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AMENDMENT 1

Industries du pétrole et du gaz naturel — Tubes en acier pour les systèmes de transport par conduites

AMENDEMENT 1

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Petroleum and natural gas industries — Steel pipe for pipeline transportation systems

AMENDMENT 1

Annex M

Replace the whole Annex M with the following:

Annex M
(normative)

PSL 2 pipe ordered for European onshore natural gas transmission pipelines

M.1 General

This annex specifies additional provisions that apply for PSL 2 pipe for European onshore natural gas transmission pipelines.

M.2 Additional information to be supplied by the purchaser

In addition to items a) to g) as specified by 7.1 and to items a) to c) as specified by 7.2, the purchase order shall indicate which of the following provisions apply for the specific order item:

a) items that are subject to mandatory agreement, if applicable:

   1) chemical composition for pipe with t > 25,0 mm (0.984 in) (see M.4.1.2);

   2) carbon equivalent limit for Grades L415NE (X60NE) and L555QE (X80QE) (see Table M.1);

   3) tensile properties for pipe with t > 25,0 mm (0.984 in) (see M.4.2.1);

   4) minimum average absorbed energy (see M.4.4.1);

   5) diameter and out-of-roundness tolerances for the ends of SMLS pipe with t > 25,0 mm (0.984 in) (see Table M.3, footnote b);

   6) diameter and out-of-roundness tolerances for pipe with D > 1 422 mm (56.000 in) (see Table M.3);

   7) type of inspection certificate (see M.7.1.1);

   8) party issuing the inspection certificate (see M.7.1.1);

b) items that apply as prescribed, unless otherwise agreed:

   1) steel casting method for coil or plate used for the manufacture of welded pipe (see M.3.3.2.1);

   2) application of diameter tolerance to the outside diameter for pipe with D ≥ 610 mm (24.000 in) (see Table M.3, footnote d);

   3) timing of NDT of HFW weld seam with outside diameter D < 219,1 mm (8.625 in) (see M.7.5.3);

   4) timing of NDT of full body seamless pipe (see M.7.5.3);

c) items that apply, if agreed:

   1) approval of the quality system (see M.3.1);

2) manufacturing procedure qualification (see M.3.1 and Annex B);

3) another steelmaking process (see M.3.2);

4) supply of helical seam pipe containing coil/plate end welds (see M.3.3.2.3);

5) chemical composition limits (see Table M.1, footnotes a, f and j);

6) temperature for the CVN impact test for the pipe body (see M.4.4.1);

7) temperature for the CVN impact test for the pipe weld and heat affected zone (see M.4.4.2);

8) use of inside diameter to determine diameter and out-of-roundness tolerances for pipe with $D \geq 219{,}1$ mm (8.625 in) (see Table M.3, footnote c);

9) pipe body DWT testing frequency (see M.7.2 and Table M.7);

10) hardness testing frequency (see M.7.2 and Table M.7);

11) orientation of tensile test piece (see Table M.8, footnote c);

12) ultrasonic inspection for laminar imperfections of pipe body and ends (see Table M.10, numbers 2, 5, 6, 8, 9);

13) flux leakage testing for longitudinal imperfections in seamless pipe (see Table M.10);

14) flux leakage or eddy current testing for longitudinal imperfections in HFW pipe (see Table M.10);

15) alternate acceptance level for ultrasonic (U2) or flux leakage (F2) testing of longitudinal imperfections (see Table M.10);

16) use of fixed-depth notches for equipment standardization [see K.5.1.1 c)];

17) radiographic inspection of the pipe ends (non-inspected pipe ends) and repaired areas on longitudinal imperfections [see Table M.10 and K.5.3 a)];

18) use of hole penetrameter instead of ISO wire penetrameter (see M.7.5.6.2);

19) use of digital radiographic inspection (see M.7.5.6.3).

M.3 Manufacturing

M.3.1 Manufacturing procedure

The pipe manufacturer and the stockist, where products are supplied through a stockist, shall operate a quality system. If agreed, the quality system shall be approved by the purchaser.

NOTE The term "stockist" is equivalent to, and interchangeable with, the term "distributor".

If agreed, the manufacturing procedure shall be qualified in accordance with Annex B.

M.3.2 Steel making

The steel shall be made to a clean steel practice, using either the basic oxygen steel-making process or the electric-arc furnace steel-making process, and shall be fully killed and be made according to fine grain practice.

Other steelmaking processes may be used by agreement.

M.3.3 Pipe manufacturing

M.3.3.1 SMLS pipe

SMLS pipe shall be manufactured from continuously (strand) cast or ingot steel. If the process of cold finishing followed by normalizing (N) or quench and tempering (Q) is used, this shall be stated in the inspection document. The as-rolled (R) pipe forming processes (see Table 3) shall not be used.

M.3.3.2 Welded pipe

M.3.3.2.1 Unless otherwise agreed, coil and plate used for the manufacture of welded pipe shall be rolled from continuously (strand) cast or pressure cast slabs. The pipe shall be SAWH, SAWL, COWH, COWL, or HFW in the N or M delivery conditions (see Table 3) only.

For HFW pipe from hot-rolled coil, the pipe forming process "cold forming followed by thermomechanical forming" (see Table 3) shall not be used.

M.3.3.2.2 For HFW pipe, the abutting edges of the coil or plate shall be sheared, milled or machined before welding such that the edges are clean and free of damage.

M.3.3.2.3 If agreed, for helical seam pipe made from coil or plate, pipe containing coil/plate end welds may be delivered, provided that such welds are located at least 300 mm (11.8 in) from the pipe end and such welds have been subjected to the same non-destructive testing that is required in M.7.5 for coil/plate edges and welds.

M.4 Acceptance criteria

M.4.1 Chemical composition

M.4.1.1 For pipe with $t \leq 25{,}0$ mm (0.984 in), the chemical composition for standard grades shall be as given in Table M.1. Intermediate grades are not allowed. The steel name shall be as given in Table M.1 and consists of an alphanumeric designation that identifies the strength level, followed by a suffix that consists of a letter (N, Q, or M) that identifies the delivery condition and a second letter (E) that identifies the pipe as manufactured to the requirements of this annex.

M.4.1.2 For pipe with $t > 25{,}0$ mm (0.984 in) up to 40 mm (1.575 in), the chemical composition shall be as agreed, with the requirements given in Table M.1 being amended as appropriate.

Table M.1 — Chemical composition for pipe with $t \leq 25{,}0$ mm (0.984 in)

Steel grade (Steel name)	Mass fraction, based upon heat and product analyses[a] % maximum									Carbon equivalent[c] % maximum	Carbon equivalent[c] % maximum
	C[b]	Si	Mn[b]	P	S	V	Nb	Ti	Other	CE_{IIW}	CE_{Pcm}
Seamless and welded pipe											
L245NE or BNE	0,18	0,40	1,20	0,025	0,015	—	—	—	d	0,42	0,25
L290NE or X42NE	0,19	0,40	1,20	0,025	0,015	0,06	0,05	0,04	d	0,42	0,25
L360NE or X52NE	0,22	0,45	1,40	0,025	0,015	0,10	0,05	0,04	d,e	0,43	0,25
L415NE or X60NE	0,23	0,45[j]	1,40[j]	0,025	0,015	0,10[j]	0,05[j]	0,04[j]	d,e,f	As agreed	As agreed
Seamless pipe											
L360QE or X52QE	0,18	0,45	1,50	0,025	0,015	0,05	0,05	0,04	d	0,42	0,25
L415QE or X60QE	0,18	0,45	1,70	0,025	0,015	0,09	0,06	0,05	d,e,f	0,43	0,25
L450QE or X65QE	0,18	0,45	1,70	0,025	0,015	0,10	0,06	0,07	d,e,f	0,43	0,25
L485QE or X70QE	0,18	0,45	1,80	0,025	0,015	0,11	0,06	0,07	d,e,f	0,43	0,25
L555QE or X80QE	0,18	0,45	1,90	0,025	0,015	0,11	0,07	0,07	e,g	As agreed	As agreed
Welded pipe											
L245ME or BME	0,18	0,45	1,20	0,025	0,015	0,05	0,05	—	d	0,40	0,25
L290ME or X42ME	0,18	0,45	1,30	0,025	0,015	0,05	0,05	—	d	0,40	0,25
L360ME or X52ME	0,18	0,45	1,40	0,025	0,015	0,06	0,06	0,05	d	0,41	0,25
L415ME or X60ME	0,12[j]	0,45	1,60	0,025	0,015	0,09	0,08[i]	0,07	e,h	0,42	0,25
L450ME or X65ME	0,12[j]	0,45	1,60	0,025	0,015	0,09	0,08[i]	0,07	e,h	0,43	0,25
L485ME or X70ME	0,12[j]	0,45	1,70	0,025	0,015	0,11	0,08[i]	0,07	e,h	0,43	0,25
L555ME or X80ME	0,12[j]	0,45	1,80	0,025	0,015	0,11	0,08[i]	0,07	e,h	0,43[j]	0,25[j]

[a] Elements not mentioned in this table shall not be added intentionally without the purchaser's approval except for elements that may be added for deoxidation and finishing of the heat.

[b] For each reduction of 0,01 % below the specified maximum for C, an increase of 0,05 % above the specified maximum for Mn is permissible, up to a maximum increase of 0,20 %.

[c] Based upon product analysis (see 9.2.4 and 9.2.5). The CE_{IIW} limits apply if C > 0,12 % and the CE_{Pcm} limits apply if C ≤ 0,12 %.

[d] 0,015 % ≤ Al_{total} ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,25 %; Ni ≤ 0,30 %; Cr ≤ 0,30 %; Mo ≤ 0,10 %.

[e] V + Nb + Ti ≤ 0,15 %.

[f] If agreed, Mo ≤ 0,35 %.

[g] 0,015 % ≤ Al_{total} ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,25 %; Ni ≤ 0,60 %; Cr ≤ 0,50 %; Mo ≤ 0,50 %.

[h] 0,015 % ≤ Al_{total} ≤ 0,060 %; N ≤ 0,012 %; Al/N ≥ 2:1, Cu ≤ 0,50 %; Ni ≤ 0,50 %; Cr ≤ 0,30 %; Mo ≤ 0,35 %.

[i] Use of higher Nb levels shall meet the following formula: Nb + C ≤ 0,20 %.

[j] Unless otherwise agreed.

M.4.2 Tensile properties

M.4.2.1 The tensile properties shall be as given in Table M.2. For pipe with $t > 25{,}0$ mm (0.984 in) up to 40 mm (1.575 in), the tensile properties shall be as agreed, with the requirements given in Table M.2 being amended as appropriate.

Table M.2 — Requirements for the results of tensile test $t \leq 25{,}0$ mm (0.984 in)

Steel grade	Pipe body of SMLS and welded pipes						Weld seam of HFW, SAW and COW pipes
	Yield strength $R_{t0,5}$ MPa (psi)		Tensile strength R_m MPa (psi)		Ratio $R_{t0,5}/R_m$	Elongation[a] A_f %	Tensile strength R_m MPa (psi)
	Minimum	Maximum	Minimum	Maximum	Maximum	Minimum	Minimum
L245NE or BNE	245 (35 500)	440 (63 800)	415 (60 200)	655 (95 000)	0,80	22	415 (60 200)
L245ME or BME	245 (35 500)	440 (63 800)	415 (60 200)	655 (95 000)	0,85	22	415 (60 200)
L290NE or X42NE L290ME or X42ME	290 (42 100)	440 (63 800)	415 (60 200)	655 (95 000)	0,85	21	415 (60 200)
L360NE or X52NE L360ME or X52ME	360 (52 200)	510 (74 000)	460 (66 700)	760 (110 200)	0,85	20	460 (66 700)
L360QE or X52QE	360 (52 200)	510 (74 000)	460 (66 700)	760 (110 200)	0,88	20	460 (66 700)
L415NE or X60NE L415ME or X60ME	415 (60 200)	565 (81 900)	520 (75 400)	760 (110 200)	0,85	18	520 (75 400)
L415QE or X60QE	415 (60 200)	565 (81 900)	520 (75 400)	760 (110 200)	0,88	18	520 (75 400)
L450QE or X65QE	450 (65 300)	570 (82 700)	535 (77 600)	760 (110 200)	0,90	18	535 (77 600)
L450ME or X65ME	450 (65 300)	570 (82 700)	535 (77 600)	760 (110 200)	0,87	18	535 (77 600)
L485QE or X70QE L485ME or X70ME	485 (70 300)	605 (92 100)	570 (82 700)	760 (110 200)	0,90	18	570 (82 700)
L555QE or X80QE L555ME or X80ME	555 (79 800)	675 (97 900)	625 (90 600)	825 (110 200)	0,90	18	625 (90 600)

[a] These values apply to transverse test pieces taken from the pipe body. When longitudinal test pieces are tested (see Table 20), the values of elongation shall be 2 units higher.

M.4.3 Hydrostatic test

Each length of pipe shall withstand the test without showing leakage or visible deformation.

M.4.4 CVN impact test

M.4.4.1 Pipe body

The minimum average (set of three test pieces) absorbed energy for the pipe body shall be in accordance with Table G.1 or Table G.2 as specified by the purchaser. Single values of the absorbed energy shall be at minimum 75 % of the minimum specified mean value. The test temperature shall be 0 °C (32 °F), or if agreed, a lower test temperature.

If no transverse test pieces can be obtained (see M.7.3.3), longitudinal test pieces shall be tested. The required absorbed energy for longitudinal test pieces shall be 50 % higher than the specified energy for transverse test pieces.

M.4.4.2 Pipe weld and heat affected zone

The minimum average (set of three test pieces) absorbed energy for pipe weld and heat affected zone, based upon full-size test pieces and a test temperature of 0 °C (32 °F), or if agreed, a lower test temperature, shall be 40 J (30 ft·lbf).

M.5 Tolerances for diameter, wall thickness, length, and straightness

M.5.1 Except as allowed by C.2.3, the diameter and out-of-roundness shall be within the tolerances given in Tables 10 and M.3.

Table M.3 — Tolerances for diameter and out-of-roundness

Specified outside diameter D mm (in)	Diameter tolerances[a] mm (in)				Out-of-roundness tolerances[a,e] mm (in)	
	Pipe except the end		Pipe end		Pipe except the end	Pipe end[b,c]
	SMLS pipe	Welded pipe	SMLS pipe[b]	Welded pipe		
<60,3 (2.375)	±0,5 (0.020) or ± 0,007 5 D, whichever is greater	±0,5 (0.020) or ± 0,007 5 D, whichever is greater, but maximum of ± 3,0 (0.125)	±0,5 (0.020) or ± 0,005 D[c] (whichever is greater), but maximum of ± 1,6 (0.063)		Included in diameter tolerance	
≥60,3 (2.375) to 610 (24.000)					0,02 D	0,015 D
>610 (24.000) to 1 422 (56.000)	±0,01 D	±0,005 D, but maximum of ± 4,0 (0.160)	±2,0 (0.079)[d]	±1,6 (0.063)[d]	0,015 D, but maximum of 15 (0.6), for $\frac{D}{t} \leq 75$	0,01 D, but maximum of 13 (0.5), for $\frac{D}{t} \leq 75$
					0,02 D for $\frac{D}{t} > 75$	0,015 D for $\frac{D}{t} > 75$
>1 422 (56.000)	As agreed		As agreed[d]		As agreed[d]	

[a] The pipe end includes a length of 100 mm (4.0 in) at each of the pipe extremities.

[b] For SMLS pipe, the tolerances apply for $t \leq 25{,}0$ mm (0.984 in) and the tolerances for heavier wall pipe shall be as agreed.

[c] Subject to agreement, the diameter tolerance may be applied to the inside diameter for $D \geq 219{,}1$ mm (8.625 in).

[d] Unless otherwise agreed, the diameter tolerance applies to the inside diameter.

[e] When the diameter tolerance is applied to the inside diameter, the inside diameter shall also be the basis for the out-of-roundness requirements.

M.5.2 The wall thickness shall be within the tolerances given in Table M.4.

Table M.4 — Tolerances for wall thickness

Wall thickness t mm (in)	Tolerances[a] mm (in)
SMLS pipe[b]	
≤4,0 (0.157)	+0,6 (0.024) −0,5 (0.020)
>4,0 (0.157) to <25,0 (0.984)	+0,150 t −0,125 t

[a] If the purchase order specifies a minus tolerance for wall thickness smaller than the applicable value given in this table, the plus tolerance for wall thickness shall be increased by an amount sufficient to maintain the applicable tolerance range.

[b] For pipe with $D \geq 355{,}6$ mm (14 000 in) and $t \geq 25{,}0$ mm (0.984 in), the wall thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional 0,05 t, provided that the plus tolerance for mass (see 9.14) is not exceeded.

[c] The plus tolerance for wall thickness does not apply to the weld area.

[d] See 9.13.2 for additional restrictions.

Table M.4 *(continued)*

Wall thickness t mm (in)	**Tolerances**[a] mm (in)
≥25,0 (0.984)	+3,7 (0.146) or +0,1 t, whichever is greater −3,0 (0.120) or −0,1 t, whichever is greater
Welded pipe[c,d]	
≤10,0 (0.394)	±0,5 (0.020)
>10,0 (0.394) to <15,0 (0.591)	+0,1 t −0,05 t
≥15,0 (0.591) to <20,0 (0.787)	+1,5 (0.060) −0,05 t
≥20,0 (0.787)	+1,5 (0.060) −1,0 (0.039)

[a] If the purchase order specifies a minus tolerance for wall thickness smaller than the applicable value given in this table, the plus tolerance for wall thickness shall be increased by an amount sufficient to maintain the applicable tolerance range.

[b] For pipe with $D \geq 355{,}6$ mm (14 000 in) and $t \geq 25{,}0$ mm (0.984 in), the wall thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional 0,05 t, provided that the plus tolerance for mass (see 9.14) is not exceeded.

[c] The plus tolerance for wall thickness does not apply to the weld area.

[d] See 9.13.2 for additional restrictions.

M.5.3 The out-of-squareness, measured as shown in Figure 3, shall not exceed

a) 1,0 mm (0.040 in) for outside diameters $D \leq 219{,}1$ mm (8.625 in), and

b) 0,005 D but a maximum of 1,6 mm (0.063 in) for outside diameters $D > 219{,}1$ mm (8.625 in).

M.6 Tolerances for the weld seam

M.6.1 Radial offset of coil/plate edges

For SAW and COW pipe, the inside and outside radial offsets of the coil/plate edges [see Figure 4 b) or Figure 4 c)] shall not exceed the applicable value given in Table M.5.

Table M.5 — Maximum permissible radial offset for SAW and COW pipe

Specified wall thickness t mm (in)	**Maximum permissible radial offset**[a] mm (in)
≤10,0 (0.394)	1,0 (0.039)
>10,0 (0.394) to 20,0 (0.787)	0,1 t
>20,0 (0.787)	2,0 (0.079)

[a] These limits apply also to coil/plate end welds.

M.6.2 Weld flash of HFW pipe

The inside flash shall not extend above the contour of the pipe by more than 0,3 mm (0.012 in) + 0,05 t to a maximum of 1,5 mm (0.060 in).

M.6.3 Maximum height of the weld beads

Height of the weld beads of SAW and COW pipe shall not exceed the applicable value given in Table M.6.

Table M.6 — Maximum permissible weld bead height for SAW and COW pipe (except at pipe ends)

Specified wall thickness *t* mm (in)	Weld bead height mm (in) maximum	
	Inside	Outside
≤15 (0.590)	3,0 (0.120)	3,0 (0.120)
>15 (0.590)	3,0 (0.120)	4,0 (0.157)

M.7 Inspection

M.7.1 Inspection certificate

M.7.1.1 Compliance with the requirements of the order shall be checked for products in accordance with this annex by specific inspection.

The purchaser shall specify the required type of inspection certificate (3.1 or 3.2) in accordance with EN 10204 (see 10.1).

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and to produce the inspection certificate. It shall also be agreed which party shall issue the certificate.

M.7.1.2 The inspection certificate shall include, in accordance with EN 10168, the following codes and information:

A	commercial transactions and parties involved;
B	description of products to which the inspection certificate applies;
C01 to C02	location of sample, direction of the test piece and, if applicable, testing temperature;
C10 to C29	tensile test;
C40 to C43	impact test and, if applicable, DWT test;
C50 to C69	bend or flattening test;
C71 to C92	cast analysis and product analysis;
D01	marking and dimensional checking and verification of the surface appearance;
D02 to D99	non-destructive testing and hydrostatic test;
Z	validation.

M.7.2 Specific inspection

The frequency of inspection shall be as given in Table 18, except as specifically modified in Table M.7.

Table M.7 — Inspection frequency

No.	Type of inspection	Type of pipe	Frequency of inspection
1	Tensile testing of the pipe body of pipe with $D < 508$ mm (20.000 in)	SMLS, HFW, SAW, or COW	Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a]
2	Tensile testing of the pipe body of pipe with $D \geq 508$ mm (20.000 in)	SMLS, HFW, SAW, or COW	Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a]
3	Tensile testing of the longitudinal or helical seam weld of welded pipe with 219,1 mm (8.625 in) $\leq D < 508$ mm (20.000 in)	HFW, SAW, or COW	Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b]
4	Tensile testing of the longitudinal or helical seam weld of welded pipe with $D \geq 508$ mm (20.000 in)	HFW, SAW, or COW	Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b,c]
5	Tensile testing of the coil/plate end weld of SAW pipe with $D \geq 219{,}1$ mm (8.625 in)	SAWH or COWH	Once per 50 coil/plate end welds from pipe with the same cold-expansion percentage[a,b,d]
6	CVN impact testing of the pipe body of pipe with $D < 508$ mm (20.000 in) and specified wall thickness as given in Table 22 (transverse test piece or either longitudinal test piece)	SMLS, HFW, SAW, or COW	Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a]
7	CVN impact testing of the pipe body of pipe with $D \geq 508$ mm (20.000 in) and specified wall thickness as given in Table 22	SMLS, HFW, SAW, or COW	Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a]
8	CVN impact testing of the longitudinal or helical seam weld of welded pipe with 114,3 mm (4.500 in) $\leq D < 508$ mm (20.000 in) and specified wall thickness as given in Table 22	HFW, SAW, or COW	Once per test unit of not more than 100 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b]
9	CVN impact testing of the longitudinal or helical seam weld of welded pipe with $D \geq 508$ mm (20.000 in) and specified wall thickness as given in Table 22	HFW, SAW, or COW	Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a,b,c]
10	CVN impact testing of the coil/plate end weld of welded pipe with $D \geq 114{,}3$ mm (4.500 in) and specified wall thickness as given in Table 22	SAWH, COWH	Once per 50 coil/plate end welds from pipe with the same cold-expansion percentage[a,b,d]
11	If agreed, DWT testing of the pipe body [$D \geq 508$ mm (20.000 in) and $t > 8$ mm (0.315 in), $R_{t0,5} > 360$ MPa]	SMLS, HFW, SAW, or COW	Once per test unit of not more than 50 lengths of pipe from the same heat of steel and with the same cold-expansion percentage[a]

[a] The cold-expansion ratio is designated by the manufacturer and is derived using the designated before-expansion outside diameter or circumference and the after-expansion outside diameter or circumference. An increase or decrease in the cold-expansion ratio of more than 0,002 requires the creation of a new test unit.

[b] Pipe produced by each welding machine shall be tested at least once per week.

[c] For double seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

[d] Applies only to finished helical seam pipe containing coil/plate end welds.

Table M.7 *(continued)*

No.	Type of inspection	Type of pipe	Frequency of inspection
12	If agreed, hardness testing of pipe body and of the longitudinal or helical seam weld and HAZ of welded pipe	HFW, SAW, or COW	Same frequency as macro- or metallographic examination
13	Pipe diameter and out-of-roundness on pipe ends	SMLS, HFW, SAW, or COW	Each pipe
14	Non-destructive inspection	SMLS, HFW, SAW, or COW	See Table M.10

[a] The cold-expansion ratio is designated by the manufacturer and is derived using the designated before-expansion outside diameter or circumference and the after-expansion outside diameter or circumference. An increase or decrease in the cold-expansion ratio of more than 0,002 requires the creation of a new test unit.

[b] Pipe produced by each welding machine shall be tested at least once per week.

[c] For double seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

[d] Applies only to finished helical seam pipe containing coil/plate end welds.

M.7.3 Samples and test pieces for mechanical and technological tests

M.7.3.1 General

For tensile tests, CVN impact tests, guided-bend tests, flattening tests, DWT test, the samples shall be taken and the corresponding test pieces prepared in accordance with the applicable reference standard.

Samples and test pieces for the various test types shall be taken from locations as shown in Figures 5 and 6, and as given in Table M.8, taking into account the supplementary details in 10.2.3.2 to 10.2.3.7 and 10.2.4.

Table M.8 — Number, orientation, and location of test pieces per sample for mechanical tests

Type of pipe	Sample location	Type of test	Number, orientation and location of test pieces per sample[a]		
			Specified outside diameter *D* mm (in)		
			<219,1 (8.625)	≥219,1 (8.625) to <508 (20.000)	≥508 (20.000)
SMLS, not cold-expanded [see Figure 5 a)]	Pipe body	Tensile	1L[b]	1L[c]	1L[c]
		CVN	3T	3T	3T
		Drop weight tear	—	—	2T
SMLS, cold-expanded [see Figure 5 a)]	Pipe body	Tensile	1L[b]	1T	1T
		CVN	3T	3T	3T
		Drop weight tear	—	—	2T
HFW [see Figure 5 b)]	Pipe body	Tensile	1L90[b]	1T180	1T180
		CVN	3T90	3T90	3T90
		Drop weight tear	—	—	2T90
	Seam weld	Tensile	—	1W	1W
		CVN	3W	3W	3W
	Pipe body and weld	Flattening	As shown in Figure 6		

[a] See Figure 5 for an explanation of the symbols used to designate orientation and location.

[b] Full-section longitudinal test pieces may be used at the option of the manufacturer.

[c] By agreement 1T instead of 1L.

[d] For double-seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

Table M.8 *(continued)*

Type of pipe	Sample location	Type of test	Number, orientation and location of test pieces per sample[a]		
			Specified outside diameter D mm (in)		
			<219,1 (8.625)	≥219,1 (8.625) to <508 (20.000)	≥508 (20.000)
SAWL, COWL [see Figure 5 b)]	Pipe body	Tensile	1L90[b]	1T180	1T180
		CVN	3T90	3T90	3T90
		Drop weight tear	—	—	2T90
	Seam weld	Tensile	—	1W	1W[d]
		CVN	3W and 3HAZ	3W and 3HAZ	3W and 3HAZ[d]
		Guided-bend	2W	2W	2W[d]
SAWH, COWH [see Figure 5 c)]	Pipe body	Tensile	1L[b]	1T	1T
		CVN	3T	3T	3T
		Drop weight tear	—	—	2T
	Seam weld	Tensile	—	1W	1W
		CVN	3W and 3HAZ	3W and 3HAZ	3W and 3HAZ
		Guided-bend	2W	2W	2W
	Coil/plate end weld	Tensile	—	1WS	1WS
		CVN	3WS and 3HAZ	3WS and 3HAZ	3WS and 3HAZ
		Guided-bend	2WS	2WS	2WS

[a] See Figure 5 for an explanation of the symbols used to designate orientation and location.

[b] Full-section longitudinal test pieces may be used at the option of the manufacturer.

[c] By agreement 1T instead of 1L.

[d] For double-seam pipe, both longitudinal weld seams in the pipe selected to represent the test unit shall be tested.

M.7.3.2 Tensile test pieces

Rectangular test pieces, representing the full wall thickness of the pipe, shall be taken in accordance with ISO 6892-1 and Figure 5. Transverse test pieces shall be flattened.

M.7.3.3 CVN impact test pieces

If the smallest permitted transverse test piece is not obtainable, the greatest possible longitudinal width between 10 mm (0.394 in) and 5 mm (0.197 in) shall be used.

M.7.3.4 Test pieces for the guided-bend test

The test pieces shall be prepared in accordance with ISO 5173 and Figure 8. For pipes with a wall thickness t > 20 mm (0.787 in), the test pieces may be machined to provide a rectangular cross-section having a thickness of 19 mm (0.748 in). Full wall thickness curved section test pieces are mandatory for pipe with wall thickness $t \leq 20$ mm (0.787 in).

The weld reinforcement shall be removed from both faces.

M.7.4 Test methods

M.7.4.1 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1.

The tensile strength R_m, the yield strength for 0,5 % total elongation $R_{t0,5}$ and the percentage elongation after fracture A_f shall be determined on the pipe body.

The percentage elongation after fracture shall be reported with reference to a proportional gauge length of $5.65\sqrt{S_o}$ with S_o as the initial cross-sectional area. If another gauge length is used, the measured value shall be converted to a proportional elongation result, according to ISO 2566-1.

In the tensile test transverse to the weld, only the tensile strength R_m shall be determined.

M.7.4.2 CVN impact test

The impact test shall be carried out in accordance with ISO 148-1 and the required striker radius is 2 mm.

M.7.4.3 Hydrostatic test

The minimum permissible wall thickness shall be used for determining the required test pressures (see 10.2.6.7).

M.7.4.4 Guided-bend test

The bend test shall be carried out in accordance with ISO 5173. The mandrel dimension shall be as indicated in Table M.9 for the appropriate steel grade. Both test pieces shall be bent through approximately 180°, one with the root of the weld, and the other with the face of the weld, directly under the mandrel.

Table M.9 — Requirements for the mandrel diameter in the guided-bend test

Pipe steel grade	Weld seam of SAW and COW pipes
	Diameter A_{gb} mm
L245NE or BNE L245ME or BME	$3t$
L290NE or X42NE L290ME or X42ME	$3t$
L360NE or X52NE L360QE or X52QE L360ME or X52ME	$4t$
L415NE or X60NE L415QE or X60QE L415ME or X60ME	$5t$
L450QE or X65QE L450ME or X65ME L485QE or X70QE L485ME or X70ME L555QE or X80QE L555ME or X80ME	$6t$

M.7.4.5 Flattening test

The flattening test shall be carried out in three steps with the following acceptance criteria.

a) Flatten to 2/3 of the original outside diameter; no weld opening shall occur.

b) Flatten to 1/3 of the original outside diameter; no crack or break shall occur other than in the weld.

c) Flatten until opposite walls of the pipe meet.

The presence of laminar imperfections or burnt metal shall not become apparent during the entire test.

M.7.5 Non-destructive testing

M.7.5.1 General

The non-destructive test requirements and acceptance levels are defined in Table M.10.

M.7.5.2 NDT personnel

All NDT activities shall be carried out by level 1, 2 and/or 3 personnel authorized to operate by the manufacturer.

The qualification for level 1 and 2 shall be in accordance with ISO 11484 or, at least, an equivalent standard. Level 3 personnel shall be certified in accordance with ISO 9712 or, at least, an equivalent standard.

Manufacturer shall authorize all NDT personnel in accordance with a documented procedure. All NDT operations shall be authorized by a level 3 NDT individual approved by the manufacturer.

Table M.10 — Survey of non-destructive tests

1	2	3	4		5
No.	**NDT operation**	**Test[a]**	**Types of test and requirements, acceptance level**		**Reference**
Seamless and welded pipes					
1	Residual magnetism at the pipe ends	M	Hall effect gauss meter or equivalent; 30 Gs max., random testing		E.7
2	Laminar imperfections at the pipe ends	O	Ultrasonic test ISO 10893-8, acceptance limit: 6 mm (0.236 in) max. circumferentially		E.3.2.3 E.3.3.2
Seamless pipe					
3	Longitudinal imperfections (including the pipe ends, where applicable; see M.7.5.4)	M		Ultrasonic test ISO 10893-10:2011, acceptance level U3 or, by agreement, U2	K.3.1
			or	[by agreement for t < 10 mm (0.394 in)] Flux leakage test ISO 10893-3:2011, acceptance level F3 or, by agreement, F2	K.3.4.2
High frequency welded pipe					
4	Longitudinal imperfections in the weld (including the pipe ends, where applicable; see M.7.5.4)	M		Ultrasonic test ISO 10893-10:2011 or ISO 10893-11:2011, acceptance level U3 or, by agreement, U2	K.4.1
			or	[by agreement for t < 10 mm (0.394 in)] Flux leakage test ISO 10893-3:2011, acceptance level F3 or, by agreement, F2	K.3.4.2 (also for HFW)
			or	[by agreement for D < 273,1 mm (10.75 in); t < 6,3 mm (0.248 in); t/D < 0,18] Eddy current test ISO 10893-2:2011, acceptance level E2H (concentric or segment coil technique)	K.3.4.3 (also for HFW)
5	Laminar imperfections in the pipe body	O	Ultrasonic test ISO 10893-9:2011, acceptance level U2 or ISO 10893-8:2011, acceptance level U2		E.8.1
6	Laminar imperfections on coil edges/area adjacent to weld seam	O	Ultrasonic test ISO 10893-9:2011 or ISO 10893-8:2011, acceptance level U2		E.9

[a] M = mandatory, O = optional test for mandatory requirement.

[b] In these subclauses, the reference to E.4 (radiographic inspecti on of the weld seam) shall be replaced by M.7.5.6 for this annex only.