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

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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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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 $D \geq 610$ 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 penetrometer instead of ISO wire penetrometer (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 equiva- lent ^c % maxi- mum	Carbon equiva- lent ^c % maxi- mum
	C ^b	Si	Mn ^b	P	S	V	Nb	Ti	Other	CE _{IW}	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 ⁱ	1,40 ⁱ	0,025	0,015	0,10 ⁱ	0,05 ⁱ	0,04 ⁱ	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 ⁱ	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 ⁱ	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 ⁱ	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 ⁱ	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 _{IW} 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 <i>D</i> 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 <i>D</i> , whichever is greater	±0,5 (0.020) or ± 0,007 5 <i>D</i> , whichever is greater, but maximum of ± 3,0 (0.125)	±0,5 (0.020) or ± 0,005 <i>D</i> ^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 <i>D</i>	0,015 <i>D</i>
>610 (24.000) to 1 422 (56.000)	±0,01 <i>D</i>	±0,005 <i>D</i> , but maximum of ± 4,0 (0.160)	±2,0 (0.079) ^d	±1,6 (0.063) ^d	0,015 <i>D</i> , but maximum of 15 (0.6), for $\frac{D}{t} \leq 75$	0,01 <i>D</i> , but maximum of 13 (0.5), for $\frac{D}{t} \leq 75$
					0,02 <i>D</i> for $\frac{D}{t} > 75$	0,015 <i>D</i> 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* ≤ 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* ≥ 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.