

Mars[®] Protection steels

Mars[®] 500 High-Hardness Armor

Mars[®] 500 is a high-hardness (typical 500 HBW) protection steel offering the optimal combination of ballistic resistance and workability for the following applications:

- Very light to medium-weight vehicles structures
- Add-on armour of any thickness for usage up to heavy tanks.
- Boxes, containers, shelters, reservoirs, door frames, etc.

Properties

Standards

Mars[®] 500 can be ordered according to the following standard: **NF A36-800 THD2**
MIL-DTL-46100

Or upon specific agreement according to **TL2350-0000 grade Z**

Chemical composition - Ladle analysis - Max weight %

C	S	P	Si	Mn	Ni	Cr	Mo	B	CE ¹⁾
0.31	0.002	0.010	0.5	1.0	1.8	1.6	0.6	0.003	0.80

1) Carbon equivalence per ASTM A6/A6M, i.e. : $CE = C + [Mn/6] + [(Cr + Mo + V)/5] + [(Ni + Cu)/15]$

Mechanical properties (in both directions)

	Hardness	Yield Strength	UTS	Elongation	Charpy KV ²⁾ @-40°C standard 10 x 10 specimen ³⁾	
	HBW	MPa	Mpa	5d(%)	J	ft.lbs
Guarantees	477 - 534	≥ 1150	≥ 1500	≥ 8	≥24	≥ 18
Typical values	500	1250	1700	12	28	21

2) Average of 3 tests. Single value min 70% of specified average.

3) For nominal thicknesses under 11mm, sub-size specimens are used. The specified minimum value is then proportional to the specimen cross section.

Brinell hardness test according to relevant standard (EN ISO 6506-1 / ASTM E10/E110), on each plate and in two places, one at each end of a diagonal, on a milled surface 0,5 to 1mm below plate surface

Charpy Impact test according to relevant standard (EN ISO 148-1 / ASTM E23) on each heat and thickness from 6mm.

Tensile test according to EN ISO 6892-1, method B on each heat and thickness when specified in the standard or order.

Ultrasonic test is performed according to standard requirements or upon special agreement up to EN 10160 Class S₃/E₄.

In service conditions

Ballistic properties

Mars® 500 exceeds the ballistic performance requirements of MIL-DTL-46100 and NF A36-800.

See our table of recommended minimum thicknesses for common protection levels.

Ballistic test to be performed upon request.

Plate processing

Cutting

Mars® 500 can be cut either by abrasive waterjet, laser or plasma.

Bending

Mars® 500 offers ability to cold forming but as other protection steels must be used with caution. The elastic energy stored during forming may lead to rupture or shifting. It is essential to maintain a safety distance and not situate oneself in front of the plate while it is being formed. It is crucial to wear appropriate individual safety equipment and to equip machines with collective protection.

The capacity of the machine and tools must be suitable information on bending loads in relation to tools, plate thickness and steel strength.

The most important parameter when bending are the use of a correct punch radius.

Please contact us if you need assistance.

General recommendations :

- Minimal recommended temperature: 15°C
- Ensure that there are no obvious defects, especially on edges. Ideally, plate edges in the bending area should be ground smooth and rounded prior to operation.
- Die edges must remain clean, smooth, and ideally lubricated.
- Perform preliminary trials on prototypes and form the first pieces with low speed recommendation.
- Make sure that there is enough room in the die for the chosen punch together with the workpiece :
Die width > punch diameter + 3 x thickness

Grade	Thickness t mm (inch)	Mandrel Radius		Width of the die
		//	⊥	
Mars® 500	< 8 (0.315")	5t	5t	Die width > 2 x radius + 3 x thickness
	8 to 16 (0.315" to 0,63")	6t	6t	
	> 16 (0.63")	Contact us		

Welding

Mars® 500 can be welded using common welding processes. Like the other protection steels, it can be sensitive to cold cracking in the heat affected zone of a weld. The best results can be obtained by :

- Make sure that the steel is at least at room temperature (≈20 °C). For thicknesses higher than 25mm, the steel must be preheated at a temperature maximum of 100°C (maximal temperature acceptable by plate to preserve mechanical proprieties).
- Clean the weld joint area, removing potential sources of hydrogen: rust, scale, moisture, grease, ...
- Using low hydrogen welding methods and consumables (filler material hydrogen content HD ≤ 5 ml/100 g).
- Preferably use MAG welding and a welding sequence that is designed to minimize residual stresses.

Delivery conditions

Heat treatment

Mars® 500 is quenched and tempered at low temperature ($\leq 200^{\circ}\text{C}$).
Air hardened version is auto-tempering which is specially adapted to hot forming.

Surface properties

According to MIL-DTL-46100 or EN 10163 class B – subclass 3.
Shot blasting and weldable primer application can be performed upon request.

Sizes and tolerances

Mars® 500 can be supplied as quarto plates or cut-to-length sheets (from hot strip mill) in standard sizes or tailor made dimensions.

	Quarto plates			Cut-to-length sheets
Thicknesses	4.0 – 50.8 mm (.157" – 2")			2.5 – 10.0 mm (.098" – .393")
Thickness Tolerances	Th	For width ≤ 2000 mm	For width ≤ 2400 mm	
	≥ 4 to ≤ 12	0/+0.8	0/+0.8	$\geq 2.5 \leq t_0 \leq 8.5$: -0/+0.4
	> 12 to 20	0/+1.0	0/+1.2	> 8.5 to ≤ 10.0 : -0/+0.5
	> 20 to 35	0/+1.2	0/+1.4	
	> 35 to 50.8	0/+1.6	0/+1.8	
Width*	1500 – 2500 mm (39" – 98")			1500 – 2000 mm (39" – 78")
Lenght	1600 – 8100 mm (63" – 319")			1800 – 8100 mm (71" – 319")
Shape, length, and width tolerances as per MIL-DTL-12560 or EN 10029				

* Depending on plate thickness.

Flatness

Maximum flatness deviation is 3 mm/m (when measured according to EN 10029).

Industeel France
Le Creusot Plant
56 rue Clemenceau
F – 71 201 Le Creusot Cedex
industeel.arcelormittal.com



Your contact

Rodolphe BOURNIQUE
Tel. +33 6 26 80 33 10

rodolphe.bournique@arcelormittal.com

Technical data and information are to the best of our knowledge at the time of editing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.