

ThyssenKrupp Steel Europe

Armour steel Heavy plate	Steel grade		Material No.	Material Specification 1943 January 2016
	TKSE-Short name	EN-Short name		
	SECURE 500	30CrMoNb5-2 30NiCrMo14-5	- 1.6947	

Scope

This Material Specification applies to the alloyed, liquid-quenched and tempered high-strength special steel SECURE 500 for civil use, that is usually produced in thickness from 3 mm up to 90 mm. This steel is delivered with defined properties of ballistic protection. The delivery above 90 mm up to 150 mm in thickness needs a special agreement.

Application

The steel may be used at the discretion of the purchaser for purposes of ballistic protection mainly for applications like armoured limousines and valuable transporters. The entire processing technique is of fundamental importance for the good performance of the products made of this steel. The processor must assure himself that his methods of calculation, designing and working conform with the material to be used, meet the latest requirements of technical progress and are suited to the proposed application.

The selection of the material is up to the purchaser

Chemical composition (heat analysis, %)

thickness	C	Si	Mn	P	S	Cr	Mo	Ni	Al
≤ 50 mm	≤ 0.32	≤ 0.40	≤ 1.00	≤ 0.015	≤ 0.005	≤ 1.50	≤ 0.50	≤ 0.70	≤ 0.110
> 50 mm	≤ 0.32	≤ 0.40	≤ 0.50	≤ 0.015	≤ 0.005	≤ 1.50	≤ 0.60	≤ 3.70	≤ 0.050

The steel additionally may contain Ti, Nb and B.

Delivery condition: quenched and tempered (see paragraph "Heat treatment")

Hardness at ambient temperature: 480 - 530 HBW

(other hardness ranges according to customers requirements are possible)

The hardness shall be determined in accordance with ISO 6506-1. The hardness is to be determined about 1 mm below plate surface.

Typical mechanical properties in the state of delivery condition at room temperature (transverse specimens according to ISO 6892-1, method B), Charpy-V-test acc. ISO 148-1 (transverse specimens).

yield strength R_{eH} ^{*)} MPa	tensile strength R_m MPa	elongation at fracture A %	Impact energy, - 40 °C J
1300	1600	9	25

^{*)} If continuous yielding occurs, the yield strength is determined as $R_{p0.2}$

Ballistic properties

Plates from SECURE 500 exhibit an increased resistance against ballistic threat. If a certain ballistic resistance is desired against a standardized ballistic threat, then it is necessary for reaching the desired performance that the customer specifies the appropriate examination and certification in the order. Orientation values for the minimum plate thickness for bullet resistance are summarized in the annex. The orientation values do not replace however a standardized examination and certification, which must be given in the order, if the customer wishes the suitability for a certain ballistic threat.

Number of tests

Unless otherwise agreed upon in the order, the tests listed below will be performed during inspection:

Hardness testing will be determined once per 40 t of a heat. The following options are possible in addition and must be agreed upon separately. If the customer doesn't take any use from these options at the time of the inquiry and ordering, the products are to be delivered in accordance with the base specifications of this document.

- a) for four-high mill plates only: ultrasonic testing acc. to EN 10160, class S₁/E₁
- b) bullet resistance testing can be performed according to customers requirements

All test results are documented by inspection certificates following EN 10204-3.1.

Independently of the requirements specified in the order the ballistic properties SECURE 500-plates with a thickness up to 14.5 mm are examined according to an TKSE-internally specified testing procedure.

General processing information

For those, who process this steel for the first time it is recommended to consult the steel supplier to take advantage of the experiences gathered so far.

The general information below can only cover a few important points. The information outlined in STAHL-EISEN-Werkstoffblatt 088 (weldable fine grain structural steels, processing directions especially for welding) applies equally to this steel.

Recommendations for welding are also given in EN 1011 part 1 and part 2 - Welding, Recommendation for welding of metallic materials.

Cold forming

Plates of the steel grade SECURE 500 can be cold formed at ambient temperature under consideration of their strength. The forming force and the amount of elastic recovery are greater than that of conventional structural steels. Cutting edges must be ground, flash trimmed and smoothly rounded before forming. Cold forming of plates must be performed at low forming speed at room temperature. Preheating is not recommended. Stress relieve heat treatment after forming should be avoided because of the decrease of hardness. Detailed information is given in our processing recommendations.

Heat treatment

In general this steel obtains its mechanical properties through austenitization followed by conventional quenching and tempering. The heat treatment depends on the chemical composition and the product thickness. To avoid decrease of hardness, SECURE 500 must not be heated above 200 °C.

Thermal cutting

For plate thickness up to 15 mm the laser-cutting process is preferably used. For plates up to 40 mm in thickness plasma cutting under water is recommended. Flame cutting is also possible without any difficulties. According to the plate thickness a sufficient pre- and post-heating is required. Detailed information is given in our processing recommendation Welding and Cutting.

Welding

If due consideration is given to the general rules for welding, this steel is weldable both manually and automatically. To prevent cold cracking in the welded joints only welding consumables should be used that lead to the lowest possible hydrogen content in the weld metal. The use of the austenitic welding consumable type 18 8 Mn (Thermanit X) is recommended. For plate thicknesses up to 25 mm preheating is generally not necessary. For high loaded welds, welded with a ferritic welding consumable, preheating should be carried out for the thicknesses specified in STAHL-EISEN-Werkstoffblatt 088. The height of the preheating temperature for welding depends on plate thickness and residual stress behavior of the construction. Interpass temperatures above 200 °C should be avoided. Detailed information is given in our processing recommendation Welding and Cutting.

Dimensions and tolerances

	four-high mill plates	plates cut from hot strip
thickness	4 - 150 mm	3 - 9 mm
thickness tolerance	≥ 4.0 and ≤ 13.0 mm: -0 / +0.8 mm >13.0 and ≤ 20.0 mm: -0 / +1.0 mm > 20.0 and ≤ 40.0 mm: -0 / +1.2 mm > 40.0 and ≤ 60.0 mm: -0 / +1.6 mm > 60.0 and ≤ 80.0 mm: -0 / +2.0 mm > 80.0 and ≤ 110.0 mm: -0 / +2.4 mm ≥ 110 mm: -0 / +3.0 mm	-0 / +0.4 mm
width	1250 - 3200 mm	850 - 1935 mm *
length	4000 - 12000 mm	1300 - 8000 mm

*depending on the plate thickness

General information

Unless otherwise agreed upon in the order, the delivery will be subjected to the conditions outlined in EN 10021.

The admissible tolerances for plates cut from hot strip are based on EN 10051 and for four-high mill plates on EN 10029, unless other terms have been agreed upon.

Thickness tolerances are according to the table shown above (paragraph on "Dimensions and tolerances").

The plates will be supplied with a maximum flatness tolerance of 6 mm/m (smaller flatness tolerances by special agreement). The flatness is determined in acc. to EN 10029, Class S.

For surface quality requirements EN 10163 is applicable.

As per special agreement it is possible to supply plates descaled or descaled and primed.

Publisher`s addresses

EN, ISO Standards

Beuth Verlag GmbH, Postfach, D-10772 Berlin

STAHL-EISEN-Werkstoffblätter

Verlag Stahleisen GmbH, Postfach 105164, D-40042 Düsseldorf

Recommendation for thermal cutting
of SECURE steels

ThyssenKrupp Steel Europe AG, D-47161 Duisburg

Recommendation for welding
of SECURE steels

ThyssenKrupp Steel Europe AG, D-47161 Duisburg

ThyssenKrupp Steel brochure
"Ballistic steels. Making life saver."

ThyssenKrupp Steel Europe AG, D-47161 Duisburg

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SECURE 500

Classification	Weapon		Bullet		Test Conditions		SECURE 500 (480-530 HB)
	Type	Calibre	Type	Mass [g]	Shot distance [m]	Bullet speed ¹⁾ [m·s ⁻¹]	
EN 1063 / EN 1522							Orientation values for minimum thickness ²⁾ for bullet resistance [mm]
BR / FB 3	handgun	.357 Magnum	FJ/CB/SC	10.2	5	430 ± 10	3.0 ³⁾
BR / FB 4		.44 Magnum	FJ/FN/SC	15.6	5	440 ± 10	3.0
BR / FB 5	rifle	5.56 mm x 45 (SS 109) <i>twist length: 178 ± 10 mm</i>	FJ/PB/SCP1	4.0	10	950 ± 10	6.5
BR / FB 6		7.62 mm x 51	FJ/PB/SC	9.5	10	830 ± 10	6.5
BR / FB 7		7.62 mm x 51 (AP) <i>twist length: 254 ± 10 mm</i>	FJ/PB/HC1	9.8	10	820 ± 10	15.0
without classification	handgun	.44 Magnum	FJ/FN/SC	15.6	3	435 - 455	3.0
	rifle	7.62 mm x 39 (Kalashnikov)	FJ/PB/SC	7.9	25	710 ± 15	4.0
			API	7.7	25	730 ± 15	12.0
		7.62 mm x 51	FJ/PB/SC	9.5	10	785 - 795	5.5
		7.62 mm x 51 (AP)	FJ/PB/HC1	9.8	25	800 - 810	14.5
5.56 mm x 45 (SS 92)	FJ/PB/SC	3.6	25	965 - 975	9.0		

Footnotes:

- 1) without classification: Bullet velocity in 2.5 m behind of muzzle
EN 1522, EN 1063: Impingement bullet velocity ≤ 2.5 m from front of sample
- 2) Values for the minimum thicknesses, given in the table, are nominal thicknesses
- 3) The required thickness of plates lies under the minimum delivery thickness of 3 mm

Terms and abbreviations:

- FJ/RN: Full metal jacket bullet, round nose
FJ/FN: Full metal jacket bullet, flat nose
FJ/PB: Full metal jacket bullet, pointed bullet
FJ/CB: Full metal jacket bullet, coned bullet
SC: Soft core (lead)
SCP1: Soft core (lead) and steel penetrator (type SS 109)
HC1: Steel hard core, mass 3.7 ± 0.1 g, > 63 HRC
API: Armoured piercing ignition