



Mars[®] 440: Medium Hardness Armor

Mars[®] 440 is a protection steel intended to be used as vehicle structures for protection against mines and IED. It offers optimal compromise in terms of hardness (typical 440 HBW), toughness, and ductility for resistance against blast loads and fragments, while keeping an excellent workability, especially bending and welding, for building specific vehicle profiles used for blast protection (example: V-shaped floor).

PROPERTIES

STANDARDS

Mars[®] 440 can be ordered according to one of the following standards:

> **NF A36-800 THD1**

> **MIL-DTL-12560 class 4a & 4b**

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

CHEMICAL COMPOSITION - LADLE ANALYSIS - MAX WEIGHT%

Version	Available Th range	C	S	P	Si	Mn	Ni	Cr	Mo	B	CE 1)
Liquid quenched (4a)	4 to 50 mm	0.22	0.002	0.015	0.5	1.5	2	1	0.6	0.003	0.70
Air hardened (4b)	20 to 70 mm	0.24	0.002	0.015	0.5	1.5	5	2	0.6	0.003	-

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)

Version		Hardness	Yield Strength	UTS	Elongation	Charpy KV 2) @-40 °C standard 10 x 10 specimen 3)	
			MPa	MPa	5d(%)	J	ft.lbs
Liquid quenched (4a)	Guarantees	420-470	≥ 1100	≥ 1250	≥ 10	≥ 27	≥ 20
Liquid quenched (4a)	Typical values	440	1150	1450	13	48	35
Air hardened(4b)	Guarantees	≥ 390	≥ 800	≥ 1200	≥ 10	≥ 20	≥ 15
Air hardened (4b)	Typical values	400	900	1300	-	-	-

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

3) For nominal thicknesses under 11 mm, 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® 440 exceeds the ballistic performance requirements of MIL-DTL-12560 for class 4 material.
Ballistic test to be performed upon request.

PLATE PROCESSING

For all information concerning machining, cutting, forming or welding, see our userguide for Mars® protection steels.

DELIVERY CONDITIONS

HEAT TREATMENT

In his liquid quenched version, Mars® 440 is **quenched** and tempered at low temperature ($\leq 200^{\circ}\text{C}/390^{\circ}\text{F}$).
Air hardened version is auto-tempering which is specially adapted to hot forming.

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® 440 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 – 70 mm (.157" – 2.75")			4 – 10.0 mm (.174" – .393")
Thickness Tolerances	Th	For width $\leq 2000\text{mm}$	For width $\leq 2400\text{mm}$	
	≥ 4 to ≤ 12	0/+0.8	0/+0.8	4 \leq to ≤ 7.8 : -0/+0.4
	>12 to 20	0/+1.0	0/+1.2	>7.8 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	
	>35 to 70	0/+2.2	0/+2.4	
Width*	1000 – 2500 mm (39" – 98")			1000 – 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				

* Depending on plate thickness

FLATNESS

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

YOUR CONTACT

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Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on protection 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.