

## Mars<sup>®</sup> Protection steels

### Mars<sup>®</sup> 380

**Rolled Homogeneous Armor heat treated for maximum resistance to shock.**

Mars<sup>®</sup> 380 is a protection steel (typical 380 HBW) designed for all vehicle structures (main battle tanks, armoured personal carriers ...) and for ammunition testing targets.

Mars<sup>®</sup> 380 steel is highly versatile, combining ease of use even in important thicknesses, with good ballistic properties against all ammunitions.

#### Properties

#### Standards

Mars<sup>®</sup> 380 can be ordered according to the following standards: **NF A36-800 CLA**

**MIL-DTL-12560 class 1 & 3**

Or upon specific agreement according to **TL2350-0000 grade H** or **DEF-STAN 95-13 type 1 & type 2** (with specific analysis and heat treatment)

#### Chemical composition - Ladle analysis - Max weight %

C	S	P	Si	Mn	Ni	Cr	Mo	V	B	CE <sup>1)</sup>
0.30	0.002	0.012	0.4	1.2	1.8	1.5	0.6	0.10	0.003	0.85

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

For thicknesses > 150 mm, analysis is modified with higher Ni & Cr content.

#### Mechanical properties (in both directions)

Below figures from MIL-DTL-12560, for information purpose only. Mechanical properties are adjusted to specified requirements (standard or on-demand).

Plate Thickness mm	Usual hardness range HBW	Charpy KV <sup>2)</sup> @-40°C standard 10 x 10 specimen <sup>3)</sup>	
		J	ft.lbs
≤ 6,32	360 - 410	≥ 22	≥ 16
6,33 to ≤ 15,85	340 - 390	≥ 22	≥ 16
15,86 to ≤ 28,58	330 - 380	≥ 22	≥ 16
28,59 to ≤ 50,77	310 - 360	≥ 24	≥ 18
50,78 to ≤ 101,57	270 - 320	≥ 38	≥ 28
101,58 to ≤ 152,4	250 - 300	≥ 49	≥ 36
152,41 to ≤ 228,6	230 - 280	≥ 62	≥ 46
228,61 to ≤ 304,8	210 - 260	≥ 76	≥ 56

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 S<sub>3</sub>/E<sub>4</sub>.

## In service conditions

### Ballistic properties

Mars® 380 meets the ballistic performance requirements of MIL-DTL-12560 for class 1 & 3 materials and NF A36-800 for CLA.

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

Ballistic test to be performed upon request.

### Plate processing

#### Cutting

Mars® 380 can be cut either by abrasive waterjet, laser or plasma.

#### Bending

Mars® 380 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® 380		5t	5t	Die width > 2 x radius + 3 x thickness

#### Welding

Mars® 380 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 40mm, 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.
- Austenitic consumables must be used. The recommended stainless austenitic consumables are of type AWS 307.

## Delivery conditions

### Heat treatment

Mars® 380 is **quenched** and tempered at high temperature ( $\geq 500^{\circ}\text{C}$ ).

### Surface properties

According to MIL-DTL-12560 or EN 10163 class B - subclass 3

Shot blasting and weldable primer application can be performed upon request

### Sizes and tolerances

Mars® 380 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	5.0 – 304.8 mm (.197" – 12") <sup>4)</sup>			5.0 – 10.0 mm (.197" – .393")
Thickness tolerances	Th	For width $\leq 2000$ mm	For width $\leq 2400$ mm	
	$\geq 5$ to $\leq 12$	0/+0.8	0/+0.8	$\geq 5.0$ to $\leq 8.5$ : -0/+0.4
	$> 12$ to 20	0/+1.0	0/+1.2	$> 8.5$ to $\leq 10.0$ : -0/+0.5
	$> 20$ to 35	0/+1.2	0/+1.4	
	$> 35$ to 50.8	0/+1.6	0/+1.8	
	$> 50.8$ to 80	0/+2.0	0/+2.2	
$> 80$ to 152.4	0/+2.2	0/+2.4		
Width*	1500 – 3500 mm ( 39" – 137")			1500 – 2000 mm ( 39" – 78")
Length	1600 – 8100 mm ( 63" – 319")			1800 – 8100 mm ( 71" – 319")
Shape, length, and width tolerances as per MIL-DTL-12560 or EN 10029				

4) Upon special agreement, thicknesses  $> 304.8$  mm (12") and up to 406.4 mm (16") can be produced.

\* Depending on plate thickness.

### Flatness

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

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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.