

Mars® Protection steels

Safe® 500 Ballistic Protection Steel

Safe® 500 is a ballistic protection steel with superior flatness. Optimized chemical composition together with its carefully controlled heating, rolling and heat treatment sequences give Safe® 500 an optimal combination of weldability, bendability and ballistic protection performance.

It can be used in most civilian protection applications i.e. civil armored vehicles (limousines and sedans, SUVs), Cash-In-Transit vehicles, police cars, bulletproof doors, window frames and wall panels, etc.

Properties

Chemical composition – Ladle analysis – Max weight %

C	S	P	Si	Mn	Cr	B	CE ¹⁾
0.39	0.003	0.025	0.40	1.50	0.40	0.004	0.67

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
Typical values	520*	1350	1850	11	24	18

* Minimum guaranteed value : 477 HBW

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 (EN ISO 6506-1), on at least one plate per heat treatment batch, on two places, one at each end of a diagonal, on a milled surface 0,5 to 1mm below plate surface.

In service conditions

Standard	Ammunition	Velocity	Recommended thickness
EN 1522/1523 FB4+ VPAM PM6 + multi hit ¹⁾	7.62 x 39 FJ/PB/SC M43	720 ± 10m/s	4.2 mm
EN 1522/1523 FB6 VPAM PM7 + multi hit ¹⁾	5.56 x 45 SS109 7.62 x 51 FMJ NATO Ball	950 ± 10m/s 830 ± 10m/s	6.5 mm
NIJ 0108.01 Lvl III	7.62 x 51 FMJ NATO Ball (M80)	838 ± 15m/s	6.5 mm
EN 1522/1523 FB6 with Skin Effect ²⁾ VPAM PM7 + multi hit ¹⁾ with Skin Effect ²⁾	5.56 x 45 SS109 7.62 x 51 FMJ NATO Ball	950 ± 10m/s 830 ± 10m/s	8.0 mm

¹⁾ multi hit test condition : equilateral triangle with sides 4 ± 1 time projectile caliber

²⁾ skin effect : the armor steel is tested with a 1mm mild-steel plate placed, in front of it, at a stand-off distance of 10mm.

Plate processing

Cutting

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

Bending

Safe® 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 (CRC SP 350).
- 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
		//	⊥	
Safe® 500	< 8 (0.315")	7t	7t	Die width > 2 x radius + 3 x thickness

Welding

Safe® 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 ($\approx 20^\circ\text{C}$)
- 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

Safe® 500 is quenched and tempered at low temperature ($\leq 200^{\circ}\text{C}$)

Surface properties

According to EN 10163 class B – subclass 3

Shot blasting and weldable primer application can be performed upon request.

Sizes and tolerances

Safe® 500 is supplied as cut-to-length sheets (from hot strip mill).

	Cut-to-lenght sheets	
Thickness	4.2 – 8.0 mm (0.165" – 0.315")	
Thickness Tolerances	Th	Tolerances
	4.2 mm	0 + / -0.4 mm
	6.5 mm	0 + / -0.5 mm
	8.0 mm	0 + / -0.5 mm
Width	1500 – 2000 mm (59" – 78")	
Lenght	3000 – 6000 mm (118" – 236")	
Shape, lenght and width tolerances as per EN 10051		

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.