.~~

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**Table 1 - Material Classes and Grades for ships in general**

<u>Structural member category</u>	<u>Material class/grade</u>
<b>SECONDARY:</b>	
A1. <u>Longitudinal bulkhead strakes, other than that belonging to the Primary category</u>	- Class I within 0.4L amidships - Grade A/AH outside 0.4L amidships
A2. <u>Deck plating exposed to weather, other than that belonging to the Primary or Special category</u>	
A3. <u>Side plating</u>	
<b>PRIMARY:</b>	
B1. <u>Bottom plating, including keel plate</u>	- Class II within 0.4L amidships - Grade A/AH outside 0.4L amidships
B2. <u>Strength deck plating, excluding that belonging to the Special category</u>	
B3. <u>Continuous longitudinal members above strength deck, excluding hatch coamings</u>	
B4. <u>Uppermost strake in longitudinal bulkhead</u>	
B5. <u>Vertical strake (hatch side girder) and uppermost sloped strake in top wing tank</u>	
<b>SPECIAL:</b>	
C1. <u>Sheer strake at strength deck (*)</u>	- Class III within 0.4L amidships - Class II outside 0.4L amidships - Class I outside 0.6L amidships
C2. <u>Stringer plate in strength deck (*)</u>	
C3. <u>Deck strake at longitudinal bulkhead, excluding deck plating in way of inner-skin bulkhead of double-hull ships (*)</u>	
C4. <u>Strength deck plating at outboard corners of cargo hatch openings in container carriers and other ships with similar hatch opening configurations</u>	- Class III within 0.4L amidships - Class II outside 0.4L amidships - Class I outside 0.6L amidships - Min. Class III within cargo region
C5. <u>Strength deck plating at corners of cargo hatch openings in bulk carriers, ore carriers combination carriers and other ships with similar hatch opening configurations</u>	- Class III within 0.6L amidships - Class II within rest of cargo region
C6. <u>Bilge strake in ships with double bottom over the full breadth and length less than 150 m (*)</u>	- Class II within 0.6L amidships - Class I outside 0.6L amidships
C7. <u>Bilge strake in other ships (*)</u>	- Class III within 0.4L amidships - Class II outside 0.4L amidships - Class I outside 0.6L amidships
C8. <u>Longitudinal hatch coamings of length greater than 0.15L</u>	- Class III within 0.4L amidships - Class II outside 0.4L amidships
C9. <u>End brackets and deck house transition of longitudinal cargo hatch coamings</u>	- Class I outside 0.6L amidships - Not to be less than Grade D/DH

(\*) Single strakes required to be of Class III within 0.4L amidships are to have breadths not less than 800+5L (mm), need not be greater than 1800 (mm), unless limited by the geometry of the ship's design.

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**Table 2 - Minimum Material Grades for ships with length exceeding 150 m and single strength deck**

<u>Structural member category</u>	<u>Material grade</u>
<u>Longitudinal strength members of strength deck plating</u>	<u>Grade B/AH within 0.4L amidships</u>
<u>Continuous longitudinal strength members above strength deck</u>	<u>Grade B/AH within 0.4L amidships</u>
<u>Single side strakes for ships without inner continuous longitudinal bulkhead(s) between bottom and the strength deck</u>	<u>Grade B/AH within cargo region</u>

**Table 3 - Minimum Material Grades for ships with length exceeding 250 m**

<u>Structural member category</u>	<u>Material grade</u>
<u>Shear strake at strength deck (*)</u>	<u>Grade E/EH within 0.4L amidships</u>
<u>Stringer plate in strength deck (*)</u>	<u>Grade E/EH within 0.4L amidships</u>
<u>Bilge strake (*)</u>	<u>Grade D/DH within 0.4L amidships</u>

(\*) Single strakes required to be of Grade E/EH and within 0.4L amidships are to have breadths not less than 800+5L (mm), need not be greater than 1800 (mm), unless limited by the geometry of the ship's design.

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**Table 4 - Minimum Material Grades for single-side skin bulk carriers subjected to SOLAS regulation XII/6.5.3**

<u>Structural member category</u>	<u>Material grade</u>
<u>Lower bracket of ordinary side frame (*), (**)</u>	<u>Grade D/DH</u>
<u>Side shell strakes included totally or partially between the two points located to 0.125<math>\ell</math> above and below the intersection of side shell and bilge hopper sloping plate or inner bottom plate (**)</u>	<u>Grade D/DH</u>

(\*) The term "lower bracket" means webs of lower brackets and webs of the lower part of side frames up to the point of 0.125 $\ell$  above the intersection of side shell and bilge hopper sloping plate or inner bottom plate.

(\*\*) The span of the side frame,  $\ell$ , is defined as the distance between the supporting structures.

**Table 5 - Minimum Material Grades for ships with ice strengthening**

<u>Structural member category</u>	<u>Material grade</u>
<u>Shell strakes in way of ice strengthening area for plates</u>	<u>Grade B/AH</u>

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**Table 26 - Material Grade Requirements for Classes I, II and III**

Class	I		II		III	
	MS	HT	MS	HT	MS	HT
$t \leq 15$	A	AH	A	AH	A	AH
$15 < t \leq 20$	A	AH	A	AH	B	AH
$20 < t \leq 25$	A	AH	B	AH	D	DH
$25 < t \leq 30$	A	AH	D	DH	D	DH
$30 < t \leq 35$	B	AH	D	DH	E	EH
$35 < t \leq 40$	B	AH	D	DH	E	EH
$40 < t \leq 50$	D	DH	E	EH	E	EH

For strength members not mentioned in Tables 1 to 5, Grade A/AH may generally be used. The steel grade is to correspond to the as-built plate thickness when this is greater than the rule requirement.

Plating materials for sternframes, rudders, rudder horns and shaft brackets are in general not to be of lower grades than corresponding to Class II. For rudder and rudder body plates subjected to stress concentrations (e.g. in way of lower support of semi-spade rudders or at upper part of spade rudders) Class III is to be applied.

## S6.2 Structures exposed to low air temperatures

For ships intended to operate in areas with low air temperatures (below and including  $-20^{\circ}\text{C}$ ), e.g. regular service during winter seasons to Arctic or Antarctic waters, the materials in exposed structures are to be selected based on the design temperature  $t_D$ , to be taken as defined in S6.3.

Materials in the various strength members above the lowest ballast water line (BWL) exposed to air are not to be of lower grades than those corresponding to Classes I, II and III, as given in Table 37, depending on the categories of structural members (SECONDARY, PRIMARY and SPECIAL). For non-exposed structures and structures below the lowest ballast water line, see S6.1.

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**Table 37 - Application of Material Classes and Grades – Structures Exposed at Low Temperatures**

Structural member category	Material class	
	Within 0.4L amidships	Outside 0.4L amidships
SECONDARY:  Deck plating exposed to weather, in general Side plating above BWL Transverse bulkheads above BWL	I	I
PRIMARY:  Strength deck plating <sup>[1]</sup> Continuous longitudinal members above strength deck, excluding longitudinal hatch coamings Longitudinal bulkhead above BWL Top wing tank bulkhead above BWL	II	I
SPECIAL:  Sheer strake at strength deck <sup>[2]</sup> Stringer plate in strength deck <sup>[2]</sup> Deck strake at longitudinal bulkhead <sup>[3]</sup> Continuous longitudinal hatch coamings <sup>[4]</sup>	III	II

Notes:

- [1] Plating at corners of large hatch openings to be specially considered. Class III or Grade E/EH to be applied in positions where high local stresses may occur.
- [2] Not to be less than Grade E/EH within 0.4L amidships in ships with length exceeding 250 metres.
- [3] In ships with breadth exceeding 70 metres at least three deck strakes to be Class III.
- [4] Not to be less than Grade D/DH.

The material grade requirements for hull members of each class depending on thickness and design temperature are defined in Table 48. For design temperatures  $t_D < -55^\circ\text{C}$ , materials are to be specially considered by each Classification Society.

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**Table 48 - Material Grade Requirements for Classes I, II and III at Low Temperatures**
**Class I**

Plate thickness, in mm	-20/-25 <sup>0</sup> C		-26/-35 <sup>0</sup> C		-36/-45 <sup>0</sup> C		-46/-55 <sup>0</sup> C	
	MS	HT	MS	HT	MS	HT	MS	HT
$t \leq 10$	A	AH	B	AH	D	DH	D	DH
$10 < t \leq 15$	B	AH	D	DH	D	DH	D	DH
$15 < t \leq 20$	B	AH	D	DH	D	DH	E	EH
$20 < t \leq 25$	D	DH	D	DH	D	DH	E	EH
$25 < t \leq 30$	D	DH	D	DH	E	EH	E	EH
$30 < t \leq 35$	D	DH	D	DH	E	EH	E	EH
$35 < t \leq 45$	D	DH	E	EH	E	EH	∅	FH
$45 < t \leq 50$	E	EH	E	EH	∅	FH	∅	FH

∅ = Not applicable

**Class II**

Plate thickness, in mm	-20/-25 <sup>0</sup> C		-26/-35 <sup>0</sup> C		-36/-45 <sup>0</sup> C		-46/-55 <sup>0</sup> C	
	MS	HT	MS	HT	MS	HT	MS	HT
$t \leq 10$	B	AH	D	DH	D	DH	E	EH
$10 < t \leq 20$	D	DH	D	DH	E	EH	E	EH
$20 < t \leq 30$	D	DH	E	EH	E	EH	∅	FH
$30 < t \leq 40$	E	EH	E	EH	∅	FH	∅	FH
$40 < t \leq 45$	E	EH	∅	FH	∅	FH	∅	∅
$45 < t \leq 50$	E	EH	∅	FH	∅	FH	∅	∅

∅ = Not applicable

**Class III**

Plate thickness, in mm	-20/-25 <sup>0</sup> C		-26/-35 <sup>0</sup> C		-36/-45 <sup>0</sup> C		-46/-55 <sup>0</sup> C	
	MS	HT	MS	HT	MS	HT	MS	HT
$t \leq 10$	D	DH	D	DH	E	EH	E	EH
$10 < t \leq 20$	D	DH	E	EH	E	EH	∅	FH
$20 < t \leq 25$	E	EH	E	EH	E	FH	∅	FH
$25 < t \leq 30$	E	EH	E	EH	∅	FH	∅	FH
$30 < t \leq 35$	E	EH	∅	FH	∅	FH	∅	∅
$35 < t \leq 40$	E	EH	∅	FH	∅	FH	∅	∅
$40 < t \leq 50$	∅	FH	∅	FH	∅	∅	∅	∅

∅ = Not applicable

Single strokes required to be of Class III or of Grade E/EH or FH are to have breadths not less than 800+ 5L mm, maximum 1800 mm.

Plating materials for sternframes, rudder horns, rudders and shaft brackets are not to be of lower grades than those corresponding to the material classes given in 6.1.

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## S6.3 Design temperature $t_D$

The design temperature  $t_D$  is to be taken as the lowest mean daily average air temperature in the area of operation.

**Mean:** Statistical mean over observation period (at least 20 years)

**Average:** Average during one day and night

**Lowest:** Lowest during year

For seasonally restricted service the lowest value within the period of operation applies.

Fig. 1 illustrates the temperature definition.

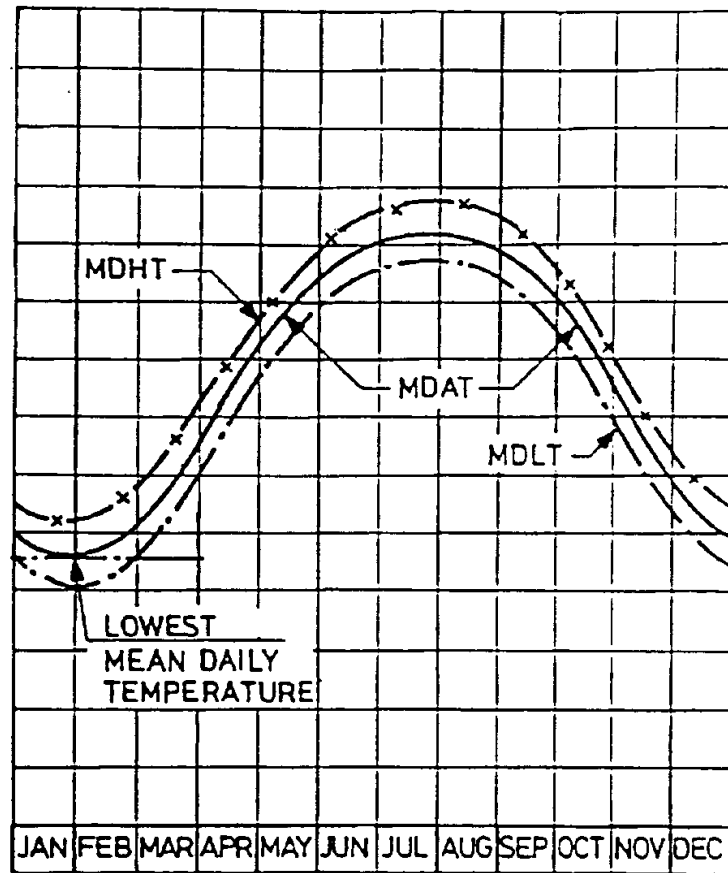


Fig. 1 Commonly used definitions of temperatures

MDHT = Mean Daily High (or maximum) Temperature

MDAT = Mean Daily Average Temperature

MDLT = Mean Daily Low (or minimum) Temperature

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