

Data sheet: A3.5

Lloyd's ship hull steel - 2001

Normal and Higher Strength Steel Plate for Hull Construction

General description

The normal strength steel grades for hull construction listed in the 'Rules and Regulations for the Construction and Classification of Steel Ships', published by Lloyd's Register of Shipping, are defined as mild steel with a tensile strength ranging from 400 to 520 MPa. The requirements apply to steel plates not exceeding 30mm in thickness: greater thicknesses are subject to special consideration. Four grades are specified, namely A, B, D and E. Although these grades have the same tensile strength, they are characterised by an increasing degree of toughness.

The higher strength grades of steel are the grades with a minimum specified yield strength equal to or in excess of 355 MPa. Three grades are specified, namely AH36, DH36 and EH36. The higher strength grades have a minimum tensile strength of 490 MPa. All grades are available in thicknesses up to 30mm maximum. The tensile requirements for these steel grades are identical. The impact requirements differ as described in Table 3.

This type of steel may be produced only at a steel works approved by the Lloyd's Committee, as is the case for Mittal Steel South Africa.

Steel making

Steel is normally supplied from a electric arc furnace but could also be supplied from basic oxygen furnaces using clean internal scrap and direct reduced iron. All steel is desulphurised to maintain a high degree of cleanliness and is made fully killed and fine-grained from continuously cast slabs. Full shrouding techniques and automatic mould level control are applied to ensure superior internal and surface quality.

Supply condition

Normal strength

- **Grade A** is usually made as aluminium and silicon killed steel. It is normally supplied in the as rolled condition.
- **Grade B** is a silicon killed aluminium treated steel and is normally supplied in the as rolled condition.
- **Grades D and E** are made to fully killed fine grain practice to ensure that toughness requirements are met. Grades D and E plate are normalised.

Higher strength

- **Grades AH36, DH36 and EH36** are produced as fully killed, grain-refined material. In thicknesses up to 30mm in the normalised condition.

For further information, contact:

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Chemical composition

Table 1 shows the chemical composition as specified by Lloyd's Rules (2001) Tables 3.2.1 and 3.3.2. The limits are set rather wide to give the steel producer maximum scope to apply his manufacturing techniques. In order to assist customers in determining fabrication parameters, the typical analyses of the steels as made by Mittal Steel South Africa are given in Table 2. It must be stressed that these values are given as an indication only and are in no way binding on Mittal Steel South Africa as manufacturer. Only the specification is binding. It should also be noted that, because thicker plates cool at a slower rate during and after rolling or normalising, they will emerge at lower strength levels if the chemical composition is not enriched to counteract this effect (even though the specification does allow for some strength reduction with thickness).

Table 1. Chemical composition (ladle analysis, percent) as specified by Lloyd's rules

Grade	C max	Mn	P max	S max	Si	Al ¹	Nb
A	0,21	²	0,035	0,035	0,50 max	-	-
B	0,21	0,80 min	0,035	0,035	0,35 max	-	-
D	0,21	0,60 min	0,035	0,035	0,10 - 0,35	0,020 min	-
E	0,18	0,70 min	0,035	0,035	0,10 - 0,35	0,020 min	-
AH 36 ³	0,18	0,70 - 1,60 ⁴	0,035	0,035	0,50 max	0,020 min	0,020 - 0,050
DH 36 ³	0,18	0,90 - 1,60	0,035	0,035	0,50 max	0,020 min	0,020 - 0,050
EH 36 ³	0,18	0,90 - 1,60	0,035	0,035	0,50 max	0,020 min	0,020 - 0,050

Notes:

1. Total aluminium
2. % manganese not less than 2,5 times % carbon.
3. Residual elements are restricted to the following maximum: copper ≤ 0,35%; chromium ≤ 0,20%; nickel ≤ 0,40%; molybdenum ≤ 0,08%
4. 0,90% - 1,60% manganese for $t \geq 12,5\text{mm}$

Table 2. Typical chemical composition (ladle analysis, percent) as produced by Mittal Steel South Africa

Grade	Deoxidation practice	Thickness t (mm)	C	Mn	P max	S max	Si	Al	Nb
A	Fully killed	$4,5 \leq t \leq 30$	0,14	0,90	0,020	0,020	0,25	0,035	-
B	Fully Killed	$4,5 \leq t \leq 30$	0,14	0,9	0,020	0,020	0,25	0,035	-
D	Fully killed	$6,0 \leq t \leq 30$	0,12	0,95	0,020	0,020	0,25	0,035	-
E	Fully killed	$6,0 \leq t \leq 30$	0,12	1,00	0,020	0,010	0,25	0,035	-
AH 36	Fully killed	$6 \leq t \leq 30$	0,15	1,45	0,015	0,015	0,40	0,035	0,025
DH 36	Fully killed	$6 \leq t \leq 30$	0,15	1,45	0,015	0,015	0,40	0,035	0,025
EH 36	Fully killed	$6 \leq t \leq 30$	0,15	1,45	0,015	0,015	0,40	0,035	0,025

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Mechanical properties

Table 3. Mechanical property requirements as specified by Lloyd's rules

Grade	Tensile strength (MPa)	Minimum yield stress (MPa)	Minimum elongation ^{1, 2} (%)	Charpy V-Notch ³ impact test in the longitudinal direction	
				Test temperature (°C)	Minimum average energy (J)
A	400 - 520	235	22	-	-
B	400 - 520	235	22	0	27
D	400 - 520	235	22	20	27
E	400 - 520	235	22	-40	27
AH36	490 - 620	355	21	0	34
DH36	490 - 620	355	21	-20	34
EH36	490 - 620	355	21	-40	34

Notes:

1. Gauge length $5,65\sqrt{S_0}$, where S_0 is the original cross sectional area of the tensile test specimen.
2. Applicable to round tensile specimens only. Refer to note 2 of Table 3.3.3 and note 3 of Table 3.2.3 of the specification for full thickness specimens.
3. Longitudinal, full size test specimen.

Dimensions

All normal strength and higher strength grades are available in thicknesses up to 30mm. For more details on dimensions available, refer to the data sheet: Plate Mill Product Dimensions (file reference A1.3).

Grade A is

also available as a Hot Strip Mill Product in the thickness range of 1,6mm to 13mm. Refer to the data sheet: Hot Strip Mill Product Dimensions (file reference A1.1) for more detail on dimensions available.

Tolerances

Plate supplied with dimensional tolerances according to Lloyds specification.

Inspection and witnessing

A Lloyd's inspector witnesses the mechanical tests. Surface inspection and verification of dimensions are the responsibility of the steel producer. Lloyds' inspector witnessing of surface inspection and/or ultrasonic testing is done only at the request of the purchaser. Every finished item is marked with the LR brand together with other relevant identification marks.

Weldability

The normal strength ship plate grades are all readily weldable by the usual metal arc welding processes. Good weldability is ensured by the specification, laid down by Lloyd's, that the maximum value for the sum of carbon and manganese divided by 6 (i.e. the main terms in the formula for the carbon equivalent) may not exceed 0,40%. When welding thick plates, especially at low heat inputs or when using processes which result in high hydrogen levels, reference should be made to BS 5135:1984, 'Specification for arc welding of carbon and carbon manganese steels' to establish possible preheat requirements.

The maximum carbon equivalent of the higher strength ship plate grades is subject to agreement.

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Certification

All material described in this data sheet is supplied with test and analysis certificates. These certificates are authorised by a Lloyd's inspector. Other certificates may also be authorised by a Lloyd's inspector.

Supply conditions

All material described in this data sheet is supplied in terms of Price List 110 and 120 for hot rolled plate and strip Respectively and Mittal Steel South Africa's General Conditions of Sale.

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