

# High Strength Steel (HSS) tubes for structural and engineering applications



Tenaris produces a large dimensional range of seamless tubes in high strength steel for engineering and structural application where the critical factor is controlling weight and/or a high resistance to stress requirement.

# High Strength Steel (HSS) tubes for structural and engineering applications

## Description and product application field

Tenaris has developed the following steel grades, supplied in quenched and tempered condition:

- TS460
- TS590
- TS690
- TS770
- TS890

The main characteristics of these products, with respect to traditional steel grades, are elevated yield strength and very good toughness at low temperature, with a chemical composition that guarantees an optimum weldability.

High strength seamless steel tubes used for structural and engineering purposes are produced according to Tenaris Specification PSP 00148. In all cases latest edition of this specification shall be used.

These tubes are used in steel construction for civil and engineering purposes where the relationship between mass and space occupied is specially critical.

## Reference Standards

The specification PSP 00148 is based on EN 10210-1/2 and SEW 090 t.2 standards. For the purpose of this specification “based on” means that these standards are only taken as reference but full compliance with those documents is not envisaged.

### EN 10210-1

Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions.

### EN 10210-2

Hot finished structural hollow sections of non-alloy and fine grain steels – Part 2: Tolerances, dimensions and sectional properties.

### SEW 090 t.2

Liquid quenched and tempered high-resistance fine grained steels – General technical delivery conditions for tubes and hollow sections

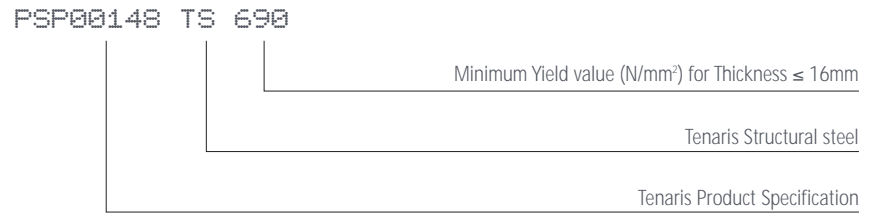
## Order definition

- Tenaris Specification PSP00148
- Steel grade
- Dimensions: External diameter, wall thickness & length in mm
- Quantity and relative tolerances

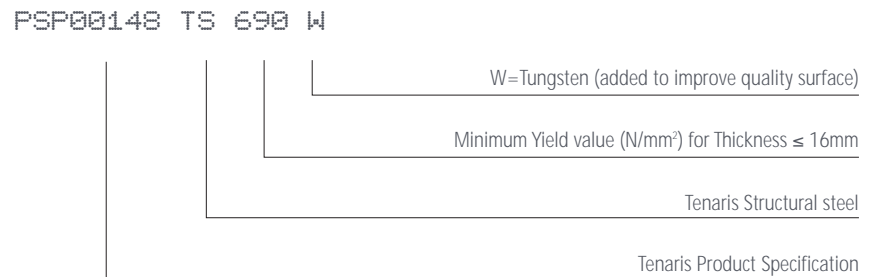
### Options

- a) Grades T690-TS770 modified with tungsten (W)
- b) Different lower maximum value of CEV
- c) Different straightness value
- d) Different length
- e) Additional specific inspections
- f) Other identification type
- g) Other color coding at one end
- h) Other certification type

### Example of steel grade designation 1



### Example of steel grade designation 2



## Steel grades

### Chemical Analysis

Steel grades with low carbon and sulfur content, with the addition of micro-

alloying and tempering elements, which can vary in percentage according to the steel grade.

CHEMICAL ANALYSIS %									
GRADE	C	Mn	Si	P	S	Ni	V	Cr	Mo
TS460-TS590	≤ 0,22	≤ 1,70	≤ 0,50	≤ 0,030	≤ 0,010	≤ 0,40	≤ 0,18	≤ 0,40	≤ 0,40
TS690-TS770	≤ 0,20	≤ 1,60	≤ 0,50	≤ 0,020	≤ 0,010	≤ 0,70	≤ 0,10	≤ 0,40	≤ 0,40
TS890	≤ 0,29	≤ 1,60	≤ 0,50	≤ 0,020	≤ 0,010	≤ 1,20	≤ 0,10	≤ 1,20	≤ 0,70

Other elements like Nb, and Ti may be added in order to increase hardenability and improve mechanical properties up to a total combined of 0.10% max. Boron shall not be intentionally added.

### Option

a) Upon request there is the possibility to supply the following steel grades modified with Tungsten (W).

This micro-alloying element (W) improves the surface quality of pipes, facilitating steel scale removal.

CHEMICAL ANALYSIS %										
GRADE	C	Mn	Si	P	S	Ni	V	Cr	Mo	W
TS690W-TS770W	≤ 0,20	≤ 1,60	≤ 0,50	≤ 0,020	≤ 0,010	≤ 0,70	≤ 0,10	≤ 0,40	≤ 0,40	≤ 0,80

### Weldability

Weldability is a key factor for the tubes in structural and engineering applications. Tenaris guarantees the good weldability of its products thanks to its controlled chemical composition with low carbon equivalent.

### Carbon Equivalent Value (CEV)

The maximum Carbon Equivalent Value (CEV) is determined, based on the cast analysis, by the following formula:

$$CEV = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MAXIMUM CEV					
GRADE	TS460	TS590	TS690	TS770	TS890
CEV % max	0,52	0,54	0,60	0,64	0,70

### Option

b) The grade TS690 with maximum CEV of 0.55% is available, with the material designation "TS690 L".

Upon request lower maximum value of CEV requirements may be agreed.

Other calculation methods like PCM may be agreed.

## Weldability

The steel grades indicated in the specification are weldable with traditional welding procedures, given observance of the generally accepted technical rules. It is important to define a welding procedure that takes into account the following conditions:

- Thickness of the base material

- Specific heat input (specially for HAZ)
- Design requirements
- Welding method used
- Weld material characteristics

Particular precautions should be taken towards crack susceptibility, which is more likely to happen with high thickness and high resistance.

This phenomenon is connected to the following factors:

- Chemical analysis (by means of CEV)
- The amount of diffusible hydrogen in the weld material
- HAZ micro-structure
- Tensile stress concentrations at the weld joint.

## Mechanical Properties

### Tensile requirements

The tensile test shall be carried out at room

temperature in longitudinal direction in accordance with EN10002-1.

MECHANICAL PROPERTIES							
GRADE	Minimum Yield Strength (MPa)			WT (mm)	Tensile Strength (MPa)		Minimum Elongation All%
	≤12	>12 ≤ 20	> 20 ≤ 40		≤ 20	>20 ≤ 40	
TS460	460	460	440		550-720	550-720	17
TS590	590	590	550		700-870	650-820	16
TS690	690	690	650		770-960	720-900	16
TS770	770	750	700		820-1000	750-930	15
TS890	890	870	850		940-1110	920-1090	14

Yield strength shall be reported as Rp0.2% proof stress (0.2% permanent offset).

### Fracture Toughness

Impact tests shall be carried out in accordance with EN10045-1 for 10 x 10 mm full size specimens in the

longitudinal direction at -40°C.

Energy values for Charpy-V notch test for each grade are indicated below.

IMPACT TEST PROPERTIES IN LONGITUDINAL DIRECTION		
Charpy V-notch 10x10 at -40°C (*) – Minimum Average Energy (J)		
Grade	WT (mm)	Longitudinal
TS460	All	30
TS590	All	30
TS690	≤20	45
	>20	40
TS770	≤20	45
	>20	40
TS890	≤20	45
	>20	40

Upon request, additionally impact tests could be carried out in the transversal direction at -40°C.

IMPACT TEST PROPERTIES IN TRANSVERSAL DIRECTION		
Charpy V-notch 10x10 at -40°C (*) – Minimum Average Energy (J)		
Grade	WT (mm)	Transversal
TS460	All	21
TS590	All	21
TS690	≤20	30
	>20	27
TS770	≤20	30
	>20	27
TS890	≤20	30
	>20	27

(\*) Other test temperature may be performed upon agreement.

When tube dimensions do not allow full size testing, sub-size specimens shall be used according to PSP00148.

## Dimension & Tolerances

DIMENSIONAL RANGE						
OD (mm)	48,3	76,2	139,7	219,1	508	
STEEL GRADE	TS460					32
	TS590					32
	TS690					25
	TS770					25
	TS890					25
						WT MAX (mm)

In the following cases, technical feasibility shall be agreed at the time of request of quotation

- For steel grades TS690/TS770/TS890 WT>25 mm
- For steel grades TS890 OD<139,7 e WT<10 mm
- For 508<OD<711 all steel grades
- For WT≤4 mm all steel grades
- For OD<48,3 mm all steel grades

DIMENSIONAL TOLERANCES	
Outside Diameter OD	+/-1% with a minimum of +/-0.5 mm
Wall Thickness WT	-10% (1), (2)
Straightness	0.2% of total length and 3 mm over any 1m length
Length	-0/+100 mm for fixed length ≥6000 mm (3)
Mass (Kg/m)	-6%/+8% on individual delivered lengths

- 1) The positive deviation is limited by the tolerance on mass
- 2) Tenaris guarantees a WT tolerance in one section of -10%/+15%, average wall thickness shall be such as to comply with minimum and maximum weight per meter
- 3) Tenaris may guarantee tighter length tolerances upon agreement

### Options

- c) Different straightness to that shown in the current specifications
- d) Different lengths to that shown in the current specifications

## Non-destructive examination

Each tube shall be inspected, at manufacturer's option, by means of one of the following non-destructive techniques and corresponding standards for detection of longitudinal and transversal discontinuities:

- Flux Leakage examination according to EN 10246-5 and EN 10246-4
- Eddy Current according to EN 10246-3
- Ultrasonic inspection according to EN 10246-7 and EN 10246-6

For all cases the inspection shall be performed using a calibration standard with artificial notches with depth of no more than 5 % (with a minimum of 0.50 mm) of the nominal wall thickness and one inch in length, made from the same chemistry and size of tubing. In the case of encircling coil technique (EN 10246-3) the calibration reference shall be through the wall radial hole with a maximum diameter of 1.4 mm.

If a particular technique among the above mentioned ones is required, it shall be stated during enquire and order.

Visual inspection shall be carried out according to Specification EN 10210-1 par. 9.3 and par. 6.8, the pipes will have a surface condition

corresponding to the manufacturing method used, that is hot rolling followed by Q&T heat treatment. The pipes shall have a maximum residual magnetism of 30 Gauss.

### Option

*e) Additional specific controls to be agreed*

## Surface protection

Tubes shall have external and internal bare surfaces. Upon request tubes can be supplied with the external varnished surface.

## Marking

All pipes shall be stenciled with: TENARIS XX (mill code), internal order number, heat number, dimensions, specification, grade, country of origin, plant inspector. Other specific marking requirements may be performed upon agreement.

### Options

*f) Other identification to be agree*

*g) Color coding at one end to be agree*

## Packaging

Diameters greater than 139,7 mm: loose

Diameters less than or equal to 139,7 mm: in bundles.

## Documentation

For each shipment a Material Test Certificate (MTC) type 3.1 according to EN10204-1

and Packing List (PL) shall be issued containing at least the following information:

- Customer reference
- Manufacturing order number
- Specification and Steel grade
- Chemical Analysis
- Mechanical test result
- Conformance with NDT.
- Quantities and lengths shipped.

### Option

*h) Other certification to be agreed*

## Product Qualification

Upon agreement, tube qualification tests as WPS and WPQ (welding procedure specification and qualification), CTOD, etc. may be performed.

## Quality Assurance

Tenaris mills, in which these products are manufactured, are qualified according to the International Standard ISO-9000-2000.

## R&D

Tenaris provides innovative and better solutions to meet its customer needs.

Tenaris operate a global network of research and development centers and maintain with leading research centers and universities throughout the world in order to develop the products required by customers and optimize its industrial processes to assure the best performance and reliability in its products.

Tenaris offers a partnership to its customers that operate in different sectors : to the mechanical industry companies that use components made up with seamless steel tubes, to engineering companies that design and built civil and industrial constructions and that are constantly looking for ways to improve their efficiency and competitiveness in the undertaking of complex works.





## Contact Us

### EUROPE

Alessandro Giacobbe  
agiacobbe@tenaris.com  
(39) 035 560 2332 tel  
(39) 035 560 3990 fax



### ARGENTINA

Buenos Aires  
Marcelo de Virgiliis  
mdevirgiliis@tenaris.com  
(54) 11 4018 3213 tel  
(54) 11 4018 8373 fax

### CANADA

Toronto  
George Nogalo  
gnogalo@tenaris.com  
(1) 416 216 4617 tel  
(1) 416 214 2043 fax

### CHINA

Beijing  
Jack Guo  
jguo@tenaris.com  
(86) 10 8459 7807 tel  
(86) 10 6437 6746 fax

### GERMANY

München  
Marc Rennings  
mrennings@tenaris.com  
(49) 89 232375 222 tel  
(49) 89 232375 200 fax

### ITALY

Dalmine  
Alessandro Giacobbe  
agiacobbe@tenaris.com  
(39) 35 560 2332 tel  
(39) 35 560 3990 fax

### JAPAN

Kawasaki  
Takeshi Esumi  
tesumi@tenaris.com  
(81) 44 328 3444 tel  
(81) 44 328 3458 fax

### KOREA

Seoul  
Leandro Ramos  
lramos@tenaris.com  
(82) 2 798 3385 tel  
(82) 2 798 3392 fax

### MEXICO

Veracruz  
Victor Palencia  
vpalencia@tamsa.com.mx  
(52) 55 5282 9943 tel  
(52) 55 5282 9966 fax

### ROMANIA

Zalau  
Andras Balogh  
abalogh@tenaris.com  
(40) 260 603 223 tel  
(40) 260 610 743 fax

### SCANDINAVIA

München  
Marc Rennings  
mrennings@tenaris.com  
(49) 89 232375 222 tel  
(49) 89 232375 200 fax

### UK

Coseley  
Kevin Whitehouse  
kwhitehouse@tenaris.com  
(44) 1902 665288  
(44) 1902 665263

### USA

Houston  
Juan Muhala  
jmuhala@tenaris.com  
(1) 713 767 4416 tel  
(1) 713 582 1650 fax