

Mars® Protection steels

Mars® 550

Very-high-Hardness Armor.

Mars® 550 is a very-high-hardness (typical 550 HBW) protection steel for lightweight armor applications such as:

- 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.

It is specially suitable for applications where the weight of a high-hardness armor is not acceptable but the workshop implementation doesn't allow the use of an ultra-high-hardness armor.

Properties

Standards

Mars® 550 can be ordered according to the following standard: **NF A36-800 THD3**
MIL-DTL-46186A

Chemical composition - Ladle analysis - Max weight %

| C | S | P | Si | Mn | Ni | Cr | Mo | CE ¹⁾ |
|------|-------|-------|-----|-----|-----|-----|-----|------------------|
| 0.35 | 0.002 | 0.010 | 1.0 | 1.2 | 1.6 | 0.6 | 0.6 | 0.77 |

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 | 530 - 570 | ≥ 1300 | ≥ 1700 | ≥ 8 | ≥ 18 | ≥ 13 |
| Typical values | 550 | 1450 | 1800 | 11 | 24 | 18 |

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® 550 exceeds the ballistic performance requirements of MIL-DTL-46186A.

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

Ballistic test to be performed upon request.

Plate processing

Cutting

Mars® 550 can be cut either by abrasive waterjet, laser or plasma.

Bending

Mars® 550 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® 550 | < 8 (0.315") | 6t | 6t | Die width > 2 x radius + 3 x thickness |

Welding

Mars® 550 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 $\text{HD} \leq 5 \text{ ml/100 g}$).
- 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® 550 is quenched and tempered at low temperature ($\leq 180^{\circ}\text{C}$)

Air hardened version is auto-tempering which is specially adapted to hot forming.

Surface properties

According to MIL-DTL-46186A or EN 10163 class B – subclass 3

Shot blasting and weldable primer application can be performed upon request

Sizes and tolerances

Mars® 550 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 – 16 mm (.197" - .630") | | | 2.5 – 10.0 mm (.098" - .393") |
| Thickness tolerances | Th | For width ≤ 2000 mm | For width ≤ 2400 mm | |
| | ≥ 5 to ≤ 12 > 12 to 16 | 0/+0.8 0/+1.0 | 0/+0.8 0/+1.2 | ≥ 2.8 ≤ to ≤ 8.5 : -0/+0.4 > 8.5 to ≤ 10.0 : -0/+0.5 |
| 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).

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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.