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

Tenaris

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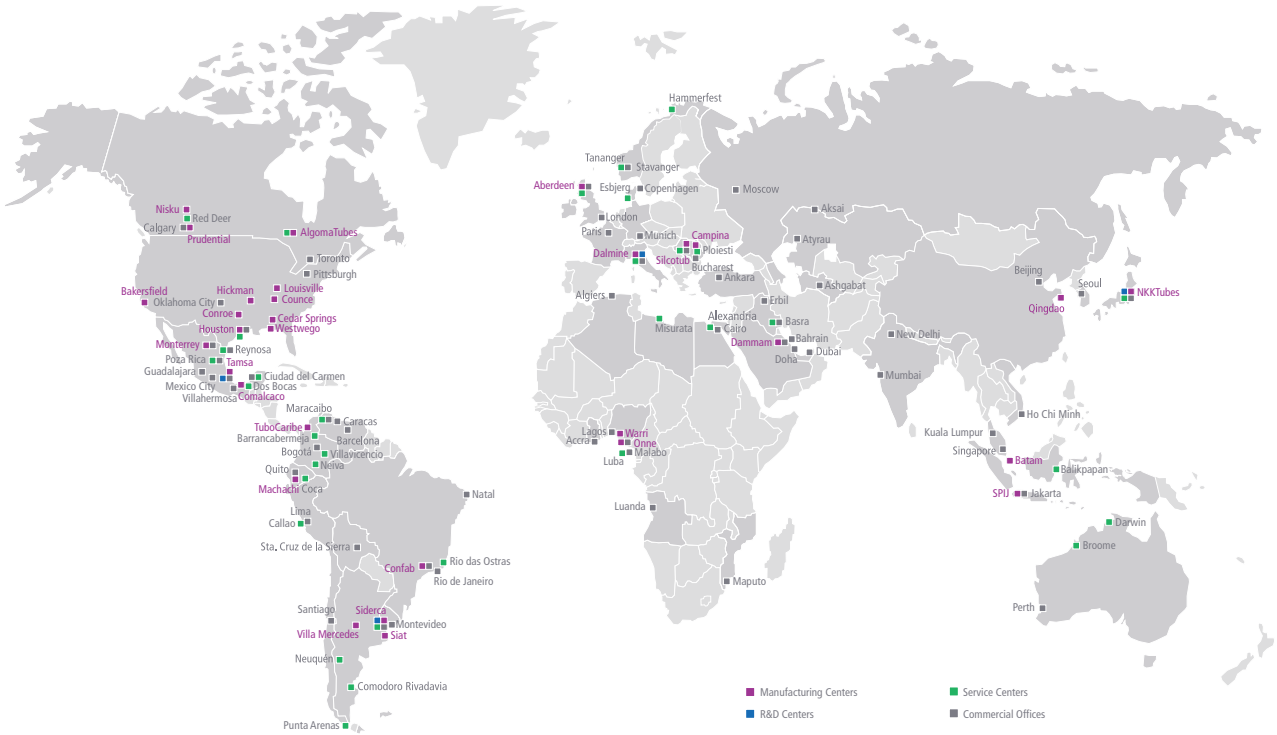
Through our integrated global network of manufacturing, R&D and service facilities, we are working with our customers to meet their needs for the timely supply of high performance products in increasingly complex operating environments.
Tenaris has annual revenues of US$10.8 billion and 26,500 employees worldwide.



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:

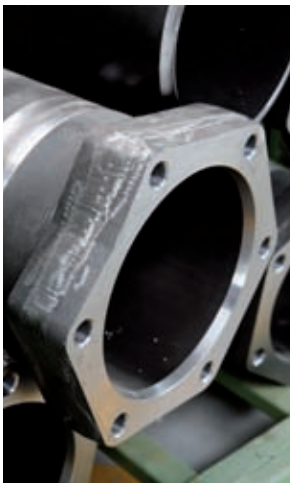
TN	Stands for "Tenaris"
[Specification]	PSP00203/002 - specification code
[Grade]	HCxxx, where xxx is the minimum guaranteed yield strength in MPa. Grades covered by this specification are listed in Section 3.
[Dimensions]	yyy.yy x zzz.zz where yyy.yy and zzz.zz are the tube outside and inside diameters respectively, in mm
[Option]:	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



3. Steel Grades

Chemical composition - cast analysis, % by mass [a] [b] [c]						
Grade	**C**	**Mn**	**Si**	**P**	**S**	**Ceq[d]**
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) Ceq = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15.

MECHANICAL PROPERTIES								
		Rp0.2% or ReH min [MPa]			**UTS min [MPa]**			**Elong. %**
Grade	**Trt**	**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.

IMPACT REQUIREMENTS

Grade	KV min at -20°C [Joules]		KV min at -40°C [Joules]	
	Long	Transv	Long	Transv
HC355	40	27	40 [Option 1]	27 [Option 1]
HC460	40	27	40 [Option 1]	27 [Option 1]
HC520	27 [Option 2]	-	-	-
HC560	40	27	-	-
HC650	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.

O.D. TOLERANCES [mm]

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						Upon request	
80	90	92	95	100	105	110	115						
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		
160	170	172	175	180	185	190	195	200	205	210	215		
165	175	177	180	185	190	195	200	205	210	215	220		
170	180	182	185	190	195	200	205	210	215	220	225	230	
175	185	187	190	195	200	205	210	215	220	225	230	235	
180	190	192	195	200	205	210	215	220	225	230	235	240	
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	295
235				255	260	265	270	275	280	285	290	295	300
240				260	265	270	275	280	285	290	295	300	305
245				265	270	275	280	285	290	295	300	305	310
250				270	275	280	285	290	295	300	305	310	315
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	335		
285							320	325	330	335	340		
290							325	330	335	340	345		
295							330	335	340	345	350		
300							335	340	345	350	355		
305							340	345	350	355			
310							345	350	355	360			
315							350	355	360	365			
320								360	365	370			
325								365	370	375			
330								370	375	380			
335									380	385			
340									385	390			
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 GRADES HC460, HC560, HC620, HC620 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
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						-0,50 / -1,00	
55	65	67	70	75	80						-0,60 / -1,40	
60	70	72	75	80	85						-0,70 / -1,40	
63	73	75	78	83	88						-0,80 / -1,60	
65	75	77	80	85	90	95						
70	80	82	85	90	95	100					Upon request	
75	85	87	90	95	100	105						
80	90	92	95	100	105	110	115					
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					
105	115	117	120	125	130	135	140	145				
110	120	122	125	130	135	140	145	150				
115	125	127	130	135	140	145	150	155				
120	130	132	135	140	145	150	155	160				
125	135	137	140	145	150	155	160	165				
130	140	142	145	150	155	160	165	170				
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	200	205		
160	170	172	175	180	185	190	195	200	205	210		
165	175	177	180	185	190	195	200	205	210	215	220	
170	180	182	185	190	195	200	205	210	215	220	225	
175	185	187	190	195	200	205	210	215	220	225	230	
180	190	192	195	200	205	210	215	220	225	230	235	
185	195	197	200	205	210	215	220	225	230	235	240	245
190	200	202	205	210	215	220	225	230	235	240	245	250
195	205	207	210	215	220	225	230	235	240	245	250	255
200	210	212	215	220	225	230	235	240	245	250	255	260
205			220	225	230	235	240	245	250	255	260	265
210			225	230	235	240	245	250	255	260	265	270
215				235	240	245	250	255	260	265	270	275
220				240	245	250	255	260	265	270	275	280
225				245	250	255	260	265	270	275	280	285
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	
265						295	300	305	310	315	320	
270						300	305	310	315	320	325	
275							310	315	320	325	330	
280							315	320	325	330	335	
285							320	325	330	335		
290							325	330	335	340		
295							330	335	340	345		
300							335	340	345	350		
305							340	345	350	355		
310							345	350	355	360		
315							350	355	360	365		
320								360	365	370		
325								365	370	375		
330								370	375	380		
335									380	385		
340									385	390		
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

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

Guaranteed Eccentricity values

ECCENTRICITY		
OD [mm]	WT [mm] < 25	WT [mm] >= 25
<= 280	7%	10%
> 280	8%	10%

Where eccentricity is measured according to the following formula:

$$\text{Eccentricity} = \frac{(WTmax - WTmin)}{(WTmax + WTmin)}$$

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

Other packaging alternatives are available upon request.

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

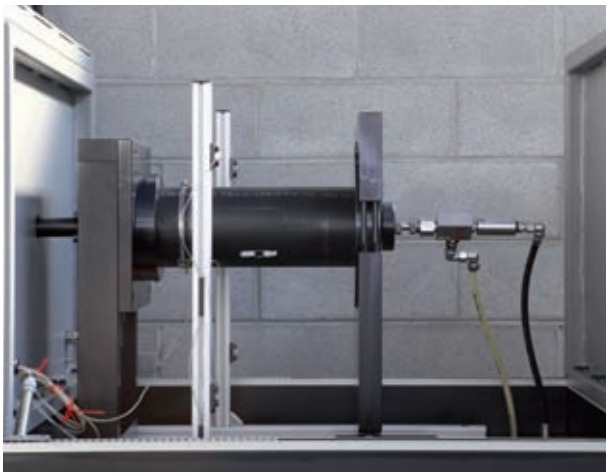
The product is supplied with 3.1 type certificate, in accordance with EN 10204.
The certificate shall be issued containing at least the following information:

- 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

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

Tenaris

For additional information, please visit:
www.tenaris.com

For technical assistance, please contact:
hydraulic.cylinders@tenaris.com

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