

LINE PIPE MATERIAL-PROPERTY REFERENCE

API 5L LINE PIPE CHEMICAL & MECHANICAL PROPERTIES

API 5L 46th Edition

PSL 1 and PSL 2 chemical composition and tensile requirements

PSL 1 CHEMISTRY

PSL 2 CHEMISTRY

PSL 1 TENSILE

PSL 2 TENSILE

GRADE LIMITS

TABLE FOOTNOTES

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REFERENCE NOTE

Source dimensional values and footnotes are retained. Confirm the applicable material, grade, schedule and project specification before ordering.

Table 4—Chemical Composition for PSL 1 Pipe with $t \leq 25.0$ mm (0.984 in.)

Steel Grade (Steel Name)	Mass Fraction, Based on Heat and Product Analyses ^{a,g}							
	%							
	C	Mn	P		S	V	Nb	Ti
	max ^b	max ^b	min	max	max	max	max	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 $\leq$ 0.50 %; Ni $\leq$ 0.50 %; Cr $\leq$ 0.50 % and Mo $\leq$ 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 $\geq$ L245 or B, but $\leq$ 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 $\leq$ 0.06 %. ^d Nb + V + Ti $\leq$ 0.15 %. ^e Unless otherwise agreed. ^f Unless otherwise agreed, Nb + V + Ti $\leq$ 0.15 %. ^g No deliberate addition of B is permitted and the residual B $\leq$ 0.001 %.								

Table 5—Chemical Composition for PSL 2 Pipe with $t \leq 25.0$ mm (0.984 in.)

Steel Grade (Steel Name)	Mass Fraction, Based on Heat and Product Analyses									Carbon Equivalent ^a	
	% max									% max	
	C ^b	Si	Mn ^b	P	S	V	Nb	Ti	Other	CE _{IW}	CE _{Pcm}
Seamless and Welded Pipe											
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
^a Based on product analysis, for seamless pipe with <i>t</i> > 20.0 mm (0.787 in.), the CE limits shall be as agreed; the CE _{IW} limits apply if C > 0.12 % and the CE _{Pcm} limits apply if C ≤ 0.12 %.											
^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 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; up to a maximum of 2.00 % for grades ≥ L485 or X70, but ≤ L555 or X80; and up to a maximum of 2.20 % for grades > L555 or X80.											
^c Unless otherwise agreed, Nb + V ≤ 0.06 %.											
^d Nb + V + Ti ≤ 0.15 %.											
^e Unless otherwise agreed, Cu ≤ 0.50 %; Ni ≤ 0.30 %; Cr ≤ 0.30 % and Mo ≤ 0.15 %.											
^f Unless otherwise agreed.											
^g Unless otherwise agreed, Nb + V + Ti ≤ 0.15 %.											
^h Unless otherwise agreed, Cu ≤ 0.50 %; Ni ≤ 0.50 %; Cr ≤ 0.50 % and Mo ≤ 0.50 %.											
ⁱ Unless otherwise agreed, Cu ≤ 0.50 %; Ni ≤ 1.00 %; Cr ≤ 0.50 % and Mo ≤ 0.50 %.											
^j B ≤ 0.004 %.											
^k Unless otherwise agreed, Cu ≤ 0.50 %; Ni ≤ 1.00 %; Cr ≤ 0.55 % and Mo ≤ 0.80 %.											
^l For PSL 2 pipe grades except those grades to which footnote j) already applies, the following applies: unless otherwise agreed no intentional addition of B is permitted and residual B ≤ 0.001 %.											

9.3 Tensile Properties

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

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

Table 6—Requirements for the Results of Tensile Tests for PSL 1 Pipe

Pipe Grade	Pipe Body of Seamless and Welded Pipe			Weld Seam of EW, LW, SAW, and COW Pipe
	Yield Strength ^a	Tensile Strength ^a	Elongation (on 50 mm or 2 in.) A_f	Tensile Strength ^b
	$R_{t0.5}$ MPa (psi)	R_m MPa (psi)	A_f %	R_m MPa (psi)
	min	min	min	min
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 1940 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 millimeters (square inches), as follows:

- 1) for circular cross-section test pieces, 130 mm² (0.20 in.²) for 12.7 mm (0.500 in.) and 8.9 mm (0.350 in.) diameter test pieces; 65 mm² (0.10 in.²) for 6.4 mm (0.250 in.) diameter test pieces;
- 2) for full-section test pieces, the lesser of a) 485 mm² (0.75 in.²) 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 in.²);
- 3) for strip test pieces, the lesser of a) 485 mm² (0.75 in.²) 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 in.²);

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

Table 7—Requirements for the Results of Tensile Tests for PSL 2 Pipe

Pipe Grade	Pipe Body of Seamless and Welded Pipe					Weld Seam of HFW, SAW and COW Pipe	
	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)		$R_{10.5}/R_m$	A_f %	R_m MPa (psi)
	min	max	min	max	max	min	min
L245R or BR L245N or BN L245Q or BQ L245M or BM	245 (35,500)	450 (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 (100,100) ^b	840 (121,800) ^b	760 (110,200)	990 (143,600)	0.97 ^h	f	760 (110,200)
L690Q or X100Q	690 (100,100) ^b	840 (121,800) ^b	760 (110,200)	990 (143,600)	0.97 ^h	f	—
L830M or X120M	830 (120,400) ^b	1050 (152,300) ^b	915 (132,700)	1145 (166,100)	0.99 ^h	f	915 (132,700)

^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.

^b For grades > L625 or X90, $R_{p0.2}$ applies.

^c This limit applies for pipe with $D > 323.9$ mm (12.750 in.).

^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).

^e For pipe requiring longitudinal testing, the maximum yield strength shall be ≤ 495 MPa (71,800 psi).

^f The specified minimum elongation, A_f , shall be as determined using the following equation:

$$A_f = C \frac{A_{xc}^{0.2}}{U^{0.9}}$$

where

C is 1940 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 millimeters (square inches), as follows:

- 1) for circular cross-section test pieces, 130 mm² (0.20 in.²) for 12.7 mm (0.500 in.) and 8.9 mm (0.350 in.) diameter test pieces; 65 mm² (0.10 in.²) for 6.4 mm (0.250 in.) diameter test pieces;
- 2) for full-section test pieces, the lesser of a) 485 mm² (0.75 in.²) 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 in.²);
- 3) for strip test pieces, the lesser of a) 485 mm² (0.75 in.²) 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 in.²);

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

^g Lower values of $R_{10.5}/R_m$ may be specified by agreement.

^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.

Send your requirement

Send a drawing, product list, size, material grade, standard, schedule or wall thickness, testing and project document requirements.

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RESPONSE AND DOCUMENT COORDINATION

Initial enquiries are answered within 24 hours, including weekends, by email or WhatsApp. Drawing review, material/standard matching and project document requirements can be discussed and organized with the buyer. Third-party inspection can be buyer-nominated or coordinated on request.

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