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STEEL TUBES

Seamless plain-end tubes in unalloyed steels for fluid piping at elevated temperatures

Dimensions - Technical delivery conditions

F : Tubes en acier - Tubes sans soudure à extrémités lisses en aciers non alliés pour canalisations de fluides à température élevée - Dimensions - Conditions techniques de livraison

French standard certified by decision of the Director General of AFNOR on 20th August 1989 to take effect on 20th September 1989.

Results from the incorporation of the amendment of September 1989 to the certified Standard dated November 1986

It supersedes the certified standard of the same number dated November 1986

CORRESPONDENCE

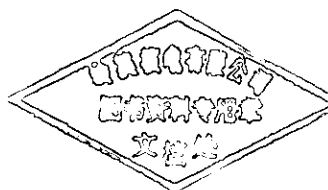
This standard NF A 49-211 defines products which were before, usually, ordered with reference to American standards ASTM A 106 or API 5L.

ANALYSIS

Tubes in accordance with standard NF A 49-211 may be used in construction of pressure vessels, of line pipes or of plant piping namely when working over the ambient temperature.

DESCRIPTORS

International Technical Thesaurus : steel tubes, seamless tubes, smooth tubes, unalloyed steels, fluid pipelines, chemical composition, grades : quality, mechanical properties, tests.



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MODIFICATIONS

Vis à vis the edition of March 1985,
this standard includes :

- guaranteed values of proof stress in temperature with optional checking.
- values of impact strength guaranteed at 20°C with optional checking for quality B.
- mandatory checking of values of impact strength guaranteed for qualities B1 and B2, respectively at 0°C and at - 20°C.

Vis à vis the edition of November 1986

- changes in table 2, page 9

CORRECTIONS



NF A 49-211

November 1986

Steel tubes
Seamless plain-end tubes in unalloyed steels
for fluid piping at elevated temperatures
Dimensions - Technical delivery conditions

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1 - GENERAL

1.1. Scope

This standard defines the dimensional, mechanical and chemical properties and the technical delivery conditions for seamless unalloyed steel tubes mainly used for line pipes and for the transport of fluids and for construction of pressure vessels.

The general technical delivery conditions and the related inspection documents are defined in the standards NF A 49-000 and A 49-001.

On request in the enquiry, confirmed in the order, these tubes may furthermore fulfill supplementary requirements, previously agreed between the purchaser and the supplier.

1.2. Field of application

1.2.1. This standard covers seamless tubes of circular cross section their dimensions are given in table 5.

1.2.2. The tubes are manufactured from those grades of steel whose chemical composition and the mechanical characteristics of the tube, in the delivery condition, are given in chapter 3.

1.2.3. The tubes can be welded and bent (cold or hot, as required), under normal conditions of use and fabrication (1) .

1.2.4. The permissible pressures and temperatures are determined by the purchaser, in accordance with his normal trade practice, by applying the safety factors specified in the regulations, codes or standards in force.

1.3. Definitions and symbols

D	Specified outside diameter in millimetres
T	Specified thickness in millimetres
TMI	Minimum thickness in millimetres, taking into account the tolerance on the thickness (see 6.2.)
R_m	Tensile strength, in megapascals at ambient temperature
R_{eL}	Lower flow limit, in megapascals at ambient temperature
$R_{p0.2}$	Conventional Proof stress at 0.2% elongation, in megapascal, at ambient temperature

(1) welding of grade TU E 275 requires, however, certain special conditions to be taken

$R_{t0.5}$	Normal 0.5% strain limit under load, in megapascals, at ambient temperature
$R_{p0.2}$	Conventional proof stress at 0.2% elongation, at temperature t degrees Celsius, in megapascals (e.g. $R_{p0.2}$).
A	Percentage elongation after rupture on proportional test piece original gauge length $L_0 = 5.65 \sqrt{S_0}$
PEH	Hydraulic test pressure in bars
S	Stress used for calculating the pressure PEH for the hydraulic test, in megapascals
c	Outside diameter required for the end of the tube in drift expanding test, in millimetres
K	Elongation constant for the flattening test
H	Distance between platens of the press used for the flattening test
M	Weight per unit length of tube, in kilograms per metre
KCV	Impact strength, in joules per square centimetre

1.4. Designation and wording the order

1.4.1. Pipes are designated by their outside diameter, thickness and steel grade, followed by the number of this standard.

1.4.2. The request for tender and the order shall also include the following informations :

- quantity (total length in metres, weight in kilograms or number of tubes)
- lengths (see 5.2.)

1.4.3. Depending of any particular options, the request for tender and the order shall, where necessary, state :

- the chamfer (see 5.3.2.)
- the special end finish (see 5.3.3.)
- the end protection (see 5.4.2.)
- the protection (see 5.4.1.)
- the hydraulic test pressure PEH if it differs from that specified in 7.8.1. (see 7.8.3.)

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- the method chosen by the Manufacturer for producing the steel (see 3.2.1.)
- the chemical analysis on the tube (see 3.3.1.)
- any heat treatment carried out (see 3.1.)
- any special marking (see 9.3.)
- any additional conditions to be respected and relating to the impact bend test (see 7.12.1) ; to the proof stress at temperature (see 7.12.2) ; to the chemical analysis on tube (see 7.12.3).
- the type of inspection documents to be issued and, where necessary, the language of issue (1) if this is other than French (see chapter 8).

If the order specifies an acceptance test and application of paragraph 6.2. of standard NF A 49-000, the order shall specify :

- the name and authority of the agent for the inspection department in the manufacturing factory and, where necessary :
 - . the name and authority of the Purchaser's agent or of the acceptance test organisation.
 - . the inspections to be carried out in the presence of the Purchaser's authorized agent (see 7.1.)

1.4.4. Example of designation and wording of the order :

1000 metres of tubes - 323.9 - 6.3 - grade TU E 250 B2 - impact strength at -20°C - NF A 49-211 - random lengths - product inspection certificate by factory in accordance with Standard NF A 49-000 - Example D of standard NF A 49-001.

2. REFERENCES

NF A 03-151	Iron and steel products - Tensile test on steel
NF A 03-161	Iron and steel products - Impact flexural test on steel using V notch beam-type test piece
NF A 03-351	High temperature testing - Determination of steel stress and verification of the permanent set elongation
NF A 49-000	Steel tubes - General technical conditions of delivery
NF A 49-001	Steel tubes - Inspection documents

- NF A 49-004 Steel tubes - General outlay of dimensions for seamless or welded tubes with circular cross section and welding accessories
- NF A 49-851 Steel tubes - Tensile test on steel tubes with a circular or polygonal cross-section
- NF A 49-853 Steel tubes - Flattening test
- NF A 49-856 Steel tubes - Drift expanding test
- NF A 49-858 Steel tubes - Bend test on test pieces taken from tubes
- NF E 29-032 Industrial pipework - Steel components - Butt welding ends - Preparation

3. MANUFACTURE

3.1. Manufacture of tubes

The tubes are produced by a seamless process and normally supplied in the as-rolled condition. If necessary, they are subjected to a heat treatment, in order that, on completion of manufacture, the characteristics specified in table 3 and table 4 can be guaranteed.

Certain sizes of tubes may be finished by cold drawing or rolling, followed by a normalization treatment.

On request, stated in the order, the Purchaser may be informed of the heat treatment used by the Manufacturer (see (1.4.3)).

3.2 Production of the steel

3.2.1. The steels are produced using processes with pure oxygen or an electric furnace, used alone or in combination, or, following agreement with the Purchaser, by any other process giving steels of equivalent quality. Casts used to produce these steels shall be killed.

Unless otherwise specified in the request for tender and the order, the method of production is left to the discretion of the manufacturer. On request, the Purchaser is informed of the procedure used.

3.2.2. This standard specifies three grades of steel : TU E 220, TU E 250, TU E 275 which can be delivered in three different qualities defined in Table 1.

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Table 1

Quality	Impact strength KCV guaranteed at a temperature of
→ B	20° C
B1	0° C
B2	- 20° C

For quality B, the value of impact strength at + 20°C is checked only if required in the request for enquiry and confirmed in the order.

For qualities B1 and B2, the value of impact strength is always checked respectively at 0°C and - 20°C (see 7.1 and 7.7).

3.3. Chemical and mechanical characteristics

3.3.1. Chemical composition

The chemical compositions on cast and on tube are given in table 2, in percentages.

The chemical composition on tube is only checked when required in the request for enquiry and after agreement in the order, and in accordance with the provisions of paragraph 7.12.3. of this standard and chapter 8 of standard NF A 49-000.

Table 2

Grades	C max		S max		P max		Si max		Mn max	
	cast	tube	cast	tube	cast	tube	cast	tube	cast	tube
→ TUE 220	0,15	0,17	0,025	0,030	0,025	0,030	0,30	0,35	0,80	0,85
TUE 250	0,21	0,23	0,025	0,030	0,025	0,030	0,35	0,40	1,00	1,05
TUE 275	0,23	0,25	0,025	0,030	0,025	0,030	0,40	0,45	1,35	1,40

Except for those elements introduced when the steel is killed, the elements not shown in the table will not be added voluntarily

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3.3.2. Mechanical characteristics of finished tubes in the delivery condition

The guaranteed mechanical characteristics measured on a longitudinal test piece are given in tables 3 and 4 (see 7.3 and 7.12).

Table 3

Grades	$R_{p0.2}$ MPa min (2)	R_m MPa (1) (2)	A % min (1)	Value of KCV min. in J/cm ²	
				Mean	Min
TU E 220	220	370 - 490	26	35	28
TU E 250	250	410 - 530	23	25	28
TU E 275	275	470 - 590	20	35	28

In addition to the guaranteed characteristics given in this table

- (1) the product R_m (A-2) is guaranteed greater than or equal to 10 500
- (2) the ratio $\frac{R_{p0.2}}{R_m}$ for characteristics measured on the same test piece is guaranteed at most equal to 0.9

Table 4

Conventional proof stress $R_{p0.2}^t$ at the reference temperature in MPa

Temperatures Grades	100 °C	150 °C	200 °C	250 °C	300 °C	325 °C	350 °C	400 °C	425 °C
TU E 220	190	176	165	145	122	116	109	103	99
TU E 250	210	199	188	170	149	143	136	128	124
TU E 275	240	223	212	195	177	168	159	150	145

The maximum values for the tensile strength R_m may exceed the stated values by up to 20 MPa, provided that the values for the proof stress $R_{p0.2}$ are increased in proportion. For example, in the case of a grade E 250 tube with a tensile strength of 550 MPa, the proof stress measured from the same test piece will be at least :

$$\frac{250 \times 550}{530} = 260 \text{ MPa}$$

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4 - DIMENSIONS AND WEIGHTS PER UNIT LENGTH

The dimensions and corresponding weights per unit length are given in table 5.

In this table, the outside diameters shall be classified according to the requirements of the standard NF A 49-004.

In table 5, the preferential thicknesses are extracted from E, F, G, H and I series of the standard NF A 49-004. These thicknesses are marked in the table using the letter of their series.

When agreed in the order, other thicknesses within the limits of table 5 may be supplied with reference to this standard.

The weights per unit length have been calculated to at least five significant figures, using the following formula and a weight per unit volume of 7.85 kg/dm³

$$M = (D - T) \times T \times 0.0246615$$

The number in the "DN" column of table 5 is a conventional designation, thus it is not a measurable size (see paragraph 3.2.2. of NF A 49-004).

5 - DELIVERY CONDITIONS

5.1. Appearance of tubes

5.1.1. The appearance of the internal and external surfaces shall be well-finished, when compared with the characteristic appearance of hot-finished tubes.

5.1.2. Tubes are inspected in the factory for appearance and dimensions.

5.1.3. Imperfections

5.1.3.1. Any imperfection such as scale, folds, lines, noticed during the inspection procedure shall be examined.

If its depth is greater than or equal to the greater of the two following values 0.05 T and 0.3 mm, the imperfection shall be removed. Under this value it is acceptable, provided it does not form part of a group.

5.1.3.2. During these visual inspections, a check shall be made to ensure that the thickness of sound metal is within the tolerances of 6.2.

5.1.3.3. In order that the tube will retain its well-finished appearance, any imperfection such as marks and lines of a mechanical origin (1) are removed, if their depth is more than 1.6 mm.

(1) Lines of mechanical origin are defined as cable and guide grooves, marks due to drive rollers and blocks, etc ...

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Table 5 : Weight per unit length - Dimensions

DN	Diameter D series			Thick-nesses		Weight per unit length kg/m	Hydraulic test pressure in bars			DN	Diameter D series			Thick-nesses		Weight per unit length kg/m	Hydraulic test pressure in bars		
	1	2	3	T	Séries		TU E 220	TU E 250	TU E 275		1	2	3	T	Séries		TU E 220	TU E 250	TU E 275
6	10.2			1.6	E	0.339	320	320	320	32	42.4			2.6	E	2.55	218	247	272
				2.0	F	0.404	320	320	320					3.6	F	3.44	318	320	320
				2.3	G	0.448	320	320	320					5.0	G	4.61	320	320	320
8	13.5			2.0	E	0.567	320	320	320	40	48.3			6.3	H	5.61	320	320	320
				2.3	F	0.635	320	320	320					10	I	7.99	320	320	320
				2.6	G	0.699	320	320	320					2.6	E	2.93	190	216	237
				2.9		0.758	320	320	320					3.6	F	3.97	276	314	320
				3.2		0.813	320	320	320					5.0	G	5.34	320	320	320
10	17.2			2.0	E	0.750	320	320	320	50	60.3			7.1	H	7.21	320	320	320
				2.3	F	0.845	320	320	320					10	I	9.45	320	320	320
				3.2	G	1.10	320	320	320					2.9	E	4.11	169	192	211
15	21.3			2.0	E	0.952	320	320	320	50	60.3			4.0	F	5.55	244	277	305
				2.6	F	1.20	320	320	320					5.6	G	7.55	320	320	320
				2.9		1.32	320	320	320					8.8	H	11.2	320	320	320
				3.6	G	1.57	320	320	320					11	I	13.4	320	320	320
				4.0		1.71	320	320	320					2.9		5.01	138	157	173
				4.5	H	1.86	320	320	320					5.0		8.38	252	287	316
				5.0		2.01	320	320	320					7.1		11.5	320	320	320
20	26.9			2.0	E	1.23	267	304	320	65	76.1		73	10		15.5	320	320	320
				2.3		1.40	310	320	320					14.2		20.6	320	320	320
				2.9	F	1.72	320	320	320					2.9	E	5.24	133	151	166
				3.6	G	2.07	320	320	320					4.5	F	7.95	216	246	270
				4.0		2.26	320	320	320					5.0		8.77	242	274	302
				5.6	H	2.94	320	320	320					7.1	G	12.1	320	320	320
				8.0	I	3.73	320	320	320					10	H	16.3	320	320	320
25	33.7			2.3	E	1.78	244	277	305					14.2		21.7	320	320	320
				3.2	F	2.41	320	320	320										
				3.6		2.67	320	320	320										
				4.5	G	3.24	320	320	320										
						4.26	320	320	320										
						5.40	320	320	320										

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Table 5 : Weight per unit length - Dimensions

DN	Diameter D series			Thick-nesses		Weight per unit length kg/m	Hydraulic test pres-sure in bars			DN	Diameter D series			Thick-nesses		Weight per unit length kg/m	Hydraulic test pres-sure in bars		
	1	2	3	T	Série		TU E 220	TU E 250	TU E 275		1	2	3	T	Série		TU E 220	TU E 250	TU E 275
80	88,9			3,2	E	6,76	125	142	156	150	168,3			4,5	E	18,2	95	108	119
				4,0		8,38	162	184	203					6,3		25,2	134	152	168
				5,0	F	10,3	205	233	256					7,1	F	28,2	152	172	190
				5,6		11,5	231	263	289					11	G	42,7	240	240	240
				7,1		14,3	301	320	320					14,2		54,0	240	240	240
				8,0	G	16,0	320	320	320					17,5		65,1	240	240	240
				11	H	21,1	320	320	320					22,2		80,0	240	240	240
				16		28,8	320	320	320					6,3		33,1	102	116	128
	101,6			3,6		8,70	127	144	158	200	219,1			7,1		37,1	116	131	144
				5,6		13,3	201	228	240					8,0	F	41,6	131	149	163
				8,0		18,5	240	240	240					10		51,6	165	187	206
				3,6	E	9,83	112	127	140					12,5	G	63,7	208	236	240
				4,0		10,9	125	142	156					16		80,1	240	240	240
				5,0		13,5	158	179	197					17,5	H	87,0	240	240	240
				5,6	F	15,0	177	202	222					22,2	I	108	240	240	240
				6,3		16,8	201	228	240					6,3	E	41,4	82	93	102
100	114,3			8,8	G	22,9	240	240	240	250	273			7,1		46,6	92	105	115
				11	H	28,0	240	240	240					8,0		52,3	104	118	130
				12,5		31,4	240	240	240					8,8	F	57,3	115	131	144
				14,2		35,1	240	240	240					10		64,9	131	149	164
				17,5		41,8	240	240	240					12,5		80,3	165	188	207
				4,0	E	13,4	102	116	127					14,2	G	90,6	189	215	236
				6,3	F	20,7	163	185	203					17,5		110	214	240	240
				10	G	32,0	240	240	240					22,2	H	137	240	240	240
125	139,7			16		48,8	240	240	240					25		153	240	240	240
				20		59,0	240	240	240					28	I	169	240	240	240
				4,5		15,2	114	129	142										
				6,3		21,0	161	183	201										
						32,4	240	240	240										
						49,4	240	240	240										
						59,8	240	240	240										

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Table 5 : Weight per unit length - Dimensions

DN	Diameter D series			Thick- nesses		Weight per unit length kg/m	Hydraulic test pres- sure in bars			DN	Diameter D series			Thick- nesses		Weight per unit length kg/m	Hydraulic test pres- sure in bars		
	1	2	3	T	Séries		TU E 220	TU E 250	TU E 275		1	2	3	T	Séries		TU E 220	TU E 250	TU E 275
300	323.9			7.1	E	55.5	77	88	97	450	457			10	E	110	77	88	97
				8.0		62.3	87	99	109					12.5		137	97	110	121
				10	F	77.4	110	125	137					14.2	F	155	111	126	138
				12.5		96.0	138	157	173					22.2		238	176	200	210
				14.2		108	158	180	197					25	G	266	199	210	210
				17.5	G	132	197	223	240					30		316	210	210	210
				22.2		165	240	240	240					11	E	135	76	87	96
				25	H	184	240	240	240					12.5		153	87	99	109
				28		204	240	240	240					16	F	194	112	128	140
				32	I	230	240	240	240					25		298	178	202	210
350	355.6			8.0	E	68.6	80	90	99	500	508			28	G	331	201	210	210
				10		85.2	100	114	125					30		354	210	210	210
				11	F	93.5	110	125	138					40		462	210	210	210
				12.5		106	127	143	157					12.5	E	184	72	87	90
				16		134	162	184	203					17.5	F	256	102	116	127
				20	G	166	205	233	240					25		361	147	167	184
				25		204	240	240	240					30	G	429	178	202	210
				28	H	226	240	240	240					40		562	210	210	210
				36		284	240	240	240										
400	406.4			8.8	E	86.3	76	87	96	600	610								
				10		97.8	87	99	109										
				12.5	F	121	110	124	137										
				17.5		168	155	176	194										
				20		191	178	202	210										
				22.2	G	210	199	210	210										
				25		235	210	210	210										
				30	H	278	210	210	210										
				40		361	210	210	210										

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7.3. Tensile test (NF A 49-851 or NF A 03-151)

This test is carried out on a length of tube or on a strip cut longitudinally from the tube in accordance with standard NF A 49-851, or on a cylindrical test piece in accordance with standard NF A 03-151.

During this test, the conventional proof stress $R_{p0.2}$ is measured, at ambient temperature, together with the tensile strength R_m and the elongation after rupture A.

However, for practical reasons when acceptance testing, a measurement may be taken of the value R_{eL} or $R_{t0.5}$ instead of the measurement $R_{p0.2}$.

The values for R_{eL} or $R_{t0.5}$ shall be at least equal to the specified value for $R_{p0.2}$.

In all cases, the test results shall satisfy the guaranteed values (table 3).

7.4. Flattening test (NF A 49-853)

7.4.1. The test is carried out in accordance with the requirements of standard NF A 49-853, on tubes which have a specified outside diameter of up to 406.4 mm.

7.4.2. The test is carried out on the end of the tube, or on a ring 30 mm long. This is flattened in a press until the distance H between platens, measured under load, reaches the value given by the following formula :

$$H = \left[\frac{1 + K}{K + \frac{T}{D}} \right] \cdot T$$

The value of K is given in Table 7
in no case, the value of H can be smaller than the value given in Table 7.

Table 7

Grade	Value of K	Lower limit of H
TU E 220	0,09	4 T
TU E 250	0,07	5 T
TU E 275	0,07	6 T

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7.4.3. The flattened ring or end shall not show any tear or crack ; small cracks in the skin are not considered as a defect.

7.5. Drift expanding test (NF A 49-856)

7.5.1. This test is carried out instead of the flattening test, at the Manufacturer's discretion, in accordance with the requirements of standard NF A 49-856, on tubes which have an outside diameter smaller than or equal to 139.7 mm and a thickness smaller than or equal to 10 mm.

7.5.2. The test is carried out on the end of the tube or on a ring, using a taper mandrel which angle at the apex is equal to 30°, until the enlarged diameter c reaches the values obtained by multiplying D by the factors given in table 8.

7.5.3. The specified flaring shall be obtained without the walls showing any crack or tear. Small cracks in the skin are not considered as a defect.

Table 8

Ratio $\frac{T}{D}$	$\leq 0,080$	0,081 to 0,120	0,121 to 0,150	$\geq 0,151$
Grades				
TU E 220	1,15	1,13	1,11	1,10
TU E 250	1,13	1,12	1,10	1,08
TU E 275	1,11	1,10	1,08	1,07

7.6. Bend test (NF A 49-858)

7.6.1. The test is carried out in accordance with the requirements of standard NF A 49-858, on tubes which have a specified outside diameter exceeding 406.4 mm.

7.6.2. The test piece comprises a portion of tube taken from a ring, length 300 mm and width 35 mm.

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- 5.1.3.4. Tubes shall not exhibit rounded dents whose depth measured as the gap between the lowest point and the prolongation of the original contour of the tube is greater than 3 mm.

The length of the dent in any direction shall not exceed one-half the outside diameter of the tube.

Inside a tube of outside diameter D shall pass a disc or a sphere with a diameter equal to

$$D - (0.01 D + 2.3 T + 1.5)$$

Tubes with defects whose dimensions exceed the above limits shall be rejected.

5.1.4. Repair of imperfections

- 5.1.4.1. The imperfections can be removed by grinding, provided that, after being removed, a smooth surface results and that the minimum tolerance on the thickness defined in 6.2. is respected, otherwise, the tube is rejected.
- 5.1.4.2. The estimation of the remaining thickness after grinding may be done at the Producer's option, using a mechanical or ultrasonic device. In case of dispute, measurement at the ends will be this obtained using a mechanical device. At the body of the tube, only the ultrasonic device shall be used.
- 5.1.4.3. It is not permissible to use peening or welding processes to repair surface defects.

5.2. Lengths

5.2.1. Standard lengths

- 5.2.1.1. Tubes are normally supplied in standard lengths of 3.5 m to 8 m, with 85% of those supplied being in lengths of not less than 5 m for tubes with thicknesses not exceeding 20 mm.
- 5.2.1.2. Tubes may be supplied in long lengths, varying in accordance with the dimensions but not exceeding 16 m. The tubes supplied may include up to 10% of shorter lengths, the minimum length being agreed in the order.

5.2.2. Accurate lengths

On special request, tubes may be supplied in accurately determined lengths, the tolerances of paragraph 6.5. being applicable.

5.3. Finishing the ends

5.3.1. Cutting

The ends shall be cut square to the axis of the tube with a tolerance less than 0.5% of the outside diameter D (with a minimum

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of 0.5 mm and a maximum of 1.6 mm). The measurement of the tolerance is carried out using a square which face applied on a generant of the tube shall bear on at least 1m. The measurement shall be conducted in two perpendicular planes after chamfering (see figure 1).

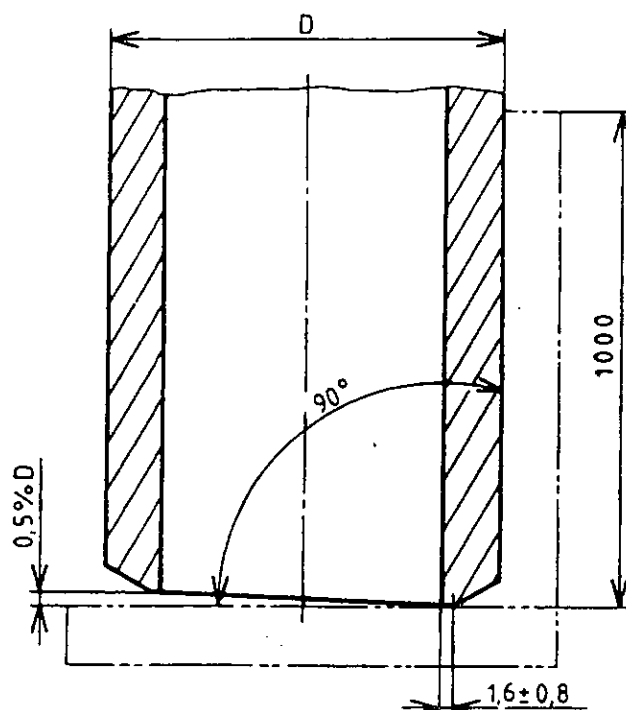


Figure 1

5.3.2. Chamfer

Except otherwise specified in the order, tubes are supplied as following :

- 5.3.2.1. For diameters D smaller than 60.3 mm, with their ends cut square to the tube axis and deburred (see 5.3.1).
- 5.3.2.2. For diameters D greater than or equal to 60.3 mm, with ends externally chamfered, in accordance with the requirements of Standard NF E 29-032 :
 - type C.2.1 for thicknesses $3 \text{ mm} < T \leq 22 \text{ mm}$ (see figure 2)
 - type C.3 for thicknesses $T > 22 \text{ mm}$ (see figure 3).

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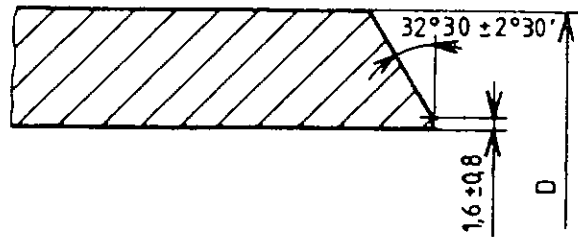


Figure 2 : Chamfer for tubes of specified thickness
 $3 \text{ mm} < T \leq 22 \text{ mm}$

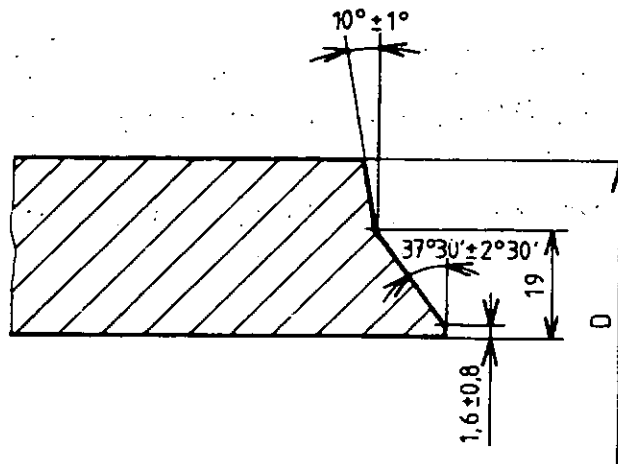


Figure 3 : Chamfer for tubes of specified thickness
 $T > 22 \text{ mm}$

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5.3.3. Special end finish

When required in the order, tubes shall be delivered with ends adapted for use of special couplings.

5.4. Protection

5.4.1. Protection on body of tubes

5.4.1.1. The order shall precise if tubes shall be delivered bare or protected. In the latter case, the type of protection shall be agreed between the Producer and the Purchaser.

5.4.1.2. Unless otherwise specified in the order, tubes shall be delivered without protection.

5.4.1.3. Any protection shall be applied after all the inspections and tests.

5.4.2. Protection of ends

As agreed in the order, the ends of tubes may be provided with special protectors to avoid any damage to the ends.

6 - TOLERANCES

6.1. Tolerance on outside diameter D

$$D \leq 48,3 \begin{matrix} + 0,4 \text{ mm} \\ - 0,8 \text{ mm} \end{matrix}$$

$$60,3 \leq D \leq 114,3 \begin{matrix} + 0,8 \text{ mm} \\ - 0,8 \text{ mm} \end{matrix}$$

$$139,7 \leq D \leq 219,1 \begin{matrix} + 1,6 \text{ mm} \\ - 0,8 \text{ mm} \end{matrix}$$

$$273 \leq D \leq 457 \begin{matrix} + 2,4 \text{ mm} \\ - 0,8 \text{ mm} \end{matrix}$$

$$508 \leq D \leq 610 \begin{matrix} + 3,2 \text{ mm} \\ - 0,8 \text{ mm} \end{matrix}$$

6.2. Tolerance on thickness T

$$T \leq 3,2 \begin{matrix} + 0,5 \text{ mm} \\ - 0,15 \text{ T} \end{matrix}$$

$$3,2 < T \leq 20 \begin{matrix} + 0,15 \text{ T} \\ - 0,125 \text{ T} \end{matrix}$$

$$T > 20 \pm 0,125 \text{ T}$$

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6.3. Tolerance on ovality and eccentricity

Tubes shall be circular in cross section. Ovality shall remain within the tolerance limits on the diameter (see 6.1.) and eccentricity within the thickness tolerances (see 6.2.).

6.4. Tolerance on the weight

6.4.1. Per tube : + 10%
 - 3.5%

6.4.2. Per carload (18 tons mini) : - 1.75%

6.5. Tolerance on accurate length

On lengths < 8 m : + 10 mm
 0

On lengths ≥ 8 m : + 15 mm
 0

6.6. Tolerance on edge camber

The total bow shall be less than 0.15% of the tube length.

The local bow shall be less than 3 mm per metre.

7 - TESTS

7.1. General

The tubes shall satisfy the following tests, examinations and checks :

- Tensile test (see 7.3)
- Flattening test (see 7.4.) or drift expanding test (see 7.5.) or bend test (see 7.6.)
- Impact flexural test for qualities B1 and B2 (see 7.7)
- Hydraulic test (see 7.8).
- Dimensional check (see 7.9.)
- Visual examination (see 7.10.)
- Weight check (see 7.11.)

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If requested in the call for tender and confirmed in the order, the tubes may also be subjected to the following additional tests :

- Impact flexural test (see 7.12.1.) for quality B
- Proof stress in temperature (see 7.12.2)
- Chemical analysis on tube (see 7.12.3.)

7.2. Definition of batches and taking samples for acceptance

7.2.1. A batch comprises tubes of the same diameter, the same thickness, the same cast and same delivery condition or, if applicable, heat treatment, in standard manufactured lengths (1).

7.2.2. If the last batch is less than or equal to half a standard batch, the tubes are included in the preceeding batch.

7.2.3. If the batch is greater than half a standard batch, tubes are considered as a whole batch.

7.2.4. Tests are carried out on tubes, these being selected in accordance with requirements of table 6.

Table 6

Outside diameter D	Maximal number of tubes per batch	Sampling (1) (2)
D < 168.3	400	one tube
D ≥ 168.3	200	one tube
(1) Each tube selected will be subjected to : - one tensile test - for D < 406.4 mm a flattening test or a drift expanding test, at the Manufacturer's discretion, when the tube dimensions permit this (see 7.4 and 7.5) - for D > 406.4 mm a bend test (see 7.6). (2) For a cast, on a test tube - one impact flexural test for qualities B1 and B2.		

ard manufactured length may differ from the delivery length

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- 7.6.3. The diameter of the mandrel or punch, together with the overall distance between the two ends of the test piece under load, on completion of the test, are given in table 9.

Table 9

Grades	Diameter of the punch or mandrel	Overall distance between the two ends of the test piece on completion of the test
TU E 220	6 T	8 T
TU E 250	7 T	9 T
TU E 275	8 T	10 T

- 7.6.4. The bent test piece shall not show any tear or crack. Small cracks in the skin are not considered as a defect.

7.7. Impact flexural test on v-notch test piece (NF A 03-161).

- 7.7.1. One test shall be conducted by cast for qualities B1 and B2 (see 7.2.4., table 6).

- 7.7.2. This test shall be conducted in accordance with the Standard on test for tubes with thickness greater than 5 mm.

- 7.7.3. The test pieces are taken along the axis of the tube near to its external surface ; the generatrix at the bottom of the notch shall be square to the rolling surface.

- 7.7.4. In case of tube with a thickness comprises between 5 mm and 10 mm, the width of the test piece shall be equal to 7.5 mm or 5 mm, depending on the thickness of the tube.

- 7.7.5. Each impact test involves three test pieces.

- 7.7.6. The guaranteed values are those indicated in table 3 for the chosen reference temperature (see 3.2.2).

7.8. Hydraulic test

- 7.8.1. Each tube shall be subjected to a hydraulic test at the Manufacturer's factory. The test pressure is held for at least 6 s on tubes which have a diameter D smaller than or equal to 406.4 mm and at least 15 s on tubes which have a diameter D exceeding 406.4 mm.

The test pressure PEH is determined by the formula :

$$PEH = 20 \frac{S \cdot TMI}{(D - TMI)}$$

where :

S = 90% of the minimum guaranteed $R_{p0.2}$ value for the related grade with a value of PEH limited to :

- 320 bar for $D \leq 88.9$
- 240 bar for $88.9 < D \leq 355.6$
- 210 bar for $355.6 < D \leq 610$

- 7.8.2. The value for the hydraulic pressure PEH defined in 7.8.1. is given in table 5.
- 7.8.3. If requested in the call for tender and agreed in the order, a different hydraulic test pressure may be specified, without however, exceeding the value for the test pressure calculated by the formula given above.
- 7.8.4. The test equipment is fitted with recording apparatus. If, during the test, the Purchaser is represented at the factory, the recordings are made available to his representatives.
- 7.8.5. During the test neither leakage nor seepage nor permanent set shall occur.

7.9. Checking dimensions

Dimensions are checked on each tube in accordance with the requirements stated in chapter 6.

7.10. Visual examination

All tubes are examined individually, using the unaided eye, under normal conditions of vision and using lighting suitable for finding surface defects on the outside and inside walls (see 5.1.)

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The tubes are submitted, for any inspection by the Purchaser's representative, in the final delivery condition stated in the order, but without any coating.

7.11. Checking the weight

The tubes are weighed and a check is made that the total weight of the tubes supplied does not exceed the tolerances specified in 6.4.

7.12. Additional tests

These tests are carried out if requested in the call for tender and confirmed in the order.

7.12.1. Impact flexural test (NF A 03-161)

One test shall be conducted by cast for quality B, under the same conditions as described in 7.7 at a temperature of 20°C.

7.12.2 Proof stress in temperature

One test by cast shall be conducted. One cast may involve several dimensions ; in this case, if only one test is carried out, the test piece shall be taken from the thickest dimension.

The guaranteed value given in table 4 is checked in accordance with the Standard NF A 03-351 paragraph 6.3 at the temperature level nearest to the one used by the Purchaser for design of the installation. However the Manufacturer is authorized to replace this check by a determination as defined in paragraph 6.1 of Standard NF A 03-351.

Test pieces are taken from tube if its thickness is at least equal to 4 mm or, if not, from a product at an earlier stage of manufacture (i.e. : forged and normalized billet).

7.12.3. Chemical analysis on tube

One analysis is made per cast. The elements are determined in accordance with the methods specified in the appropriate French standards. Spectrographic analysis is permitted.

The results shall satisfy the values given in table 2.

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8 - INSPECTION DOCUMENTS

Depending on the conditions of the request for tender, and the provisions in the order (see 1.4.3.), tubes may be supplied with or without acceptance testing. The tubes supplied are accompanied by the corresponding document, issued in accordance with the provisions of standards NF A 49-000 and A 49-001.

Unless otherwise stated in the request for tender and the order, tubes are supplied with an inspection report in accordance with standard NF A 49-000 - example 3.1.B called "CCPU" of standard NF A 49-001.

9 - MARKING

9.1. Marking requirements

In order to conform to this standard, the markings used shall at least include the following information :

- name or trade mark of Manufacturer(XXX),
- grade of steel, and quality index,
- reference to this standard,
- specified dimensions : outside diameter in millimetres, thickness in millimetre
- hydraulic test pressure, if different to that of table 5, (see 7.8.3.),
- a mark identifying the tube with the corresponding attached inspection document(ZZZ).
- the mark (K) of the Purchaser's agent or of the Plant inspection agent in case of acceptance tests according to paragraph 6.2 of Standard NF A 49-000. (see 1.4.3.).

9.2. Providing the marking

9.2.1. Tubes which have an outside diameter less than 26.9 mm

The information described in 9.1 is written indelibly on a resistant label fixed to each bundle.

However the Manufacturer's name or mark shall be indicated on the tube.

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- 9.2.2. Tubes which have an outside diameter less than or equal to 48.3 mm and at least equal to 26.9 mm

The information described in 9.1. is written indelibly on a resistant label fixed to each bundle.

In addition, an indelible marking is provided over the full length of the tube ; this is repetitive and the spacing between two sets of information shall not exceed 1.50 m.

The information is limited to the following :

- name or trade mark of Manufacturer,
- number of the standard,
- a mark identifying the tube with the corresponding inspection document attached.

Example : XXX-211-ZZZ

- 9.2.3. Tubes with outside diameter exceeding 48.3 mm

The information given in 9.1 is written indelibly and repeated over the full length of the tube. The spacing between each individual group of information shall not exceed 1.50 m.

Example : XXX - E 250 B - 211 - 406 X 8.8 - ZZZ

9.3. Special marking

Except when specially requested in the order, tubes which are supplied in accurately determined lengths may have this continuous marking replaced by a single marking 300 mm from one end.

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