

1 Pipe grade, steel grade and delivery condition

1.1 Pipe grade and steel grade

1.1.1 The pipe grade for PSL 1 pipe is identical to the steel grade (designated by a steel name) and shall be as given in Table 1. It consists of an alpha or alphanumeric designation that identifies the strength level of the pipe and is linked to the chemical composition of the steel.

NOTE The designations for Grade A and Grade B do not contain any reference to the specified minimum yield strength; however, the numerical portion of other designations correspond with the specified minimum yield strength in SI units or with the upward-rounded specified minimum yield strength, expressed in 1 000 psi for USC units. The suffix 'P' indicates that the steel has a specified phosphorus range.

1.1.2 The pipe grade for PSL 2 pipe shall be as given in Table 1 and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (R, N, Q or M) that identifies the delivery condition (see Table 3).

NOTE 1 The designation for Grade B does not contain any reference to the specified minimum yield strength; however, the numerical portion of other designations correspond with the specified minimum yield strength in SI units or USC units.

1.1.3 Other steel grade designations (steel numbers) that are used in addition to the steel name in Europe are given for guidance in Table L.1.

Delivery condition

1.2 For each order item, the delivery condition for PSL 1 pipes shall be at the option of the manufacturer unless a specific delivery condition is specified in the purchase order. Delivery conditions for PSL 1 and PSL 2 pipes are given in Table 1 with additional information for PSL 2 pipes in Table 3.

1.2.1 For PSL 2 pipes, the delivery condition shall be in accordance with the purchase order as specified in the steel name.

Table 1 — Pipe grades, steel grades and acceptable delivery conditions

PSL	Delivery condition	Pipe grade/steel grade ^{a,b}
PSL 1	As-rolled, normalizing rolled, normalized or normalizing formed	L175 or A25
		L175P or A25P
		L210 or A
	As-rolled, normalizing rolled, thermomechanical rolled, thermomechanical formed, normalizing formed, normalized, normalized and tempered; or, if agreed, quenched and tempered for SMLS pipe only	L245 or B
	As-rolled, normalizing rolled, thermomechanical rolled, thermomechanical formed, normalizing formed, normalized, normalized and tempered or quenched and tempered	L290 or X42
		L320 or X46
		L360 or X52
		L390 or X56
		L415 or X60
		L450 or X65
PSL 2	As-rolled	L245R or BR
		L290R or X42R
	Normalizing rolled, normalizing formed, normalized or normalized and tempered	L245N or BN
		L290N or X42N
		L320N or X46N
		L360N or X52N
		L390N or X56N

Quenched and tempered	L415N or X60N
	L245Q or BQ
	L290Q or X42Q
	L320Q or X46Q
	L360Q or X52Q
	L390Q or X56Q
	L415Q or X60Q
	L450Q or X65Q
	L485Q or X70Q
	L555Q or X80Q
	L625Q or X90Q ^c
	L690Q or X100Q ^c

Table 1 — Pipe grades, steel grades and acceptable delivery conditions (continued)

PSL	Delivery condition	Pipe grade/steel grade ^{a,b}
PSL 2	Thermomechanical rolled or thermomechanical formed	L245M or BM
		L290M or X42M
		L320M or X46M
		L360M or X52M
		L390M or X56M
		L415M or X60M
		L450M or X65M
		L485M or X70M
		L555M or X80M
	Thermomechanical rolled	L625M or X90M
		L690M or X100M
		L830M or X120M

^a For intermediate grades, the steel grade shall be in one of the following formats: (1) The letter L followed by the specified minimum yield strength in MPa and, for PSL 2 pipe, the letter describing the delivery condition (R, N, Q or M) consistent with the above formats. (2) The letter X followed by a two or three digit number equal to the specified minimum yield strength in 1000 psi rounded down to the nearest integer and, for PSL 2 pipe, the letter describing the delivery condition (R, N, Q or M) consistent with the above formats.

^b The suffix (R, N, Q or M) for PSL 2 grades belongs to the steel grade.

^c Seamless only.

Acceptance criteria

2.1 General

2.1.1 The general technical delivery requirements shall be in accordance with ISO 404.

2.1.2 Pipe manufactured as Grade L415 or X60 or higher shall not be substituted for pipe ordered as Grade L360 or X52 or a lower grade, without the purchaser's approval.

2.2 Chemical composition

2.2.1 For PSL 1 pipe with $t \geq 25,0$ mm (0.984 in), the chemical composition for standard grades shall be as given in Table 4, and the chemical composition for intermediate grades shall be as agreed, but consistent with those given in Table 4.

NOTE Grade L175P or A25P is re-phosphorized and, therefore, has better threading properties than Grade L175 or A25; however, it can be somewhat more difficult to bend.

2.2.2 For PSL 2 pipe with $t \leq 25,0$ mm (0.984 in), the chemical composition for standard grades shall be as given in Table 5 and the chemical composition for intermediate grades shall be as agreed, but consistent with those given in Table 5.

2.2.3 For PSL 1 or PSL 2 pipe with $t > 25,0$ mm (0.984 in), the chemical composition shall be agreed, with the requirements of Tables 4 and 5 being amended as appropriate.

2.3 For PSL 2 pipe with a product analysis carbon mass fraction equal to or less than 0,12 %, the carbon equivalent, CE_{Pcm} , shall be determined using Equation (2):

$$CE_{Pcm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B \quad (2)$$

where the symbols for the chemical elements represent the mass fraction in percent (see Table 5).

If the heat analysis for boron is less than 0,000 5 %, then it is not necessary for the product analysis to include boron, and the boron content may be considered to be zero for the CE_{Pcm} calculation.

2.3.1 For PSL 2 pipe with a product analysis carbon mass fraction greater than 0,12 %, the carbon equivalent, CE_{IIW} , shall be determined using Equation (3):

$$CE_{IIW} = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15} \quad (3)$$

where the symbols for the chemical elements represent the mass fraction in percent (see Table 5).

Table 2 — Chemical composition for PSL 1 pipe with $t \leq 25,0$ mm (0.984 in)

Steel grade (Steel name)	Mass fraction, based upon heat and product analyses ^{a, g}							
	C max. ^b	Mn max. ^b	P %		S max.	V max.	Nb max.	Ti max.
			min.	max.				
Seamless pipe								
L175 or A25	0,21	0,60	—	0,030	0,030	—	—	—
L175P or A25P	0,21	0,60	0,045	0,080	0,030	—	—	—
L210 or A	0,22	0,90		0,030	0,030	—		
L245 or B	0,28	1,20	—	0,030	0,030	c,d	c,d	d
L290 or X42	0,28	1,30	—	0,030	0,030	d	d	d
L320 or X46	0,28	1,40		0,030	0,030	d	d	d
L360 or X52	0,28	1,40	—	0,030	0,030	d	d	d
L390 or X56	0,28	1,40	—	0,030	0,030	d	d	d
L415 or X60	0,28 ^e	1,40 ^e	—	0,030	0,030	f	f	f
L450 or X65	0,28 ^e	1,40 ^e	—	0,030	0,030	f	f	f
L485 or X70	0,28 ^e	1,40 ^e	—	0,030	0,030	f	f	f
Welded pipe								
L175 or A25	0,21	0,60	—	0,030	0,030	—	—	—
L175P or A25P	0,21	0,60	0,045	0,080	0,030	—	—	—
L210 or A	0,22	0,90		0,030	0,030	—		
L245 or B	0,26	1,20	—	0,030	0,030	c,d	c,d	d
L290 or X42	0,26	1,30	—	0,030	0,030	d	d	d
L320 or X46	0,26	1,40		0,030	0,030	d	d	d
L360 or X52	0,26	1,40	—	0,030	0,030	d	d	d
L390 or X56	0,26	1,40	—	0,030	0,030	d	d	d
L415 or X60	0,26 ^e	1,40 ^e	—	0,030	0,030	f	f	f
L450 or X65	0,26 ^e	1,45 ^e	—	0,030	0,030	f	f	f
L485 or X70	0,26 ^e	1,65 ^e	—	0,030	0,030	f	f	f
^a Cu 0,50 %; Ni 0,50 %; Cr 0,50 % and Mo 0,15% ^b For each reduction of 0,01 % below the specified maximum concentration for carbon, an increase of 0,05 % above the specified maximum concentration for Mn is permissible, up to a maximum of 1,65 % for grades L245 or B, but L360 or X52; up to a maximum of 1,75 % for grades > L360 or X52, but < L485 or X70; and up to a maximum of 2,00 % for grade L485 or X70. ^c Unless otherwise agreed, Nb + V 0,06 %. ^d Nb + V + Ti 0,15 %. ^e Unless otherwise agreed. ^f Unless otherwise agreed, Nb + V + Ti 0,15 %. ^g No deliberate addition of B is permitted and the residual B 0,001 %.								

Table 3 — Chemical composition for PSL 2 pipe with $t \leq 25,0$ mm (0.984 in)

Steel grade (Steel name)	Mass fraction, based upon heat and product analyses % maximum									Carbon equivalent ^a % maximum	
	C ^b	Si	Mn ^b	P	S	V	Nb	Ti	Other	CE _{IW}	CE _{Pcm}
Seamless and welded pipes											
L245R or BR	0,24	0,40	1,20	0,025	0,015	c	c	0,04	e,l	0,43	0,25
L290R or X42R	0,24	0,40	1,20	0,025	0,015	0,06	0,05	0,04	e,l	0,43	0,25
L245N or BN	0,24	0,40	1,20	0,025	0,015	c	c	0,04	e,l	0,43	0,25
L290N or X42N	0,24	0,40	1,20	0,025	0,015	0,06	0,05	0,04	e,l	0,43	0,25
L320N or X46N	0,24	0,40	1,40	0,025	0,015	0,07	0,05	0,04	d,e,l	0,43	0,25
L360N or X52N	0,24	0,45	1,40	0,025	0,015	0,10	0,05	0,04	d,e,l	0,43	0,25
L390N or X56N	0,24	0,45	1,40	0,025	0,015	0,10 ^f	0,05	0,04	d,e,l	0,43	0,25
L415N or X60N	0,24 ^f	0,45 ^f	1,40 ^f	0,025	0,015	0,10 ^f	0,05 ^f	0,04 ^f	g,h,l	as agreed	
L245Q or BQ	0,18	0,45	1,40	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L290Q or X42Q	0,18	0,45	1,40	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L320Q or X46Q	0,18	0,45	1,40	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L360Q or X52Q	0,18	0,45	1,50	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L390Q or X56Q	0,18	0,45	1,50	0,025	0,015	0,07	0,05	0,04	d,e,l	0,43	0,25
L415Q or X60Q	0,18 ^f	0,45 ^f	1,70 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L450Q or X65Q	0,18 ^f	0,45 ^f	1,70 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L485Q or X70Q	0,18 ^f	0,45 ^f	1,80 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L555Q or X80Q	0,18 ^f	0,45 ^f	1,90 ^f	0,025	0,015	g	g	g	i,j	as agreed	
L625Q or X90Q	0,16 ^f	0,45 ^f	1,90	0,020	0,010	g	g	g	j,k	as agreed	
L690Q or X100Q	0,16 ^f	0,45 ^f	1,90	0,020	0,010	g	g	g	j,k	as agreed	
Welded pipe											
L245M or BM	0,22	0,45	1,20	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L290M or X42M	0,22	0,45	1,30	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L320M or X46M	0,22	0,45	1,30	0,025	0,015	0,05	0,05	0,04	e,l	0,43	0,25
L360M or X52M	0,22	0,45	1,40	0,025	0,015	d	d	d	e,l	0,43	0,25
L390M or X56M	0,22	0,45	1,40	0,025	0,015	d	d	d	e,l	0,43	0,25
L415M or X60M	0,12 ^f	0,45 ^f	1,60 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L450M or X65M	0,12 ^f	0,45 ^f	1,60 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L485M or X70M	0,12 ^f	0,45 ^f	1,70 ^f	0,025	0,015	g	g	g	h,l	0,43	0,25
L555M or X80M	0,12 ^f	0,45 ^f	1,85 ^f	0,025	0,015	g	g	g	i,l	0,43 ^f	0,25
L625M or X90M	0,10	0,55 ^f	2,10 ^f	0,020	0,010	g	g	g	i,l	—	0,25
L690M or X100M	0,10	0,55 ^f	2,10 ^f	0,020	0,010	g	g	g	i,j		0,25
L830M or X120M	0,10	0,55 ^f	2,10 ^f	0,020	0,010	g	g	g	i,j		0,25

3.1 Tensile properties

3.1.1 For PSL 1 pipe, the tensile properties shall be as given in Table 6.

3.1.2 For PSL 2 pipe, the tensile properties shall be as given in Table 7.

Table 4 — Requirements for the results of tensile tests for PSL 1 pipe

Pipe grade	Pipe body of seamless and welded pipes			Weld seam of EW, LW, SAW and COW pipes
	Yield strength ^a $R_{t0,5}$ MPa (psi) minimum	Tensile strength ^a R_m MPa (psi) Minimum	Elongation (on 50 mm or 2 in) A_f % minimum	Tensile strength ^b R_m MPa (psi) Minimum
L175 or A25	175 (25 400)	310 (45 000)	c	310 (45 000)
L175P or A25P	175 (25 400)	310 (45 000)	c	310 (45 000)
L210 or A	210 (30 500)	335 (48 600)	c	335 (48 600)
L245 or B	245 (35 500)	415 (60 200)	c	415 (60 200)
L290 or X42	290 (42 100)	415 (60 200)	c	415 (60 200)
L320 or X46	320 (46 400)	435 (63 100)	c	435 (63 100)
L360 or X52	360 (52 200)	460 (66 700)	c	460 (66 700)
L390 or X56	390 (56 600)	490 (71 100)	c	490 (71 100)
L415 or X60	415 (60 200)	520 (75 400)	c	520 (75 400)
L450 or X65	450 (65 300)	535 (77 600)	c	535 (77 600)
L485 or X70	485 (70 300)	570 (82 700)	c	570 (82 700)

^a For intermediate grades, the difference between the specified minimum tensile strength and the specified minimum yield strength for the pipe body shall be as given in the table for the next higher grade.

^b For intermediate grades, the specified minimum tensile strength for the weld seam shall be the same value as was determined for the pipe body using footnote a).

^c The specified minimum elongation, A_f , expressed in percent and rounded to the nearest percent, shall be as determined using the following equation:

$$A_f = C \frac{A_{xc}^{0,2}}{U^{0,9}}$$

where

C is 1 940 for calculations using SI units and 625 000 for calculations using USC units;

A_{xc} is the applicable tensile test piece cross-sectional area, expressed in square millimetres (square inches), as follows:

- for circular cross-section test pieces, 130 mm² (0.20 in²) for 12,7 mm (0.500 in) and 8,9 mm (0.350 in) diameter test pieces; and 65 mm² (0.10 in²) for 6,4 mm (0.250 in) diameter test pieces;
- for full-section test pieces, the lesser of a) 485 mm² (0.75 in²) and b) the cross-sectional area of the test piece, derived using the specified outside diameter and the specified wall thickness of the pipe, rounded to the nearest 10 mm² (0.01 in²);
- for strip test pieces, the lesser of a) 485 mm² (0.75 in²) and b) the cross-sectional area of the test piece, derived using the specified width of the test piece and the specified wall thickness of the pipe, rounded to the nearest 10 mm² (0.01 in²);

U is the specified minimum tensile strength, expressed in megapascals (pounds per square inch).

Table 5— Requirements for the results of tensile tests for PSL 2 pipe

Pipe grade	Pipe body of seamless and welded pipes						Weld seam of HFW, SAW and COW pipes
	Yield strength ^a		Tensile strength ^a		Ratio ^{a, c}	Elongation (on 50 mm or 2 in) ^{A_f}	Tensile strength ^d
	$R_{10,5}$ MPa (psi)		R_m MPa (psi)		$R_{10,5}/R_m$	%	R_m MPa (psi)
	minimum	maximum	minimum	Maximum	maximum	minimum	minimum
L245R or BR L245N or BN L245Q or BQ L245M or BM	245 (35 500)	450 ^e (65 300) ^e	415 (60 200)	655 (95 000)	0,93	f	415 (60 200)
L290R or X42R L290N or X42N L290Q or X42Q L290M or X42M	290 (42 100)	495 (71 800)	415 (60 200)	655 (95 000)	0,93	f	415 (60 200)
L320N or X46N L320Q or X46Q L320M or X46M	320 (46 400)	525 (76 100)	435 (63 100)	655 (95 000)	0,93	f	435 (63 100)
L360N or X52N L360Q or X52Q L360M or X52M	360 (52 200)	530 (76 900)	460 (66 700)	760 (110 200)	0,93	f	460 (66 700)
L390N or X56N L390Q or X56Q L390M or X56M	390 (56 600)	545 (79 000)	490 (71 100)	760 (110 200)	0,93	f	490 (71 100)
L415N or X60N L415Q or X60Q L415M or X60M	415 (60 200)	565 (81 900)	520 (75 400)	760 (110 200)	0,93	f	520 (75 400)
L450Q or X65Q L450M or X65M	450 (65 300)	600 (87 000)	535 (77 600)	760 (110 200)	0,93	f	535 (77 600)
L485Q or X70Q L485M or X70M	485 (70 300)	635 (92 100)	570 (82 700)	760 (110 200)	0,93	f	570 (82 700)
L555Q or X80Q L555M or X80M	555 (80 500)	705 (102 300)	625 (90 600)	825 (119 700)	0,93	f	625 (90 600)
L625M or X90M	625 (90 600)	775 (112 400)	695 (100 800)	915 (132 700)	0,95	f	695 (100 800)
L625Q or X90Q	625 (90 600)	775 (112 400)	695 (100 800)	915 (132 700)	0,97 ^g	f	—
L690M or X100M	690 ^b (100 100) ^b	840 ^b (121 800) ^b	760 (110 200)	990 (143 600)	0,97 ^h	f	760 (110 200)
L690Q or X100Q	690 ^b (100 100) ^b	840 ^b (121 800) ^b	760 (110 200)	990 (143 600)	0,97 ^h	f	—
L830M or X120M	830 ^b (120 400) ^b	1 050 ^b (152 300) ^b	915 (132 700)	1 145 (166 100)	0,99 ^h	f	915 (132 700)

Table 6 — Requirements for the results of tensile tests for PSL 2 pipe (continued)

<p>a For intermediate grades, the difference between the specified maximum yield strength and the specified minimum yield strength shall be as given in the table for the next higher grade, and the difference between the specified minimum tensile strength and the specified minimum yield strength shall be as given in the table for the next higher grade. For intermediate grades up to Grade L320 or X46, the tensile strength shall be ≤ 655 MPa (95 000 psi). For intermediate grades greater than Grade L320 or X46 and lower than Grade L555 or X80, the tensile strength shall be ≤ 760 MPa (110 200 psi). For intermediate grades higher than Grade L555 or X80, the maximum permissible tensile strength shall be obtained by interpolation. For SI units, the calculated value shall be rounded to the nearest 5 MPa. For USC units, the calculated value shall be rounded to the nearest 100 psi.</p> <p>b For grades > L625 or X90, $R_{p0,2}$ applies.</p> <p>c This limit applies for pipe with $D > 323,9$ mm (12.750 in).</p> <p>d For intermediate grades, the specified minimum tensile strength for the weld seam shall be the same value as was determined for the pipe body using footnote a).</p> <p>e For pipe requiring longitudinal testing, the maximum yield strength shall be ≤ 495 MPa (71 800 psi).</p> <p>f The specified minimum elongation, A_f, shall be as determined using the following equation:</p> $A_f = C \frac{A_{xc}^{0,2}}{U^{0,2}}$ <p>where</p> <p>C is 1 940 for calculations using SI units and 625 000 for calculations using USC units;</p> <p>A_{xc} is the applicable tensile test piece cross-sectional area, expressed in square millimetres (square inches), as follows:</p> <ul style="list-style-type: none"> — for circular cross-section test pieces, 130 mm² (0.20 in²) for 12,7 mm (0.500 in) and 8,9 mm (0.350 in) diameter test pieces; and 65 mm² (0.10 in²) for 6,4 mm (0.250 in) diameter test pieces; — for full-section test pieces, the lesser of a) 485 mm² (0.75 in²) and b) the cross-sectional area of the test piece, derived using the specified outside diameter and the specified wall thickness of the pipe, rounded to the nearest 10 mm² (0.01 in²); — for strip test pieces, the lesser of a) 485 mm² (0.75 in²) and b) the cross-sectional area of the test piece, derived using the specified width of the test piece and the specified wall thickness of the pipe, rounded to the nearest 10 mm² (0.01 in²); <p>U is the specified minimum tensile strength, expressed in megapascals (pounds per square inch).</p> <p>g Lower values of $R_{t0,5}/R_m$ may be specified by agreement.</p> <p>h For grades > L625 or X90, $R_{p0,2}/R_m$ applies. Lower values of $R_{p0,2}/R_m$ may be specified by agreement.</p>
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3.4 Hydrostatic test

3.4.1 Except as allowed by 9.4.2, the pipe shall withstand the hydrostatic test without leakage through the weld seam or the pipe body.

3.4.2 Joints need not be hydrostatically tested, provided that the portions of pipe used in making the joints were successfully hydrostatically tested prior to the joining operation.

3.5 Bend test

No cracks shall occur in any portion of the test piece and no opening of the weld shall occur.

NOTE For all bend tests, the weld extends to a distance of 6,4 mm (0.25 in) on each side of the fusion line.

3.6 Flattening test

Acceptance criteria for flattening tests shall be as follows:

a) EW pipe in grades \geq L210 or A and LW pipe with $D < 323,9$ mm (12.750 in):

- 1) For grades \geq L415 or X60 with $t \geq 12,7$ mm (0.500 in), there shall be no opening of the weld before the distance between the plates is less than 66 % of the original outside diameter. For all

other combinations of pipe grade and specified wall thickness, there shall be no opening of the weld before the distance between the plates is less than 50 % of the original outside diameter.

- 2) For pipe with a $D/t > 10$, there shall be no cracks or breaks other than in the weld before the distance between the plates is less than 33 % of the original outside diameter.
 - 3) There shall be no evidence of lamination or burnt metal during the entire test before opposite walls of the pipe meet.
- b) EW and CW pipes in Grade L175, L175P, A25 or A25P:
- 1) There shall be no opening of the weld before the distance between the plates is less than 75 % of the original outside diameter.
 - 2) There shall be no cracks or breaks other than in the weld before the distance between the plates is less than 60 % of the original outside diameter.

NOTE 1 The weld extends to a distance, on each side of the weld line, of 6,4 mm (0.25 in) for $D < 60,3$ mm (2.375 in) and 13 mm (0.5 in) for $D \geq 60,3$ mm (2.375 in).

NOTE 2 For EW pipe that is processed through a hot-stretch mill and is flattened prior to such treatment, the original outside diameter is as designated by the manufacturer; for all other cases, the original outside diameter is the specified outside diameter.

NOTE 3 The term 'opening of the weld' includes any cracks, breaks or tears that become visible during the flattening test but does not include slight incipient cracking at the test piece edges.

3.7 Guided-bend test

3.7.1 Except as allowed by 9.7.2, the test pieces shall not

- a) fracture completely,
- b) reveal any cracks or ruptures in the weld metal longer than 3,2 mm (0.125 in), regardless of depth, or
- c) reveal any cracks or ruptures in the parent metal, HAZ or fusion line longer than 3,2 mm (0.125 in) or deeper than 12,5 % of the specified wall thickness.

3.7.2 Cracks that occur at the edges of the test piece during testing shall not be cause for rejection, provided that they are not longer than 6,4 mm (0.250 in).

3.8 CVN impact test for PSL 2 pipe

3.8.1 General

3.8.1.1 If subsize test pieces are used, the required minimum average (set of three test pieces) absorbed energy values shall be the required values for full-size test pieces times the ratio of the specified width of the subsize test piece to the specified width of the full-size test piece, with such derived values rounded to the nearest joule (foot-pound force).

3.8.1.2 Individual test values for any test piece shall be ≥ 75 % of the required minimum average (of a set of three test pieces) absorbed energy values.

3.8.1.3 Tests conducted at temperatures lower than the specified test temperature shall be acceptable if the applicable requirements for energy absorption and shear fracture area are met at such lower temperatures.

3.9 Pipe body tests

3.9.1 The minimum average (of a set of three test pieces) absorbed energy for each pipe body test shall be as given in Table 8, based upon full-size test pieces and a test temperature of 0 °C (32 °F) or, if agreed, a lower test temperature.

NOTE The energy values specified in Table 8 provide sufficient fracture-initiation resistance for most pipeline designs.

3.9.1.1 For welded pipe with $D \geq 508$ mm (20.000 in), if agreed, the minimum average (set of three test pieces) shear fracture area for each test shall be at least 85 %, based upon a test temperature of 0 °C (32 °F) or, if agreed, a lower test temperature.

NOTE This percentage of shear fracture area ensures sufficiently ductile fracture at or above the test temperature.

3.9.1.2 If 9.8.2.2 does not apply for the order item, the shear fracture area on the CVN specimen shall be estimated and reported for information purposes for all grades and sizes of pipe that have been CVN tested, unless otherwise agreed.

Table 7 — CVN absorbed energy requirements for pipe body of PSL 2 pipe

Specified outside diameter D mm (in)	Full-size CVN absorbed energy, minimum						
	K_V J (ft·lbf)						
	Grade						
	L415 or X60	> L415 or X60 to L450 or X65	> L450 or X65 to L485 or X70	> L485 or X70 to L555 or X80	> L555 or X80 to L625 or X90	> L625 or X90 to L690 or X100	> L690 or X100 to L830 or X120
508 (20.000)	27 (20)	27 (20)	27 (20)	40 (30)	40 (30)	40 (30)	40 (30)
> 508 (20.000) to 762 (30.000)	27 (20)	27 (20)	27 (20)	40 (30)	40 (30)	40 (30)	40 (30)
> 762 (30.000) to 914 (36.000)	40 (30)	40 (30)	40 (30)	40 (30)	40 (30)	54 (40)	54 (40)
> 914 (36.000) to 1 219 (48.000)	40 (30)	40 (30)	40 (30)	40 (30)	40 (30)	54 (40)	68 (50)
> 1 219 (48.000) to 1 422 (56.000)	40 (30)	54 (40)	54 (40)	54 (40)	54 (40)	68 (50)	81 (60)
> 1 422 (56.000) to 2 134 (84.000)	40 (30)	54 (40)	68 (50)	68 (50)	81 (60)	95 (70)	108 (80)

4.1 DWT test for PSL 2 welded pipe

4.1.1 For each test (of a set of two test pieces), the average shear fracture area shall be ≥ 85 %, based upon a test temperature of 0 °C (32 °F) or, if agreed, a lower test temperature. For wall thickness $> 25,4$ mm (1.000 in), DWT test acceptance requirements shall be by agreement.

NOTE 1 Such shear-fracture area ensures a sufficiently ductile fracture at or above the test temperature.

4.2 Tests conducted at temperatures lower than the specified test temperature shall be acceptable if the applicable requirements for shear fracture area are met at such lower temperatures.

4.3 Surface conditions, imperfections and defects

4.3.1 General

4.3.2 All pipes shall be free from defects in the finished condition.

4.3.2.1 All pipes shall be free from cracks, sweats and leaks.

4.3.2.2 The acceptance criteria for imperfections found by non-destructive inspection shall be in

accordance with Annex E.

4.4 Dimensions, mass and tolerances

4.4.1 Dimensions

4.4.1.1 The pipe shall be delivered to the dimensions specified in the purchase order, subject to the applicable tolerances.

4.4.1.2 The specified outside diameter and specified wall thickness shall be within the applicable limits given in Table 9.

4.4.1.3 The pipe shall be delivered in random lengths or approximate length, as specified in the purchase order.

Table 8 — Permissible specified outside diameter and specified wall thickness

Specified outside diameter <i>D</i> mm (in)	Specified wall thickness <i>t</i> mm (in)	
	Special light sizes ^a	Regular sizes
≥ 10,3 (0.405) to 13,7 (0.540)	—	≥ 1,7 (0.068) to 2,4 (0.094)
> 13,7 (0.540) to 17,1 (0.675)	—	≥ 2,2 (0.088) to 3,0 (0.118)
> 17,1 (0.675) to 21,3 (0.840)	—	≥ 2,3 (0.091) to 3,2 (0.125)
> 21,3 (0.840) to 26,7 (1.050)	—	≥ 2,1 (0.083) to 7,5 (0.294)
> 26,7 (1.050) to 33,4 (1.315)	—	≥ 2,1 (0.083) to 7,8 (0.308)
> 33,4 (1.315) to 48,3 (1.900)	—	≥ 2,1 (0.083) to 10,0 (0.394)
> 48,3 (1.900) to 60,3 (2.375)	—	≥ 2,1 (0.083) to 12,5 (0.492)
> 60,3 (2.375) to 73,0 (2.875)	≥ 2,1 (0.083) to 3,6 (0.141)	> 3,6 (0.141) to 14,2 (0.559)
> 73,0 (2.875) to 88,9 (3.500)	≥ 2,1 (0.083) to 3,6 (0.141)	> 3,6 (0.141) to 20,0 (0.787)
> 88,9 (3.500) to 101,6 (4.000)	≥ 2,1 (0.083) to 4,0 (0.156)	> 4,0 (0.156) to 22,0 (0.866)
> 101,6 (4.000) to 168,3 (6.625)	≥ 2,1 (0.083) to 4,0 (0.156)	> 4,0 (0.156) to 25,0 (0.984)
> 168,3 (6.625) to 219,1 (8.625)	≥ 2,1 (0.083) to 4,0 (0.156)	> 4,0 (0.156) to 40,0 (1.575)
> 219,1 (8.625) to 273,1 (10.750)	≥ 3,2 (0.125) to 4,0 (0.156)	> 4,0 (0.156) to 40,0 (1.575)
> 273,1 (10.750) to 323,9 (12.750)	≥ 3,6 (0.141) to 5,2 (0.203)	> 5,2 (0.203) to 45,0 (1.771)
> 323,9 (12.750) to 355,6 (14.000)	≥ 4,0 (0.156) to 5,6 (0.219)	> 5,6 (0.219) to 45,0 (1.771)
> 355,6 (14.000) to 457 (18.000)	≥ 4,5 (0.177) to 7,1 (0.281)	> 7,1 (0.281) to 45,0 (1.771)
> 457 (18.000) to 559 (22.000)	≥ 4,8 (0.188) to 7,1 (0.281)	> 7,1 (0.281) to 45,0 (1.771)
> 559 (22.000) to 711 (28.000)	≥ 5,6 (0.219) to 7,1 (0.281)	> 7,1 (0.281) to 45,0 (1.771)
> 711 (28.000) to 864 (34.000)	5,6 (0.219) to 7,1 (0.281)	≥ 7,1 (0.281) to 52,0 (2.050)
> 864 (34.000) to 965 (38.000)	—	≥ 5,6 (0.219) to 52,0 (2.050)
> 965 (38.000) to 1 422 (56.000)	—	≥ 6,4 (0.250) to 52,0 (2.050)
> 1 422 (56.000) to 1 829 (72.000)	—	≥ 9,5 (0.375) to 52,0 (2.050)
> 1 829 (72.000) to 2 134 (84.000)	—	10,3 (0.406) to 52,0 (2.050)

NOTE Standardized values for specified outside diameter and specified wall thickness of pipe are given in ISO 4200 [7] and ASME B36.10M [8].

^a Pipe having the combination of specified outside diameter and specified wall thickness is defined as special light size pipe. Other combinations given in this table are defined as regular size pipe. Pipe that has a combination of specified outside diameter and specified wall thickness that is intermediate to the tabulated values is considered to be special light size if the next lower tabulated value is for special light size pipe; other intermediate combinations are considered to be regular size pipe.

4.5 Tolerances for diameter, wall thickness, length and straightness

4.5.1 Except as allowed by C.2.3, the diameter and out-of-roundness shall be within the tolerances given in Table 10 (see 10.2.8.2).

Table 9 — Tolerances for wall thickness

Wall thickness <i>t</i> 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 <i>t</i> – 0,125 <i>t</i>
25,0 (0.984)	+ 3,7 (0.146) or + 0,1 <i>t</i> , whichever is the greater – 3,0 (0.120) or – 0,1 <i>t</i> , whichever is the greater
Welded pipe ^{c,d}	
5,0 (0.197)	± 0,5 (0.020)
> 5,0 (0.197) to < 15,0 (0.591)	± 0,1 <i>t</i>
15,0 (0.591)	± 1,5 (0.060)
^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 <i>D</i> 355,6 mm (14.000 in) and <i>t</i> 25,0 mm (0.984 in), the wall-thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional 0,05 <i>t</i> , 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 10 — Tolerances for random length pipe

Random length designation m (ft)	Minimum length m (ft)	Minimum average length for each order item m (ft)	Maximum length m (ft)
Threaded-and-coupled pipe			
6 (20)	4,88 (16.0)	5,33 (17.5)	6,86 (22.5)
9 (30)	4,11 (13.5)	8,00 (26.2)	10,29 (33.8)
12 (40)	6,71 (22.0)	10,67 (35.0)	13,72 (45.0)
Plain-end pipe			
6 (20)	2,74 (9.0)	5,33 (17.5)	6,86 (22.5)
9 (30)	4,11 (13.5)	8,00 (26.2)	10,29 (33.8)
12 (40)	4,27 (14.0)	10,67 (35.0)	13,72 (45.0)
15 (50)	5,33 (17.5)	13,35 (43.8)	16,76 (55.0)
18 (60)	6,40 (21.0)	16,00 (52.5)	19,81 (65.0)
24 (80)	8,53 (28.0)	21,34 (70.0)	25,91 (85.0)

4.5.2 If the purchase order specifies a minus tolerance for wall thickness smaller than the applicable value given in Table 11, the plus tolerance for mass shall be increased by a percentage equivalent to the applicable percentage reduction of the minus tolerance for wall thickness.

4.5.3 For each order item with a mass of 18 tonnes (20 ton) or more, the mass of the order item shall not deviate from its nominal mass, determined by multiplying the total length of pipe in the order item by its mass per unit length (see 9.11.2), by more than the following:

- a) for Grades L175, L175P, A25 and A25P: – 3,5 %;

b) for all other grades: - 1,75 %.

Table 11 — Test pressures for light-wall threaded pipe

Specified outside diameter <i>D</i> mm (in)	Specified wall thickness <i>t</i> mm (in)	Test pressure MPa (psi) minimum			
		Grade			
		L175 or A25	L175P or A25P	L210 or A	L245 or B
10,3 (0.405)	1,7 (0.068)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
13,7 (0.540)	2,2 (0.088)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
17,1 (0.675)	2,3 (0.091)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
21,3 (0.840)	2,8 (0.109)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
26,7 (1.050)	2,9 (0.113)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
33,4 (1.315)	3,4 (0.133)	4,8 (700)	4,8 (700)	4,8 (700)	4,8 (700)
42,2 (1.660)	3,6 (0.140)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)
48,3 (1.900)	3,7 (0.145)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)
60,3 (2.375)	3,9 (0.154)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)
73,0 (2.875)	5,2 (0.203)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)
88,9 (3.500)	5,5 (0.216)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)	6,9 (1 000)
101,6 (4.000)	5,7 (0.226)	8,3 (1 200)	8,3 (1 200)	8,3 (1 200)	9,0 (1 300)
114,3 (4.500)	6,0 (0.237)	8,3 (1 200)	8,3 (1 200)	8,3 (1 200)	9,0 (1 300)
141,3 (5.563)	6,6 (0.258)	8,3 (1 200)	8,3 (1 200)	8,3 (1 200)	9,0 (1 300)
168,3 (6.625)	7,1 (0.280)	a	a	8,3 (1 200)	9,0 (1 300)
219,1 (8.625)	7,0 (0.277)	a	a	7,9 (1 160)	9,2 (1 350)
219,1 (8.625)	8,2 (0.258)	a	a	9,3 (1 340)	10,8 (1 570)
273,1 (10.750)	7,1 (0.280)	a	a	6,5 (940)	7,5 (1 090)
273,1 (10.750)	7,8 (0.307)	a	a	7,1 (1 030)	8,3 (1 200)
273,1 (10.750)	9,3 (0.365)	a	a	8,5 (1 220)	9,8 (1 430)
323,9 (12.750)	8,4 (0.330)	a	a	6,4 (930)	7,5 (1 090)
323,9 (12.750)	9,5 (0.375)	a	a	7,3 (1 060)	8,5 (1 240)
355,6 (14.000)	9,5 (0.375)	a	a	6,6 (960)	7,7 (1 130)
406,4 (16.000)	9,5 (0.375)	a	a	5,8 (840)	6,8 (980)
457 (18.000)	9,5 (0.375)	a	a	5,2 (750)	6,0 (880)
508 (20.000)	9,5 (0.375)	a	a	4,6 (680)	5,4 (790)
^a Not applicable.					