

# PSP 00203/002 Cold Drawn Seamless Steel Tubes for Hydraulic Cylinder Barrels







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# PSP 00203/002

## Cold Drawn Seamless Steel Tubes for Hydraulic Cylinder Barrels

### Product description and application

Tenaris produces a wide dimensional range of cold drawn seamless tubes suitable for manufacturing of hydraulic cylinder barrels according to Tenaris Specification PSP00203 for several applications (Earth Moving Machinery, Cranes, Energy, etc.).

Steel grades and manufacturing process have been optimized in order to comply with the most severe conditions of hydraulic cylinder components in terms of:

- improved fatigue life
- increased working pressure
- reliability (also at low temperature).

### 1. Order definition

#### Details

TN [Specification] [Grade] [Dimensions]  
[Option]

**Where:** Stands for "Tenaris"  
**TN** PSP00203/002 - specification code  
**[Specification]** HCxxx, where xxx is the  
**[Grade]** minimum guaranteed yield strength in MPa. Grades covered by this specification are listed in Section 3.

**[Dimensions]** yyy.yy x zzz.zz where yyy.yy and zzz.zz are the tube outside and

**[Option]:** inside diameters respectively, in mm see option 1,2 and 3 in the next paragraphs

### Examples:

TN PSP00203/002 HC355 150.00 x 130.00 Option 1 Tubes produced according to this Specification, in grade HC355, and an outer diameter of 150.00 mm and inside diameter of 130.00 mm, option 1 means that the Impact requirements are guaranteed also at -40 °C.

TN PSP00203/002 HC560 HFL 250.00 x 220.00 Option 3 Tubes produced according to this Specification, in grade HC560 HFL (High Fatigue Life), outer diameter of 250.00 mm and inside diameter of 220.00 mm, Option 3 means skived and burnished in the I.D.

### 2. Standards of reference

- |              |   |
|--------------|---|
| EN 10305-1   | Steel tubes for precision applications  |
| EN 10020     | Definition and classification of grades of steel  |
| EN ISO 377   | Steel and steel products – Location and preparation of samples and test pieces for mechanical testing                 |
| EN 10204     | Metallic products – Types of inspection documents   |
| ISO 286-2    | ISO system of limits and fits – Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts |
| ISO 6892-1   | Metallic material – Tensile testing   |
| ISO 148-1    | Metallic Material – Charpy pendulum impact test   |
| ISO 10893-2  | Automated eddy current testing of seamless steel tubes  |
| ISO 10893-10 | Automated ultrasonic testing of seamless steel tubes  |

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### 3. Steel Grades

Chemical composition - cast analysis, % by mass (a) (b) (c)						
Grade	C	Mn	Si	P	S	Ceq <sup>(d)</sup>
HC355	≤0,20	≤1,55	≤0,50	≤0,020	≤0,010	≤0,49
HC460	≤0,21	≤1,70	≤0,50	≤0,025	≤0,010	≤0,54
HC520	≤0,20	≤1,55	≤0,50	≤0,020	≤0,010	≤0,49
HC520-M				≤0,025	0,020÷0,040	
HC560	≤0,21	≤1,60	≤0,50	≤0,025	≤0,010	≤0,54
HC620	≤0,21	≤1,70	≤0,50	≤0,025	≤0,010	≤0,54
HC620-M					0,020÷0,040	≤0,60
HC650	≤0,18	≤1,70	≤0,50	≤0,020	≤0,008	≤0,45

(a) For grades HC355, HC520, and HC520-M at manufacturer's discretion the elements Nb, Ti and V may be added up to a combined maximum of 0.12 %.

(b) For other grades not listed in note (a) the elements like Nb, Ti and V are normally added up to a combined maximum of 0.22 %.

(c) For other grades not listed in note (a) some of the following elements: Cr, Mo, Ni, V are normally added up to a combined maximum of 2.0 % in order to improve mechanical properties, the content of these elements shall be reported.

(d)  $C_{eq} = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15$ .

### MECHANICAL PROPERTIES

Chemical composition - cast analysis, % by mass (a) (b) (c)								
Grade	Trt	Rp0.2% or ReH min [MPa]			UTS min [MPa]			Elong. %
		WT ≤16	25≥WT<16	WT>25	WT ≤16	25≥WT<16	WT>25	
HC355	N*	355	355	345	490 ÷ 630			22
HC460	N*	460	440	440	560 ÷ 730			22
HC520	SR	520	490	460	600	580	560	15
HC520-M	SR							
HC560	SR	560	540	520	670 ÷ 820	650 ÷ 820	630 ÷ 800	15
HC620	SR	620	590	550	700	680	650	15
HC620-M	SR							
HC650	SR	650	630	-	700 ÷ 900	670 ÷ 900	-	15

\*For the purpose of this document "normalized and tempered" heat treatment is considered equivalent to "normalized" condition.

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Xxxxxxx

## IMPACT REQUIREMENTS

Grade	KV min at -20°C [Joules]		KV min at -40°C [Joules]	
	Long	Transv	Long	Transv
<b>HC355</b>	40	27	40 [Option 1]	27 [Option 1]
<b>HC460</b>	40	27	40[Option 1]	27 [Option 1]
<b>HC520</b>	27 [Option 2]	-	-	-
<b>HC520-M</b>	40	27	-	-
<b>HC560</b>	90	60	-	-

Charpy V-notch 10x10 mm. Minimum Average Energy

Option 1:

Upon request grades HC355 and HC460 can be supplied with impact toughness guaranteed at - 40°C.

Option 2:

Upon request grade HC520 (for WT<=12,5 mm) can be supplied with impact toughness guaranteed at – 20°C.



## 4. Dimensions & Tolerances

Nominal dimensions are understood to mean the dimensions of the finished cylinder barrel after I.D. machining. Tubes are produced with tolerances on O.D. and I.D. with controlled eccentricity.

For all grades the O.D. tolerances are compliant with EN 10305-1 and shown in the following tables. O.D. and I.D. ovality shall be within the diameters tolerances.

## IMPACT REQUIREMENTS

O.D.	O.D. Tol	O.D.	O.D. Tol
(up to and including)	+/-	(up to and including)	+/-
30	0,08	180	0,90
40	0,15	200	1,00
50	0,20	220	1,10
60	0,25	240	1,20
70	0,30	260	1,30
80	0,35	280	1,40
90	0,40	300	1,50
100	0,45	320	1,60
120	0,50	340	1,70
140	0,70	360	1,80
160	0,80	380	1,90



FEASIBILITY MATRIX FOR GRADES HC355, HC520, HC520 M

		WALL THICKNESS												
OUTSIDE DIAMETER	ID/WT	5,0	6,0	7,5	10,0	12,5	15,0	17,5	20,0	22,5	25,0	27,5	30,0	32,5
	20	30	32	35	40									ID tolerances
25	35	37	40	45									-0,15 / -0,35	
30	40	42	45	50									-0,20 / -0,40	
32	42	44	47	52									-0,20 / -0,45	
35	45	47	50	55									-0,25 / -0,55	
40	50	52	55	60									-0,40 / -0,70	
45	55	57	60	65									-0,50 / -0,90	
50	60	62	65	70	75	80							-0,50 / -1,00	
55	65	67	70	75	80	85							-0,60 / -1,40	
60	70	72	75	80	85	90							-0,70 / -1,40	
63	73	75	78	83	88	93							-0,80 / -1,60	
65	75	77	80	85	90	95							-1,00 / -2,00	
70	80	82	85	90	95	100								
75	85	87	90	95	100	105								
80	90	92	95	100	105	110	115						Upon request	
85	95	97	100	105	110	115	120							
90	100	102	105	110	115	120	125							
95	105	107	110	115	120	125	130							
100	110	112	115	120	125	130	135	140	145					
105	115	117	120	125	130	135	140	145	150					
110	120	122	125	130	135	140	145	150	155					
115	125	127	130	135	140	145	150	155	160					
120	130	132	135	140	145	150	155	160	165					
125	135	137	140	145	150	155	160	165	170					
130	140	142	145	150	155	160	165	170	175					
135	145	147	150	155	160	165	170	175	180					
140	150	152	155	160	165	170	175	180	185					
145	155	157	160	165	170	175	180	185	190					
150	160	162	165	170	175	180	185	190	195	200	205			
155	165	167	170	175	180	185	190	195	200	205	210	215		
160	170	172	175	180	185	190	195	200	205	210	215	220		
165	175	177	180	185	190	195	200	205	210	215	220	225		
170	180	182	185	190	195	200	205	210	215	220	225	230	235	
175	185	187	190	195	200	205	210	215	220	225	230	235	240	
180	190	192	195	200	205	210	215	220	225	230	235	240	245	
185	195	197	200	205	210	215	220	225	230	235	240	245	250	
190	200	202	205	210	215	220	225	230	235	240	245	250	255	
195	205	207	210	215	220	225	230	235	240	245	250	255	260	
200	210	212	215	220	225	230	235	240	245	250	255	260	265	
205			220	225	230	235	240	245	250	255	260	265	270	
210			225	230	235	240	245	250	255	260	265	270	275	
215				235	240	245	250	255	260	265	270	275	280	
220				240	245	250	255	260	265	270	275	280	285	
225				245	250	255	260	265	270	275	280	285	290	
230					250	255	260	265	270	275	280	285	290	
235					255	260	265	270	275	280	285	290	295	
240					260	265	270	275	280	285	290	295	300	
245					265	270	275	280	285	290	295	300	305	
250					270	275	280	285	290	295	300	305	310	
260					285	290	295	300	305	310	315	320	325	
265						295	300	305	310	315	320	325	330	
270							300	305	310	315	320	325		
275								310	315	320	325	330		
280									315	320	325	330		
285										320	325	330		
290											325	330		
295												330		
300													335	
305														
310														
315														
320														
325														
330														
335														
340														
ID/WT	5,0	6,0	7,5	10,0	12,5	15,0	17,5	20,0	22,5	25,0	27,5	30,0	32,5	

WALL THICKNESS



FEASIBILITY MATRIX FOR GRADE HC650

		WALL THICKNESS									
OUTSIDE DIAMETER	ID/WT	5,0	6,0	7,5	10,0	12,5	15,0	17,5	20,0	22,5	25,0
		80									ID tolerances
	85									-0,50/-1,00	
	90									-0,60/-1,40	
	95	105	107	110	115	120					
	100	110	112	115	120	125	130			Upon request	
	105	115	117	120	125	130	135				
	110	120	122	125	130	135	140				
	115	125	127	130	135	140	145				
	120	130	132	135	140	145	150	155			
	125	135	137	140	145	150	155	160			
	130	140	142	145	150	155	160	165			
	135	145	147	150	155	160	165	170	175		
	140	150	152	155	160	165	170	175	180		
	145	155	157	160	165	170	175	180	185		
	150	160	162	165	170	175	180	185	190		
	155	165	167	170	175	180	185	190	195		
	160	170	172	175	180	185	190	195	200		
	165	175	177	180	185	190	195	200	205		
	170	180	182	185	190	195	200	205	210		
	175	185	187	190	195	200	205	210	215		
	180	190	192	195	200	205	210	215	220	225	
	185	195	197	200	205	210	215	220	225	230	
	190	200	202	205	210	215	220	225	230	235	
	195	205	207	210	215	220	225	230	235	240	
	200	210	212	215	220	225	230	235	240	245	250
	205			220	225	230	235	240	245	250	255
	210			225	230	235	240	245	250	255	260
	215			230	235	240	240	250	255	260	265
	220			235	240	245	240	255	260	265	270
	225			240	245	250	240	260	265	270	275
	230			245	250	255	240	265	270	275	280
	235			250	255	260	240	270	275	280	285
	240			255	260	265	270	275	280	285	290
	245			260	265	270	275	280	285	290	295
	250				270	275	280	285	290	295	300
	260					285	290	295	300	305	
	265						295	300	305	310	
	270						300	305	310	315	
	275							310	315	320	
	280							315	320	325	
	285							320	325	330	
	290							325	330	335	
	295							330	335	340	
	300							335	340		
	305							340	345		
	310							345	350		
	315							350	355		
	320								360		
	325										
	330										
	335										
	340										
	ID/WT	5,0	6,0	7,5	10,0	12,5	15,0	17,5	20,0	22,5	25,0

WALL THICKNESS

## Product description and application

### ECCENTRICITY

OD [mm]	WT [mm] < 25	WT [mm] ≥ 25
≤ 280	7%	10%
> 280	8%	10%

Where eccentricity is measured according to the following formula:

$$\text{Eccentricity} = \frac{(\text{WT}_{\text{max}} - \text{WT}_{\text{min}})}{(\text{WT}_{\text{max}} + \text{WT}_{\text{min}})}$$

Where WT\_max and WT\_min are the maximum and minimum wall thickness measured on the same tube section.

Note: Upon request other dimensions, tolerances and machining allowances can be analyzed.

### Straightness

- Local deviation from straight line  
It shall be measured, as the distance between the tube surface and a ruler 1000 mm long. Maximum allowed is 1 mm per each meter of length.
- Total deviation from straightness

It shall be measured, as the distance between the tube surface and a chord linking both ends of the tube. Maximum allowed is 3.5 mm for tubes with length less than 6 m; for tubes with length greater than 6 m, the tolerance shall be increased by 0.5 mm for each meter over 6 m.

### 5. Lengths

The minimum and maximum manufacturing lengths are 5.5 and 14.5 m respectively. Tubes are supplied in random lengths within a range of 2 m. The average production length varies according to the OD and ID dimensions.

Manufacture of tubes in fixed lengths or fixed multiple lengths can be agreed upon request. The cutting tolerance for fixed lengths is -0 +100mm; different cutting tolerances may be agreed upon request.

## 6. Surface protection

Tubes shall be internally and externally oiled in order to provide temporary protection against rusting in a covered stock-yard for around 6 months.

## 7. Identification and marking

The identification of the tubes for cylinder is carried out through the following continuous marking, in indelible ink, along the entire length. The marking will include at least the following information:

- Tenaris XX (where XX is the mill code)
- this specification number
- steel grade + Delivery condition
- nominal OD x ID in mm
- heat number

Different marking can be agreed upon at the time of enquire and order.

## 8. Packaging

Tubes shall be packed in strapped bundles. When the number of tubes is sufficient, hexagonal bundles shall be used. The minimum weight is shown in the Table. The maximum weight of the bundle is 6000 kg.

MINIMUM BUNDLE WEIGHT

OD [mm]	Min bundle weight (kg)
< 100	1500
100 ÷ 160	2000
> 160	3000

## 9. Skived and burnished tubes\*

For steel grades up to and including HC620 it is possible to supply skived and burnished tubes with tolerances on the inside diameter in accordance with ISO Standard 286-2, with a maximum surface roughness on the worked surface of 0.30 micrometer Ra.

The internal diameter tolerances shall be guaranteed according to internal diameter/wall thickness ratio.

### ISO TOLERANCES - ID/WT RATIO

ID/WT	ID tolerances (ISO 286)
≤ 20	H8
20,1 ÷ 25	H9
25,1 ÷ 28	H10
> 28,1	H11

Upon request we can supply tubes with inside diameter honed. In this case ID tolerances and surface roughness has to be agreed.

\*Option 3

## 10. Documentation

The product is supplied with 3.1 type certificate, in accordance with EN 10204. The certificate shall be issued containing at least the following information:

- Customer
- Manufacturer's Production Order
- Steel grade + Delivery condition
- Chemical Analysis
- Mechanical test result
- Conformance with NDT
- Sample test number

Alternatively, a type 3.2 certification can be agreed upon request at time of enquire and order. In this case, the customer must notify at the time of ordering the organization or the individual responsible who must conduct the inspection.

## High Fatigue Life (HFL)

Tenaris designed seamless tubes for hydraulic cylinders applications with increased fatigue resistance (HFL steel grades) key parameter to guarantee the structural integrity and reliability throughout the entire life of the component. The performance of these special grades have been characterized in Tenaris R&D Centers through small scale fatigue test and full scale fatigue test to study crack propagation on the real component.

## Non Destructive Testing

Tenaris performs automatic non destructive controls on standard products superior than the ones requested by international regulations.

NDT level has been defined for two families of grades depending on the expected working condition (e.g.: hoop stress and expected fatigue life) of the cylinder barrel:

- Standard grades
- HFL (High Fatigue Life) grades with improved surface quality

The table at page 11 defines the technique and employed calibration standard for each grade.

## NDT CONTROL LEVELS

	Grades	Techn.	Orient	Position	Calibration				
					Depth			Max length	Max width
					Nominal	Max (mm)	Min (mm)		
<b>Standard grades</b>	HC355								
	HC460								
	HC520								
	HC520-M	EC	Long.	Ext	5% WT	1,50	0,50	50	0,30
	HC560								
	HC620								
	HC 620-M								
<b>High performance grades</b>	HC520 HFL	EC	Long.	Ext	2 % WT	Nominal	0,30	50	0,30
	HC560 HFL	US	Long.	Ext	2 % WT	Nominal	0,30	25	0,50
	HC620 HFL								
	HC650 HFL	US	Long.	Int	5%WT	0,90	0,30	25	0,50

Eddy current test shall be performed in accordance with ISO 10893-2; ultrasonic test shall be executed according to ISO 10893-10.

Tubes with indications above the rejection level established in the table shall be segregated. For segregated tubes one of the following actions shall be taken:

1. the suspect area is cropped off;
2. the suspect area is dressed by grinding;
3. the tube is rejected.

Dressed tubes shall be re-inspected by means of the same technique or alternatively by an equivalent technique (e.g. Magnetic Particle Inspection). The dressed area shall conform to the requested dimensional tolerances.



For further information  
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