

API5L 45th Edition Specification for Line Pipe

Scope

Specified the manufacture of two product levels (PSL1 and PSL2) of seamless and welded steel pipe for the use of a pipeline in the transportation of petroleum and natural gas. For material use in a Sour service application refer to Annex H and for offshore service application refer to Annex J of API5L 45th.

Delivery Condition

PSL	Delivery Condition	Pipe grade
PSL1	As-rolled, normalized, normalizing formed	A
	As-rolled, normalizing rolled, thermomechanical rolled, thermo-mechanical formed, normalizing formed, normalized, normalized and tempered or if agreed Q&T SMLS only	B
	As-rolled, normalizing rolled, thermomechanical rolled, thermo-mechanical formed, normalizing formed, normalized, normalized and tempered	X42, X46, X52, X56, X60, X65, X70
PSL 2	As-rolled	BR, X42R
	Normalizing rolled, normalizing formed, normalized or normalized and tempered	BN, X42N, X46N, X52N, X56N, X60N
	Quenched and tempered	BQ, X42Q, X46Q, X56Q, X60Q, X65Q, X70Q, X80Q, X90Q, X100Q
	Thermomechanical rolled or thermomechanical formed	BM, X42M, X46M, X56M, X60M, X65M, X70M, X80M
	Thermomechanical rolled	X90M, X100M, X120M
The suffice (R, N, Q or M) for PSL2 grades, belongs to the steel grade		

Ordering Information

The purchase order shall include the quantity, PSL level, type or Grade, reference to API5L, outside diameter, wall thickness, length and any applicable annexes or additional requirements related to chemical composition, mechanical properties, heat treatment, additional testing, manufacturing process, surface coatings or end finish.

Typical process of manufacturing

Type of Pipe	PSL 1			PSL 2	
	Grade A	Grade B	X42 to X70	B to X80	X80 to X100
SMLS	✓	✓	✓	✓	✓
LFW	✓	✓	✓		
HFW	✓	✓	✓	✓	
LW			✓		
SAWL	✓	✓	✓	✓	✓
SAWH	✓	✓	✓	✓	✓
SMLS – Seamless, without weld LFW – Low frequency welded pipe, <70 kHz					

HFW – High frequency welded pipe, >70 kHz
 SAWL – Submerge-arc welding longitudinal welded
 SAWH - Submerge-arc welding helical welded

Starting Material

Ingots, blooms, billets, coils or plates used for the manufacture of pipe shall be made by the following processes, basic oxygen, electric furnace or open hearth in combination with a ladle refining process. For PSL2, the steel shall be killed and melted according to a fine grain practice. Coil or plate used for PSL2 pipe shall not contain any repair welds.

Chemical Composition for PSL 1 pipe with $t \leq 0.984''$

Steel Grade	Mass fraction, % based on heat and product analyses a,g						
	C max b	Mn max b	P max	S max	V max	Nb max	Ti max
Seamless Pipe							
A	0.22	0.90	0.30	0.30	-	-	-
B	0.28	1.20	0.30	0.30	c,d	c,d	d
X42	0.28	1.30	0.30	0.30	d	d	d
X46	0.28	1.40	0.30	0.30	d	d	d
X52	0.28	1.40	0.30	0.30	d	d	d
X56	0.28	1.40	0.30	0.30	d	d	d
X60	0.28 e	1.40 e	0.30	0.30	f	f	f
X65	0.28 e	1.40 e	0.30	0.30	f	f	f
X70	0.28 e	1.40 e	0.30	0.30	f	f	f
Welded Pipe							
A	0.22	0.90	0.30	0.30	-	-	-
B	0.26	1.2	0.30	0.30	c,d	c,d	d
X42	0.26	1.3	0.30	0.30	d	d	d
X46	0.26	1.4	0.30	0.30	d	d	d
X52	0.26	1.4	0.30	0.30	d	d	d
X56	0.26	1.4	0.30	0.30	d	d	d
X60	0.26 e	1.40 e	0.30	0.30	f	f	f
X65	0.26 e	1.45 e	0.30	0.30	f	f	f
X70	0.26e	1.65 e	0.30	0.30	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 max. concentration for carbon, and increase of 0.05% above the specified max. concentration for Mn is permissible, up to a max. of 1.65% for grades \geq B, but \leq X52; up to a max. of 1.75% for grades $>$ X52, but $<$ X70; and up to a maximum of 2.00% for 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%						

Chemical Composition for PSL 2 pipe with $t \leq 0.984''$

Steel Grade	Mass fraction, % based on heat and product analyses									Carbon Equiv a	
	C max b	Si max	Mn max b	P max	S max	V max	Nb max	Ti max	Other	CE _{IIW} max	CE _{Pcm} max
Seamless and Welded Pipe											
BR	0.24	0.40	1.20	0.025	0.015	c	c	0.04	e,l	.043	0.25
X42R	0.24	0.40	1.20	0.025	0.015	0.06	0.05	0.04	e,l	.043	0.25
BN	0.24	0.40	1.20	0.025	0.015	c	c	0.04	e,l	.043	0.25

X42N	0.24	0.40	1.20	0.025	0.015	0.06	0.05	0.04	e,l	.043	0.25
X46N	0.24	0.40	1.40	0.025	0.015	0.07	0.05	0.04	d,e,l	.043	0.25
X52N	0.24	0.45	1.40	0.025	0.015	0.10	0.05	0.04	d,e,l	.043	0.25
X56N	0.24	0.45	1.40	0.025	0.015	0.10f	0.05	0.04	d,e,l	.043	0.25
X60N	0.24f	0.45f	1.40f	0.025	0.015	0.10f	0.05f	0.04f	g,h,l	As agreed	
BQ	0.18	0.45	1.40	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X42Q	0.18	0.45	1.40	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X46Q	0.18	0.45	1.40	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X52Q	0.18	0.45	1.50	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X56Q	0.18	0.45f	1.50	0.025	0.015	0.07	0.05	0.04	e,l	.043	0.25
X60Q	0.18f	0.45f	1.70f	0.025	0.015	g	g	g	h,l	.043	0.25
X65Q	0.18f	0.45f	1.70f	0.025	0.015	g	g	g	h,l	.043	0.25
X70Q	0.18f	0.45f	1.80f	0.025	0.015	g	g	g	h,l	.043	0.25
X80Q	0.18f	0.45f	1.90f	0.025	0.015	g	g	g	i,j	As agreed	
X90Q	0.16f	0.45f	1.90	0.020	0.010	g	g	g	j,k	As agreed	
X100Q	0.16f	0.45f	1.90	0.020	0.010	g	g	g	j,k	As agreed	
Welded Pipe											
BM	0.22	0.45	1.20	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X42M	0.22	0.45	1.30	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X46M	0.22	0.45	1.30	0.025	0.015	0.05	0.05	0.04	e,l	.043	0.25
X52M	0.22	0.45	1.40	0.025	0.015	d	d	d	e,l	.043	0.25
X56M	0.22	0.45f	1.40	0.025	0.015	d	d	d	e,l	.043	0.25
X60M	0.12f	0.45f	1.60f	0.025	0.015	g	g	g	h,l	.043	0.25
X65M	0.12f	0.45f	1.60f	0.025	0.015	g	g	g	h,l	.043	0.25
X70M	0.12f	0.45f	1.70f	0.025	0.015	g	g	g	h,l	.043	0.25
X80M	0.12f	0.45f	1.85f	0.025	0.015	g	g	g	i,j	.043f	0.25
X90M	0.10	0.55f	2.10f	0.020	0.010	g	g	g	i,j	-	0.25
X100M	0.10	0.55f	2.10f	0.020	0.010	g	g	g	i,j	-	0.25
<p>a. SMLS $t > 0.787''$, CE limits shall be as agreed. The CEIIW limits applied if $C > 0.12\%$ and the CEPcm limits apply if $C \leq 0.12\%$</p> <p>b. For each reduction of 0.01% below the specified max. concentration for carbon, and increase of 0.05% above the specified max. concentration for Mn is permissible, up to a max. of 1.65% for grades $\geq B$, but $\leq X52$; up to a max. of 1.75% for grades $> X52$, but $< X70$; and up to a maximum of 2.00% for X70.</p> <p>c. Unless otherwise agreed $Nb = V \leq 0.06\%$</p> <p>d. $Nb = V = Ti \leq 0.15\%$</p> <p>e. Unless otherwise agreed, $Cu \leq 0.50\%$; $Ni \leq 0.30\%$ $Cr \leq 0.30\%$ and $Mo \leq 0.15\%$</p> <p>f. Unless otherwise agreed</p> <p>g. Unless otherwise agreed, $Nb + V + Ti \leq 0.15\%$</p> <p>h. Unless otherwise agreed, $Cu \leq 0.50\%$ $Ni \leq 0.50\%$ $Cr \leq 0.50\%$ and $MO \leq 0.50\%$</p> <p>i. Unless otherwise agreed, $Cu \leq 0.50\%$ $Ni \leq 1.00\%$ $Cr \leq 0.50\%$ and $MO \leq 0.50\%$</p> <p>j. $B \leq 0.004\%$</p> <p>k. Unless otherwise agreed, $Cu \leq 0.50\%$ $Ni \leq 1.00\%$ $Cr \leq 0.55\%$ and $MO \leq 0.80\%$</p> <p>l. For all PSL 2 pipe grades except those grades with footnotes j noted, the following applies. Unless otherwise agreed no intentional addition of B is permitted and residual $B \leq 0.001\%$.</p>											

Tensile and Yield – PSL1 and PSL2

Pipe Grade	Tensile Properties - Pipe Body of SMLS and Welded Pipes PSL 1			Seam of Welded Pipe
	Yield Strength a $R_{10,5}$ PSI Min	Tensile Strength a R_m PSI Min	Elongation (in 2in Af % min)	Tensile Strength b R_m PSI Min
A	30,500	48,600	c	48,600
B	35,500	60,200	c	60,200
X42	42,100	60,200	c	60,200
X46	46,400	63,100	c	63,100
X52	52,200	66,700	c	66,700
X56	56,600	71,100	c	71,100

X60	60,200	75,400	c	75,400
X65	65,300	77,500	c	77,500
X70	70,300	82,700	c	82,700

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

b. For the intermediate grades, the specified minimum tensile strength for the weld seam shall be the same as determined for the body using foot note a.

c. The specified minimum elongation, A_f , expressed in percent and rounded to the nearest percent, shall be determined using the following equation: $A_f = C \frac{A_{xc}^{0.2}}{U_{0.9}}$

Where C is 1 940 for calculation using Si units and 625 000 for calculation using USC units

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

- For circular cross-section test pieces, 130mm² (0.20 in²) for 12.7 mm (0.500 in) and 8.9 mm (.350 in) diameter test pieces; and 65 mm² (0.10 in²) for 6.4 mm (0.250in) 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 (0.10in²)
- 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 (0.10in²)

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

Pipe Grade	Tensile Properties - Pipe Body of SMLS and Welded Pipes PSL 2						Seam of Welded Pipe
	Yield Strength a R _{t0.5} PSI Min		Tensile Strength a R _m PSI Min		Ratio a,c R _{10.5} /R _m	Elongation (in 2in) A _f %	Tensile Strength d R _m (psi)
	Minimum	Maximum	Minimum	Maximum	Maximum	Minimum	Minimum
BR, BN,BQ,BM	35,500	65,300	60,200	95,000	0.93	f	60,200
X42,X42R,X2Q,X42M	42,100	71,800	60,200	95,000	0.93	f	60,200
X46N,X46Q,X46M	46,400	76,100	63,100	95,000	0.93	f	63,100
X52N,X52Q,X52M	52,200	76,900	66,700	110,200	0.93	f	66,700
X56N,X56Q,X56M	56,600	79,000	71,100	110,200	0.93	f	71,100
X60N,X60Q,S60M	60,200	81,900	75,400	110,200	0.93	f	75,400
X65Q,X65M	65,300	87,000	77,600	110,200	0.93	f	76,600
X70Q,X65M	70,300	92,100	82,700	110,200	0.93	f	82,700
X80Q,X80M	80,500	102,300	90,600	119,700	0.93	f	90,600

- a. For intermediate grade, refer to the full API5L specification.
- b. for grades > X90 refer to the full API5L specification.
- c. This limit applies for pies with D> 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 foot a.
- e. for pipe requiring longitudinal testing, the maximum yield strength shall be ≤ 71,800 psi
- f. The specified minimum elongation, A_f , expressed in percent and rounded to the nearest percent, shall be determined using the following equation: $A_f = C \frac{A_{xc}^{0.2}}{U_{0.9}}$
- Where C is 1 940 for calculation using Si units and 625 000 for calculation using USC units
- A_{xc} is the applicable tensile test piece cross-sectional area, expressed in square millimeters (square inches) , as follows
- For circular cross-section test pieces, 130mm² (0.20 in²) for 12.7 mm (0.500 in) and 8.9 mm (.350 in) diameter test pieces; and 65 mm² (0.10 in²) for 6.4 mm (0.250in) 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 (0.10in²)
 - 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 (0.10in²)
- U is the specified minimum tensile strength, expressed in megapascals (pounds per square inch)
- g. Lower values fo R_{10.5}/R_m may be specified by agreement
- h. for grades > x90 refer to the full API5L specification.

Hydrostatic Test

Pipe to withstand a hydrostatic test without leakage through the weld seam or the pipe body. Jointers need not be hydrostatic tested provide the pipe sections used were successfully tested.

Bend Test

No cracks shall occur in any portion of the test piece and not opening of the weld shall occur.

Flattening Test

Acceptance criteria for flattening test shall be

- a) EW pipes $D < 12.750$ in
 - $\geq X60$ with $T \geq 0.500$ 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 grades and wall, 50%.
 - For pipe with a $D/t > 10$, there shall be no opening of the weld before the distance between the plates is less than 30% of the original outside diameter.
- b) For other sizes refer to the full API5L specification

CVN impact test for PSL2

Many PSL2 pipe sizes and grades require CVN. Seamless pipe is to be tested in the body. Welded pipe is to be tested in the Body, Pipe Weld and heat affected zone (HAZ). Refer to the full API5L specification for the chart of sizes and grades and required absorbed energy values.

Tolerances Outside Diameter, Out of roundness and wall thickness

Specified Outside Diameter D (in)	Diameter Tolerance, inches d				Out-of-Roundness Tolerance in	
	Pipe except the end a		Pipe end a,b,c		Pipe except the End a	Pipe End a,b,c
	SMLS Pipe	Welded Pipe	SMLS Pipe	Welded Pipe		
< 2.375	-0.031 to + 0.016		- 0.031 to + 0.016		0.048	0.036
≥ 2.375 to 6.625	+/- 0.0075D		- 0.016 to + 0.063		0.020D for $\frac{D}{t} \leq 75$ By agreement for $\frac{D}{t} > 75$	0.015D for $\frac{D}{t} \leq 75$ By agreement for $\frac{D}{t} > 75$
>6.625 to 24.000	+/- 0.0075D	+/- 0.0075D, but max of 0.125	+/- 0.005D, but max of 0.063		0.020D	0.015D
>24 to 56	+/- 0.01D	+/- 0.005D but max of 0.160	+/- 0.079	+/- 0.063	0.015D for but max of 0.060 For $\frac{D}{t} \leq 75$ By agreement for $\frac{D}{t} > 75$	0.01D for but max of 0.500 For $\frac{D}{t} \leq 75$ By agreement for $\frac{D}{t} > 75$
>56	As agreed					
a. The pipe end includes a length of 4 in at each of the pipe extremities b. For SMLS pipe the tolerance apply for $t \leq 0.984$ in and the tolerances for the thicker pipe shall be as agreed c. For expanded pipe with $D \geq 8.625$ in and for non-expanded pipe, the diameter tolerance and the out-of-roundness tolerance may be determined using the calculated inside diameter or measured inside diameter rather than the specified OD. d. For determining compliance to diameter tolerance, the pipe diameter is defined as the circumference of the pipe in any circumferential plane divide by Pi.						

Wall thickness t inches	Tolerances a inches
SMLS pipe b	
≤ 0.157	+ 0.024 / - 0.020
> 0.157 to < 0.948	+ 0.150t / - 0.125t
≥ 0.984	+ 0.146 or + 0.1t, whichever is the greater - 0.120 or - 0.1t, whichever is the greater

Welded pipe c,d	
≤ 0.197	± 0.020
> 0.197 to < 0.591	$\pm 0.1t$
≥ 0.591	± 0.060
<p>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.</p> <p>b. For pipe with $D \geq 14.000$ in and $t \geq 0.984$ in, the wall thickness tolerance locally may exceed the plus tolerance for wall thickness by an additional $0.05t$ provided that the plus tolerance for mass is not exceeded.</p> <p>c. The plus tolerance for wall thickness does not apply to the weld area</p> <p>d. See the full API5L spec for full details</p>	