



DILLINGER HÜTTE GTS

DIMARINE 36

HIGH-STRENGTH SHIPBUILDING STEEL THERMOMECHANICALLY ROLLED

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DIMARINE 36 is a thermomechanically rolled fine grained steel which, in its delivery condition ex works, has a minimum yield strength of 355 MPa. DIMARINE 36 has been approved by many classification societies conforming to the appropriate classification rules for use in shipbuilding.

Due to its chemical composition, this material has a low carbon equivalent and hence excellent weldability, even for thicker plates. It is preferentially used by the customers for shipbuilding, the manufacture of which places exacting demands on weldability.

Product description

Designation and range of application

DIMARINE 36 can be delivered in four qualities as follows :

- Quality A with minimum impact values at 0 °C: **DIMARINE 36 A**
recorded under Material No. 1.0583 for shipbuilding steel Grade AH36
- Quality D with minimum impact values at -20 °C: **DIMARINE 36 D**
recorded under Material No. 1.0584 for shipbuilding steel Grade DH36
- Quality E with minimum impact values at -40 °C: **DIMARINE 36 E**
recorded under Material No. 1.0589 for shipbuilding steel Grade EH36
- Quality F with minimum impact values at -60 °C: **DIMARINE 36 F**
recorded under Material No. 1.8841 for shipbuilding steel Grade FH36

DIMARINE 36 can be delivered from 8 to 100 mm thickness. Other dimensions are possible on request.

Chemical composition according to ladle analysis

For the ladle analysis the following limiting values are applicable in weight %¹⁾:

C	Si	Mn	P	S	N	Nb ²⁾
≤ 0.12	≤ 0.50	≤ 1.60	≤ 0.020	≤ 0.005	≤ 0.008	≤ 0.05

¹⁾ Furthermore the maximum values of Cu, Ni, Cr, Mo et Ti according to the requirements of the classification societies are met.
For the carbon equivalent CEV also the following values are met: CEV ≤ 0.38 for thickness ≤ 50 mm and CEV ≤ 0.40 for thickness > 50 mm, ≤ 100 mm.

The steel is fine grained through sufficient content of Al, Nb and/or V.

Auxiliary data for the carbon equivalents CEV (IIW) and the Pcm value (Ito):

plate thickness [mm]	25	75
CEV [%]	0.33	0.34
Pcm [%]	0.18	0.17

$$CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15$$

$$Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$$

Delivery condition

Thermomechanically rolled (TM, M or TMCP).

Mechanical and technological properties in the delivery condition

Tensile test at ambient temperature¹⁾

Upper yield strength R_{eH} ²⁾ [MPa], min.	Tensile strength R_m [MPa]	Elongation A_5 [%], min.
355	490-620 ³⁾	22

¹⁾ For test specimens refer to paragraph "testing"

²⁾ If not apparent, the yield strength $R_{p0.2}$ is measured.

³⁾ A minimum tensile strength of 460 MPa required by special classification societies can be fulfilled too and is performed when explicitly specified with this classification society.

For plate of more than 15 mm thickness, a minimum necking on tensile specimens perpendicular to the plate surface (grades Z15, Z25 or Z35) in accordance with EN 10164 or comparable standards or regulations of classification societies, can be agreed when placing the order.

Impact test on Charpy-V specimens

DIMARINE 36	Test temperature [°C]	Minimum impact values A_v [J] for plate thickness: average value (single value)					
		≤ 50 mm		> 50 mm ≤ 70 mm		> 70 mm	
		longitudinal	transverse	longitudinal	transverse	longitudinal	transverse
Quality A	0						
Quality D	-20	75	50	75	50	75	50
Quality E	-40	(45)	(30)	(45)	(30)	(45)	(30)
Quality F	-60						

The specified minimum value is the average of 3 tests. Moreover, none of the measured values should remain under the values given in parenthesis.

Testing

Testing will be performed conforming to the rules of the specified classification societies. In case no special classification society is given, the tests are performed based on the classification societies' unified requirements as follows:

The test specimens are taken from one end of the plate in 1/4 of the plate width.

The tensile test at ambient temperature is carried out on flat or on round tensile test specimens taken transverse to the rolling direction as follows :

- with a plate thickness ≤ 30 mm: full plate thickness, both rolled surfaces maintained,
- with a plate thickness > 30 mm: full plate thickness, both rolled surfaces maintained or half plate thickness, one rolled surface maintained or round tensile test specimens (taken in 1/4 of the plate thickness).

Testing is carried out in accordance with EN 10002-1 on flat tensile test specimens of gauge length $L_0 = 5.65 \sqrt{S_0}$ or on round tensile test specimens with $L_0 = 70$ mm and $d_0 = 14$ mm.

The impact test will be carried out at one temperature and one specimen sampling direction, as agreed when placing the order. Unless otherwise agreed, the impact values are determined using transverse Charpy-V-specimens in accordance with EN 10045-1 as follows:

- for plate thickness ≤ 40 mm: close to surface,
- for plate thickness > 40 mm: 1/4 of the plate thickness.

Inspection unit, specimen location and testing conditions can be adapted on request to the specific requirements of any classification society. Unless otherwise agreed the plates are delivered with inspection certificate 3.1 in accordance with EN 10204. If an inspection certificate 3.2 is requested, the inspection body / classification society is to be stated on the order.

Identification of plates

Unless otherwise agreed the marking is carried out via steel stamps with at least the following information:

- steel grade (if necessary only according to the classification society)
- heat number
- number of mother plate and individual plate
- the manufacturer's symbol
- sign of classification society's inspection representative

Fabrication properties

The entire fabrication and application techniques are of fundamental importance to the reliability of the products made from this steel. The fabricator should ensure that his calculation, design and fabricating methods are aligned with the material, correspond to the state-of-the-art that the fabricator has to comply with and are suitable for the intended use. The customer is responsible for the selection of the material. The recommendations in accordance with EN 1011 should be followed accordingly. For more precise information see also the latest version of DIMARINE Technical Information of Dillinger Hütte GTS.

Formability

Cold forming

As a rule, but depending on the actual processing type, DIMARINE 36 has excellent cold forming properties, i.e. forming at temperatures below 580 °C, because of the high toughness. It should be noted that cold forming raises the yield stress and decreases the toughness. Normally, these changes in mechanical properties can be partially recovered by a subsequent stress-relieving heat treatment. In case of higher cold forming ratios it is advisable to consult the steel manufacturer prior to placing the order.

Hot forming

Hot forming, that means forming at temperatures above A_{C3} , leads to essential changes in the original microstructure. It is impossible to re-establish the same material properties that had been achieved during the original manufacture through a further heat treatment. Therefore a heat treatment above 580 °C is not allowed.

Weldability and flame cutting aptitude

DIMARINE 36 has excellent weldability and flame cutting aptitude if the general technical rules are observed (see EN 1011). The risks of cold cracking and HAZ hardenability are low. Therefore, generally regardless of plate thickness, preheating is not necessary for flame cutting and welding. The low content of carbon and other alloy elements leads to favourable toughness properties in the heat-affected-zone, even for welding with high heat inputs. For special flame cutting requirements as i.g. long parallel cuts inner of the plate (cutting of lamellae), DIMARINE 36 can be delivered in an optimized condition in order to minimize the cambering deformations.

Heat treatment

Normalizing is not permitted for TM-steels.

A stress-relieving should be carried out between 530 and 580 °C followed by cooling in still air. The total holding time should not exceed 150 minutes (even if multiple operations are carried out). For a holding time of more than 90 minutes, the lower limit of the temperature range should be aimed at. A heat treatment at higher temperatures may affect the mechanical properties.

Flame straightening

Flame straightening is possible but should be carried out taking into account special working procedures (see DIMARINE Technical Information 1/92 of Dillinger Hütte GTS). Generally, a working temperature of 950 °C in the case of purely superficial heating (line heating) and 700 °C in the case of heating of the full plate thickness shall not be exceeded.

General technical delivery requirements

Unless otherwise agreed, the general technical delivery requirements in accordance with EN 10021 apply.

Tolerances

Unless otherwise agreed, tolerances are in accordance with EN 10029, with class B for thickness (lower tolerance: -0.3 mm).

Surfaces quality

Unless otherwise agreed, the provisions in accordance with EN 10163, class A2 are applicable. Stricter surface requirements can be arranged when placing the order.

General note

If particular requirements are demanded and not covered in this material data sheet, please contact us with the specifications for our review and agreement prior to ordering.

The indications in this data sheet are product descriptions. This data sheet is updated if necessary. The latest version is available from the mill or as download at www.dillinger.de.

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