

**CORRIGENDUM # 4****SUPPLY OF 172.5 KM STEEL LINEPIPE TO MEET PROJECTS REQUIREMENT
FOR STRETCHES OF GR.NOIDA & HAPUR AND BANDA GA EXPANSION****Tender No :IGL/ET2/CP/CP17510, Dated 24.05.2023**

VCS Ref. No. VCS/C&P/17028/PC/CS PIPE/10

Owner: Indraprastha Gas Ltd.

Consultant: VCS Quality Services Pvt. Ltd.

Date: 23.06.2023

Sl. No.	Tender Page No.	Clause/ Para/ Section	Description	Amendment/ Addition/ Modification/ Deletion	
COMMERCIAL					
1	8 of 106	IFB Clause No. 3.0	Brief Scope	Amendment	Refer Annexure - 1
2	SOR	-	Un-priced SOR Item No. C i.e. Steel Pipe With PE Coating - 16"	Amendment	Refer "UNPRICED SCHEDULE OF RATES (SOR), Revision - 1"
3	SOR	-	Priced SOR Item No. C i.e. Steel Pipe With PE Coating - 16"	Amendment	Refer "PRICED SCHEDULE OF RATES (SOR), Revision - 1"
TECHNICAL					
1	Material Requisition	Clause No. 5.0	Scope of Supply	Amendment	Refer Annexure - 2

Note: All other Term & Conditions of the Tender shall remain unchanged

Annexure – 1 to Corrigendum 4

3.0 BRIEF SCOPE

3.1 The scope of supply covers Design, Manufacturing, Inspection, Testing, Coating of 3LPE and Transportation CS Line Pipe to IGL Site/ store to be used in City Gas Distribution Project in Uttar Pradesh to meet projects requirement for stretches of Gr.Noida & Hapur and Banda GA expansion, by INDRAPRASTHA GAS LIMITED as per detail given below:

ITEM No.	SIZE (Inch)	THK. (mm)	MATERIAL (PSL-2)	EXTERNAL COATING	METHOD	QTY (meters)
A	8"	6.4	API 5L Gr. X-52	3LPE	HFW/SMLS	22,000
B	12"	6.4	API 5L Gr. X-60	3LPE	HFW/SMLS	9,000
C	16"	7.9	API 5L Gr. X-60	3LPE	HFW / SMLS / LSAW / HSAW	141,500

3.2 The above quantities are indicative and for evaluation purpose only. Purchaser reserves the right to increase or decrease at the time of award.

3.3 Bidder can quote any or all items. The bidder has to quote for full quantity of quoted item(s). Bid with part quantity shall be liable for rejection.

3.4 For detailed Scope of work and specifications, refer Technical volume II of II.



MATERIAL REQUISITION

17028-CGD-PL-MR-001

1.0 SCOPE OF SUPPLY

The scope of supply covers Design, Manufacturing, Inspection, Testing, coating of 3LPE and Transportation of Carbon Steel Line Pipes to IGL Site/ store to be used in City Gas Distribution Project in NCT of Delhi, Uttar Pradesh, Haryana and Rajasthan as per detail given below:

Item No.	SIZE (Inch)	THK. (mm)	MATERIAL (PSL-2)	EXTERNAL COATING	METHOD	QTY(mtrs)
A	8"	6.4	API 5L Gr. X-52	3LPE	HFW/SMLS	22,000
B	12"	6.4	API 5L Gr. X-60	3LPE	HFW/SMLS	9,000
C	16"	7.9	API 5L Gr. X-60	3LPE	HFW/SMLS/LSAW/ HSAW	141,500

The above quantities are indicative. Purchaser reserves the right to increase or decrease the quantity at the time of award.

Abbreviations

1. HFW- High Frequency Welding
2. SMLS- Seamless
3. LSAW- Longitudinally Submerged Arc Welding
4. HSAW- Helical Submerged Arc Welding



ENERGISING QUALITY

VCS QUALITY SERVICES PVT. LTD.
STANDARD SPECIFICATION
FOR
SUBMERGED ARC LONGITUDINAL WELDED (SAWL)
LINE PIPE (ONSHORE)

VCS – SS – PP – 2045

00	10.10.2022	AK	MC	HK	GW
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

UNCONTROLLED COPY	: If printed
CONTROLLED COPY	: If in soft and signed



REVISION RECORD						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	10.10.2022					Issued as Standard Specification
		AK	MC	HK	GW	



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1 SCOPE

1.1 Coverage

This specification establishes the minimum requirements for the manufacture of submerged arc longitudinal welded steel line pipe in accordance with the requirements of API Specification 5L, Forty-Sixth Edition, April 2018 and makes restrictive amendments to API Specification 5L. Unless modified and/or deleted by this specification, the requirements of API Specification 5L shall remain applicable.

The sections, paragraphs and annexes contained herein have the same numbering as that of API Specification 5L in order to facilitate reference. Additional requirements, which are not specified in API Specification 5L, have also been numbered and marked as "(New)".

The coverage by this specification is limited to line pipe to be used in onshore pipelines transporting non-sour hydrocarbons in liquid or gaseous phase. The product specification level for line pipe to be supplied as per this specification shall be "PSL2".

1.2 Application of the API Monogram

The Manufacturer shall have a valid license to use API Monogram and line pipes supplied as per this specification shall bear API monogram in accordance with the requirements of Annex A of API Specification 5L, Forty—Sixth Edition, April 2018 for Product Specification Level PSL 2.

1.3 (New) Pipe Size

This Specification shall be applied to line pipe of size 16" (406.4 mm) OD thru 48" (1219.0 mm) OD (both sizes included).

2 NORMATIVE REFERENCES

The latest edition (edition enforce at the time of issue of enquiry) of following additional references are included in this specification:

ASTM E112-13: Standard Test Methods for Determining Average Grain size

6. PIPE GRADES AND STEEL GRADES, AND DELIVERY CONDITION

6.1 Pipe Grades and Steel Grades

6.1.2 Line pipe supplied to this specification shall conform to Product Specification Level 2 (PSL2) as given in Table 1 of this specification 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 (M) that identifies the delivery condition as per Table 3 of this specification.

Table 1 of API Specification 5L stands replaced by Table 1 of this specification.

Table 1- Pipe Grade and Steel Grades, and Acceptable Delivery Conditions

PSL	Delivery Condition	Pipe grade/ steel grade ^{a, b}
PSL -2	Thermomechanical rolled	BM, X42M, X46M, X52M, X56M, X60M, X65M, X70M & X80M
<p>a Deleted</p> <p>b The suffix (M) for PSL 2 grades belongs to steel grade</p>		



6.2 Delivery Condition

6.2.2 The delivery condition for starting material shall be in accordance with Table 1 of this specification.

8 MANUFACTURING

8.1 Process of Manufacture

Pipe furnished to this specification shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 of API Specification 5L and Table 3 of this specification.

Table 3 of API Specification 5L stands replaced by Table 3 of this specification.

Table 3 - Acceptable Manufacturing Routes for PSL 2 Pipe

Type of Pipe	Starting Material	Pipe forming	Pipe heat treatment	Delivery condition
SAWL	Thermomechanical-rolled plate	Cold forming	—	M

8.3 Starting Material

8.3.2 Line pipe furnished to this specification shall be made from steel produced in basic oxygen or electric arc furnace. Steel shall be made by continuous casting only.

8.3.3 The steel used for manufacture of pipe shall be fully killed and fine grained with ASTM E 112 with following:

- ASTM grain size number 7 or finer for grades up to X70M
- ASTM grain size number 8 or finer for grade X80M

8.4 Tack Welds

8.4.3(New) Tack welds shall be made by a continuous process only. Any repair in tack welds shall be performed before start of Submerged Arc Welding (SAW) of seam.

8.6 Weld Seams in SAW Pipes

For the production of weld seams in SAW pipe, at least one submerged-arc welding pass shall be made on the inside of the pipe (ID welding) and at least one submerged-arc welding pass shall be made on the outside of the pipe (OD welding). Pipes shall be manufactured with one longitudinal seam only.

8.9 Cold Sizing and Cold Expansion

8.9.2 All pipes shall be mechanically cold expanded for full length. The sizing ratio for the pipe, s_r , measured on the circumference, shall not be less than 0.008 or more than 0.015.

8.9.3 The sizing ratio, S_r shall be calculated as per the following formula:

$$s_r = (D_a - D_b)/D_b$$

Where,

D_a is the actual outside diameter after sizing

D_b is the actual outside diameter before sizing

The actual outside diameter shall be measured with a tape measure (i.e. perimeter as an average of all possible diameters) at both ends and at the centre of the pipe.



8.11 Jointers

8.11.1 Jointers on pipes are not permitted.

9 ACCEPTANCE CRITERIA

9.2 Chemical Composition

9.2.2 For pipes supplied as per this specification, the chemical composition of each heat of steel on product analysis shall be as given in Table 5 of this specification.

Table 5 of API Specification 5L stands replaced by Table 5 of this specification.

Table 5 - Chemical Composition for Pipe

Element	Mass Fraction based upon Heat and Product Analyses (%)	
C ^b	0.16	max. (For Grade BM to X56M)
	0.12 ^f	max. (For Grade X60M to X80M)
Si	0.15 ^{m(new)}	min.
	0.45	max.
Mn ^b	1.20	max. (For Grade BM to X46M)
	1.40	max. (For Grade X52M & X56M)
	1.60	max. (For Grade X60M & X65M)
	1.70	max. (For Grade X70M)
	1.85	max. (For Grade X80M)
P	0.020	max.
S	0.015	max.
V	0.05	max. (For Grade BM to X46M)
	^d	max. (For Grade X52M to X80M)
Nb	0.05	max. (For Grade BM to X46M)
	^d	max. (For Grade X52M to X80M)
Ti	0.04	max. (For Grade BM to X46M)
	^d	max. (For Grade X52M to X80M)
Al ^{n(new)}	0.02 ^{o(new)}	min.
	0.07	max.
Cr	0.20	max.
Mo	0.10	max. (For Grade BM to X65M)
	0.20	max. (For Grade X70M)
	0.25	max. (For Grade X80M)
Cu	0.35	max.
Ni	0.20	max.
N ^{n(new)}	0.012	max.
B	0.0005	max.

a. Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Specification 5L, the CE_{Pcm} limits apply if $C \leq 0.12\%$ and CE_{IIW} limits apply if $C > 0.12\%$. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:

	<u>For Gr. BM to Gr. X70M</u>	<u>For Gr. X80M</u>
CE_{Pcm}	$\leq 0.20\%$	$\leq 0.23\%$
CE_{IIW}	$\leq 0.40\%$	--

Boron content shall be considered in CE_{Pcm} formula even if it is less than 0.0005%.

- b. Deleted
- c. Deleted
- d. $Nb + V + Ti = < 0.15\%$
- e. Deleted
- f. Deleted
- g. Deleted
- h. Deleted.
- i. Deleted
- j. Deleted
- k. Deleted
- l. Deleted

(New) m: Minimum for Si is not applicable for Al killed steel.

(New) n: Al/N shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel).

(New) o: Applicable for Al killed steel only.

9.2.3 For heat analysis and product analysis, all the elements listed in Table 5 of this specification shall be analyzed and reported, even if those are not purposely added but are present as residuals only.

If alloying elements other than those specified in Table 5 of this specification are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

9.3 Tensile Properties

9.3.2 The finished pipe (after cold expansion or sizing operation) shall conform to the requirements of Table 7 of API Specification 5L and as modified herein.

The actual yield strength shall be as close as possible to the specified minimum yield strength (SMYS) but in no case it shall exceed the limits specified here under:

<u>API Specification 5L Grade</u>	<u>Permissible in excess of SMYS, MPa (psi)</u>
Upto and including X46 M	131 (19,000)
X52M to X60M	125 (18,000)
X65M to X80M	120 (17,400)

The ratio of body yield strength and body tensile strength of each test pipe on which yield strength and tensile strength are determined, shall not exceed 0.90 when tested using flattened test specimen. The ratio between yield strength and tensile strength for weld metal of finished expanded pipe shall not exceed 0.90, when tested using cylindrical all weld specimen.

The tensile strength of the weld shall be equal to or higher than the specified minimum tensile strength of the base metal.



The minimum elongation of base metal shall be determined in accordance with the formula given in foot note (f) of Table 7 of API Specification 5L, however, minimum elongation in no case shall be less than 20%.

9.8 CVN Impact Test For PSL 2 Pipe

9.8.1 General

9.8.1.2 Individual test value for any test piece shall not be less than 80% of the required minimum average absorbed energy value as per this specification.

9.8.2 Pipe Body Tests

9.8.2.1 The average (set of three test pieces) absorbed energy value (KvT) for each pipe body test shall be as specified in Table G of this specification, based on full sized test pieces at a test temperature of 0°C(32°F) or at a lower test temperature as specified in the Purchase Order.

9.8.2.2 For pipe with $D \leq 508$ mm (20 inch), the minimum average (set of three test pieces) shear fracture area shall be at least 85 % with one minimum value of 75%, based at a test temperature of 0 °C (32 °F) or at a lower test temperature as specified in the Purchase Order.

Note: For pipe with $D \geq 508$ mm (20 inch), the shear fracture area on CVN specimen shall be estimated and reported for information only. For ensuring avoidance of brittle fracture propagation and control of ductile fracture propagation, DWT testing as per clause 9.9 of this specification shall be performed for pipe with $D \geq 508$ mm (20 inch), also see Table 18 of this specification.

9.8.3 Pipe Weld and HAZ Tests

The average (set of three test pieces) absorbed energy value (KvT) for each pipe weld and HAZ test shall be as specified in Table G of this specification, based on full-size test pieces at a test temperature of 0°C (32°F) or at a lower test temperature as specified in the Purchase Order.

9.9 DWT Test for PSL 2 Welded Pipe

9.9.1 For each test (set of two test pieces), the average shear fracture area shall be ≥ 85 % based on a test temperature of 0 °C (32 °F) or at a lower test temperature as specified in the Purchase Order.

9.10 Surface Conditions, Imperfections and Defects

9.10.1 General

9.10.1.2 All pipes shall be free from cracks, sweats, leaks and slivers. Pipe containing such defects shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.10.2 Undercuts

Undercut in the pipes shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L except it meets below specified limits:

- a) Undercuts that have a depth ≤ 0.4 mm and not encroaching upon minimum specified wall thickness are acceptable and shall be treated in accordance with clause C.1 of this specification.
- b) Undercut that have a depth > 0.4 mm but ≤ 0.8 mm and not encroaching upon the minimum specified wall thickness are acceptable and shall be treated in accordance with clause C.2 of API Specification 5L and as modified in this specification, provided that:
 - individual length is ≤ 0.5 t.
 - there are no more than two such undercuts in any 300 mm (12.0 in) length of weld

9.10.4 Laminations

Any lamination or inclusion either extending into the face or bevel of the pipe or present within 50 mm from pipe ends shall be classified as defect. Pipes that contain such defects shall be rejected or cut back until no lamination or inclusion is present at the pipe ends and shall be treated in accordance with clause C.3 b) or c) of API Spec 5L.

9.10.5 Geometric Deviations

9.10.5.1 For other than dents, geometric deviations from the normal cylindrical contour of the pipe, such as flat spots and peaks, that exceed 3.2 mm in depth at the pipe body and 1.6 mm at the pipe ends (upto 100 mm), measured as the gap between the extreme point of the deviation and the prolongation of the normal contour of the pipe, shall be considered as defects and shall be treated in accordance with C.3 b) or C.3 c) of API Specification 5L.

9.10.5.2 For dents, the length in any direction shall be $\leq 0.5 D$ and the depth, measured as the gap between the extreme point of the dent and the prolongation of the normal contour of the pipe, shall not exceed the following:

- a) 3.2 mm for cold-formed dents with sharp-bottom gouges and not encroaching upon the specified minimum wall thickness
- b) 6.4 mm for other dents
- c) 1 mm at the pipe ends, i.e. within a length of 100 mm at each of the pipe ends.
- d) Any dent on weld and heat affected zone (HAZ).

Dents that exceed the above specified limits shall be considered as defect and shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L. Acceptable cold-formed dents with sharp-bottom gouges shall be treated in accordance with clause C.2 of API Specification 5L & as modified in this specification.

9.10.6 Hard Spots

Any hard spot larger than 50 mm (2.0 in) in any direction and hardness greater than 248HV₁₀ for material grade upto Gr. X70M and 248HV₁₀ for Gr. X80M shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.10.7 Other Surface Imperfection

Other surface imperfections found by visual inspection or non-destructive inspection shall be investigated, classified and treated as follows:

- a) Imperfections that have a depth $< 0.05t$ and do not encroach on the minimum specified wall thickness shall be classified as acceptable imperfections and shall be treated in accordance with Clause C.1 of this specification.
- b) Imperfections that have a depth $> 0.05t$ and do not encroach on the minimum specified wall thickness shall be classified as defects, and shall be dressed-out by grinding in accordance with Clause C.2 of API Specification 5L and as modified in this specification or shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.
- c) Imperfections that encroach on the minimum specified wall thickness shall be classified as defects and treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.11 Dimensions, Mass and Tolerances

9.11.3 Tolerances for Diameter, Wall Thickness, Length and Straightness

9.11.3.1 The diameter and out-of-roundness shall be within the tolerances given in Table 10 of this specification.

Table 10 of API Specification 5L stands replaced by Table 10 of this specification.

Table 10 - Tolerances for Diameter and Out-of-roundness

Specified outside Diameter (D) mm (in)	Diameter tolerances ^d		Out-of-roundness Tolerance ^{e (new)}	
	Pipe Except the End ^a	Pipe End ^{a,c}	Pipe Except the End ^a	Pipe End ^{a,c}
D < 508 (20)	± 3.0 mm	± 1.6mm	0.020 D	0.005 D
508 (20) ≤ D ≤ 610 (24)	+ 3 mm -0.0025 D	± 1.6mm	0.020 D	0.005 D
610 (24) < D ≤ 914 (36)	+ 3 mm -0.0025 D	± 1.6mm	0.015 D	0.005 D
D > 914 (36)	± 3.0 mm	± 1.6mm	0.015 D but a maximum of 15 mm	5 mm

a. The pipe end includes a length of 100 mm at each of the pipe extremities.

b. Deleted

c. The diameter tolerance and out-of-roundness tolerance shall apply on inside diameter. The inside diameter, based on circumferential measurement, shall be calculated as ID = (D – 2t). Diameter measurements shall be taken at both ends of the pipe with a circumferential tape.

d. For determining compliance to the diameter tolerances, the pipe diameter is defined as the circumference of the pipe in any circumferential plane divided by Pi (π).

e. (New) Out-of-roundness tolerances apply to maximum and minimum diameters as measured with bar gage, caliper, or device measuring actual, maximum and minimum diameters.

9.11.3.2 In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 O' clock, 3 O' clock, 6 O' clock and 9 O' clock positions. The tolerances for wall thickness shall be as given in Table 11 of this specification.

Table 11 of API Specification 5L stands replaced by Table 11 of this specification.

Table 11- Tolerances for Wall Thickness

Wall Thickness (mm)	Tolerances ^{c, d} (mm)
5.0 mm < t < 15.0 mm	+0.20 t -0.0 t
t ≥ 15.0 mm	+3.0 mm -0.0 mm
a) Deleted b) Deleted c) The +ve tolerance for wall thickness does not apply to the weld area. d) See 9.13.2 of API Specification 5L and as modified herein for additional restrictions.	

9.11.3.3 All pipes shall be supplied with length between 11.5 m and 12.5 m. However pipe with length between 10.0 m and 11.5 m can also be accepted for a maximum of 5% of the ordered quantity. The minimum average length of the entire ordered quantity in any case shall be 12.0 m. Overall length tolerance shall be (-) Zero and (+) One pipe length to complete the ordered quantity. Table 12 of API Specification 5L stands deleted.

9.11.3.4 The tolerances for straightness shall be as follows:

- a) The total deviation from a straight line over the entire pipe length shall not exceed 12 mm, as shown in Figure 1 of API Specification 5L.
- b) The local deviation from straight line in 1.0 m (3.0 ft) portion at each pipe end shall be ≤ 3.0 mm (0.120 in), as shown in Figure 2 of API Specification 5L.

9.12 Finish of Pipe Ends

9.12.5 Plain Ends

9.12.5.6(New) During removal of inside burrs at the pipe ends, care shall be taken not to remove excess metal and not to form an inside cavity on bevel. Removal of excess metal beyond the minimum wall thickness as indicated in clause 9.11.3.2 of this specification shall be a cause for re-bevelling. In case root face of bevel is less than that specified, the pipe ends shall be re-bevelled and rectification by filing or grinding shall not be done.

9.12.5.7(New) Bevel Protectors

Both pipe ends of each pipe shall be provided with metallic or high impact plastic bevel protectors as per Manufacturer's standard. Bevel protectors shall be of a design such that they can be re-used by coating applicator for providing on externally anti-corrosion coated pipes subsequent to coating of line pipe.

9.13 Tolerances for the Weld Seam

9.13.2 Height of the Flash or Weld Bead/ Reinforcement

9.13.2.2 c) For a distance of at least 100 mm (4.0 in) from each pipe end, the inside weld bead shall be removed by grinding such that it does not extend above the adjacent pipe surface by more than 0.5 mm (0.020 in). For remainder of the pipe, the inside weld bead shall not extend above the adjacent pipe surface by more than 3.2 mm for all specified wall thicknesses. Table 16 of API Specification 5L stands modified accordingly.

d) The outside weld bead shall not extend above the adjacent pipe surface by more than

3.2 mm (1/8 in.) for all specified wall thicknesses. Table 16 of API Specification 5L stands modified accordingly.

e) For a distance of at least 150 mm (6.0 in) from each pipe end, the outside weld bead shall be removed by grinding such that it does not extend above the adjacent pipe surface by more than 0.5 mm (0.020 in).

9.13.3 Misalignment of the Weld Beads of SAW Pipes

Misalignment of weld seam exceeding 3.0 mm shall be treated in accordance with clause C.3 b) of C.3 c) of API Specification 5L. The misalignment shall be measured on radiographic film and calculated using the formula $(a + b) / 2$ where 'a' and 'b' are the relative offsets of the outside edges of the seam [see Figure 4 d) of this specification]. Checking of the weld seam misalignment shall also be carried out on metallographic examination specimen as per clause 10.2.5 of this specification.

9.15 Weldability of PSL 2 Pipe

9.15.1(New) Weldability tests are applicable only for pipes manufactured as per this specification with material grade X80M. Manufacturer shall carry out weldability tests to demonstrate that the pipe is suitable for field welding using established manual welding and/or mechanised (automatic) and/or semi-automatic welding processes, as applicable, and the properties of the field girth weld is equivalent/ superior to the properties of pipe longitudinal weld.

9.15.2(New) The acceptance criteria for the tests, indicated in clause 10.2.4.9 of this specification, shall be as per the requirements of this specification.

Manufacturer shall submit the test results to Company in compliance with the requirements of this specification prior to shipment/ dispatch of pipes.

10 INSPECTION

10.1 Types of Inspection and Inspection Documents

10.1.3 Inspection documents for PSL 2 Pipes

10.1.3.1 Inspection certificate 3.2 in accordance with EN 10204 shall be issued for each dispatched pipe by Purchaser's authorized representative.

10.2 Specific Inspection

10.2.1 Inspection Frequency

10.2.1.2 For PSL 2 pipe, the inspection frequency shall be as given in Table 18 of this specification.

Table 18 of API Specification 5L stands replaced by Table 18 of this specification.

Table 18 - Inspection Frequency of Pipe

Sl. no.	Type of Inspection	Frequency of Inspection
1	Heat analysis ^a	One analysis per heat of steel
2	Product analysis ^b	Two pipes per lot (maximum 100 pipes) per heat
3	Tensile testing of the pipe body	Once per test unit of not more than 100 pipes per heat
4	Tensile testing of the longitudinal weld seam of pipe ^c	Once per test unit of not more than 100 pipes per heat
5	Tensile testing of all weld test specimen	Once; during manufacturing procedure qualification tests (MPQT) and whenever batch of electrode or wire & flux combination is changed (see Annex B)
6	CVN impact testing of the body pipe body	Once per test unit of not more than 50 pipes
7	CVN impact testing of the longitudinal seam weld and HAZ of pipe	Once per test unit of not more than 50 pipes
8	DWT testing of the pipe body of pipe with $D \geq 508$ mm (20.000 in)	Once per test unit of not more than 50 pipes
9	Guided-bend testing of the longitudinal seam weld of pipe	Once per test unit of not more than 50 pipes
10	Hardness testing	Any hard spot exceeding 50 mm (2.0 in) in any direction
11	Macrographic & metallographic testing (including Vicker's hardness test) of the longitudinal seam weld of pipe as defined in clause 10.2.5 of this specification	At least one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs max.) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered and at the beginning of the production of each combination of specified outside diameter and specified wall thickness
12	Hydrostatic testing	Each pipe
13	Wall thickness measurement ^d	Each pipe
14	Cold expansion sizing ratio	Once per test unit of not more than 50 pipes (measurement shall be recorded)
15	Visual inspection	Each pipe
16	Weighing of pipe	Each pipe shall be measured and



		recorded
17	Pipe diameter and out-of-roundness ^d	Each pipe
18	Length	Each pipe shall be measured and recorded
19	Straightness ^d	Each pipe
20	Non-destructive inspection	In accordance with Annex E of API Specification 5L and as modified herein
21	Geometric deviation ^d	Each pipe
22	Radial offset of strip edges ^d	Each pipe ^e
23	Height of the flash or weld bead/reinforcement ^d	Each pipe ^f
24	Misalignment of the weld beads of SAW ^d	Each pipe (including specimen for macro graphic examination)
25	Other dimensional testing	Random testing, with the details left to the discretion of the manufacturer
<p>a. Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of pipe production.</p> <p>b. Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented.</p> <p>c. Pipe produced by each welding machine shall be tested.</p> <p>d. Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum).</p> <p>e. Measurements shall be taken at two locations (at a distance of one to two diameters from each end) on each pipe joint.</p> <p>f. Measurement shall be performed by welding gauge and/or by using template having cut out for weld bead.</p> <p>g. "Test unit" is as defined in clause 3.1.60 of API Specification 5L.</p>		

10.2.2 Samples and Test Pieces for Product Analysis

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806. Samples used for product analysis shall be taken from finished pipes only. Samples for product analysis from plate may be used provided the traceability of samples is guaranteed.

10.2.3 Samples and Test Pieces for Mechanical Tests

10.2.3.1 General

In addition to API Specification 5L requirements, samples and test pieces for various types of tests shall be taken from Figure 5 b) and Figure 6 a) of API Specification 5L and Figure 10.2.5.3.1 & 10.2.5.3.2 of this specification, whichever is applicable, and as given in Table 20 of this specification.

Table 20 of API Specification 5L stands replaced by Table 20 of this specification.

Table 20 – Number, Orientation and Location of Test Pieces per Sample for Mechanical Test for PSL2 Pipe

Sample Location	Type of Test	Number, Orientation and Location of Test Pieces per Sample ^a	
		Specified Outside Diameter, D mm (inch)	
		< 508 mm (20.000)	≥508 mm (20.000)
Pipe body	Tensile	1T180	1T180
	CVN	3T90	3T90
	DWT	---	2T90
Seam Weld	Tensile	1W ^b	1W ^b
	CVN	3W and 3HAZ	3W and 3HAZ
	Guided - bend	2W ^c	2W ^c
<p>a. See figure 5 (b) of API Specification 5L for an explanation of the symbols used to designate orientation and location of samples and test pieces.</p> <p>b. Test specimen shall be tested for ultimate tensile strength only.</p> <p>c. One face and one root guided bend weld test shall be conducted on the samples prepared from the finished pipe.</p>			

10.2.3.2 Test Pieces for the Tensile Test

Rectangular test pieces, representing the full wall thickness of the pipe, shall be taken in accordance with ASTM A370 and as shown in Figure 5 c) of API Specification 5L.

Transverse tensile test for pipe body with shall be carried out on flattened rectangular test specimens only.

For tensile test of longitudinal seam weld, both inside and outside weld beads shall be ground flushed and local imperfections shall be removed from the test piece.

For all weld tensile test during MPQT, round cross-section test piece shall be prepared in accordance with ASTM A370. As an alternate, all weld tensile test shall be carried out as per ASME Section II, Part—C and test piece shall have gauge length, $L = 5d$, where, 'L' is the gauge length (mm) and 'd' is the diameter (mm) of the test piece.

10.2.3.3 Test Pieces for the CVN Impact Test

In addition to the API Specification 5L requirements, the test pieces shall be prepared in accordance with ASTM A370. Non-flattened test pieces shall be used. The axis of the notch shall be perpendicular to the pipe surface.

For pipe weld and HAZ tests, each test piece shall be etched prior to notching in order to enable proper placement of the notch.

CVN impact-test combinations of specified outside diameter and specified wall thickness not covered by Table 22 of API Specification 5L shall also be tested.

10.2.3.4 Test Pieces for the DWT Test

Drop weight tear test shall be carried out in accordance with API RP 5L3. Full thickness test pieces shall be used.

The test piece shall be taken transverse to the rolling direction or pipe axis, with the notch perpendicular to the surface.

10.2.3.8 Test Pieces for Macrographic and Metallographic Tests

(New) Test piece for metallographic testing shall be taken transverse to the longitudinal weld. The test piece extraction shall be as per Fig. 10.2.5.3.1 of this specification. The test piece shall be suitably ground, polished and etched to reveal the macro-structure.

10.2.3.9 Test Pieces for Weldability of PSL2 Pipe (for steel Gr. X-80 only)

(New) Weldability tests shall be carried out as per clause 10.2.4.9 (New) of this specification using pipes from heat with highest carbon equivalent among the first three heats for each pipe size and each wall thickness specified in the purchase order. If Manufacturer proposes more than one mill for manufacturing the pipes, then weldability tests shall be carried out for each mill.

10.2.4 Test Methods

10.2.4.3 CVN Impact Test

The Charpy test shall be carried out in accordance with ASTM A370.

10.2.4.4 DWT Test

The drop-weight tear test shall be carried out in accordance with API RP 5L3. The testing temperature reduction given in API RP 5L3 shall apply.

10.2.4.6 Guided-bend Test

The guided-bend test shall be carried out in accordance with ASTM A370.

The mandrel dimension, A_{gb} , shall not exceed 4.0 times the thickness of the specimen.

Both test pieces shall be bent 180° in a jig as shown in Figure 9 of API Specification 5L. One test piece shall have the root of the weld directly in contact with the mandrel; the other test piece shall have the face of the weld directly in contact with the mandrel.

10.2.4.9 Weldability of PSL2 Pipe (for steel Gr. X-80 only)

(New) Procedure for field weldability test shall be prepared by the Manufacturer and submitted to Company for approval in accordance with API RP 1104 and welding chart enclosed with the Purchase Order. Weldability testing shall commence only after approval of the welding procedure by the Company.

In addition to the testing requirements of API RP 1104 for validating the quality of the girth weld, following tests shall also be carried out as per the requirements of this specification:

- Tensile test of girth weld.
- CVN impact testing of the girth weld and HAZ of pipe
- Guided-bend testing for girth weld
- Macrographic & metallographic testing (including Vicker's hardness test) of the girth weld of pipe as defined in clause 10.2.5 of this specification.

10.2.5 Macrographic and Metallographic Tests

10.2.5.3 Metallographic tests shall be performed on pipes supplied as per this specification. The test piece shall be visually examined using a minimum 10X magnification to provide evidence that proper fusion has been obtained for the full thickness, and there is proper interpretation of passes, their alignment and texture of weld zone. In case imperfections or defects are observed, it will become a cause for re-evaluation of welding parameters as deemed necessary by Purchaser's Representative.

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3.2 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248HV₁₀ for material grade upto Gr. X70M and 270HV₁₀ for Gr. X80M. Modalities of retest shall be in accordance with clause 10.2.12.7 of API Specification 5L.

10.2.6 Hydrostatic test

10.2.6.1 Test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipes.

10.2.6.2 In addition to the requirements of API Specification 5L, following shall also be applicable:

The pressure gauge used for hydrostatic testing shall have a minimum range of 1.5 times and maximum range of 4 times the test pressure. The test-pressure measuring device shall be calibrated by means of a dead-weight tester only. The test configuration shall permit bleeding of trapped air prior to pressurisation of the pipe.

10.2.6.5 The test pressure for all sizes and grades of pipe shall be such that hoop stress (fibre stress) generated is at least 95% of SMYS, computed based on the Equation (6) indicated in clause 10.2.6.5 of API Specification 5L. Table 26 of API Specification 5L stands deleted.

10.2.7 Visual Inspection

10.2.7.1 Each pipe shall be visually examined for entire external surface and internal surface to the extent feasible and shall be free of defects in finished condition. Visual examination shall be carried out in a sufficiently illuminated area; minimum 1000 1x. If required additional lights shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

10.2.8 Dimensional Testing

10.2.8.1 Diameter measurements shall be made with a circumferential tape only.

10.2.10 Non-destructive Inspection

Non-destructive inspection shall be performed in accordance with Annex E of API Specification 5L and as modified herein.

10.2.11 Reprocessing

This clause of API Specification 5L stands cancelled.

10.2.12 Retesting

10.2.12.1 Recheck Analyses

Modalities of recheck analysis shall be as per API Specification 5L as applicable to the lot being tested (see Table 18 of this specification). However, during individual testing, each pipe shall be fully analysed to meet the requirements of Table 5 of this specification.

10.2.12.9(New) Weldability of PSL2 Pipe Retests (for steel Gr. X-80 only)

If any test, as per clause 10.2.4.9 (New) of this specification, fails to meet the acceptance criteria, Manufacturer shall revise the welding procedure adopted and carry out all tests again to meet the specification requirement.

11 MARKING

11.1 General

11.1.1 Pipe manufactured in accordance with this specification shall be marked by the manufacturer as per the requirements of API Specification 5L and as modified herein. Marking shall be in English language and International System (SI) of Units.

11.1.5 (New) Marking shall also include Purchase Order number, item number, pipe number and heat number.

11.2 Pipe Markings

11.2.1 (New) k) Actual length in metres and actual pipe weight in kilogram shall be marked.

11.2.3 (New) c) Paint used for stencil marking shall withstand a temperature up to 250°C expected to be experienced during further external anti-corrosion coating operations of line pipe by coating applicator.

11.2.4 The pipe number shall be placed by cold rolling or low stress dot marking or vibro-etching on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of non-availability of either cold rolling or low stress dot marking facility in pipe mill, an alternative marking scheme of a permanent nature may be proposed by the Manufacturer.

11.2.8 A colour code band shall be marked on inside surface of finished pipe for identification of pipes of same diameter but different wall thickness, as indicated in the Purchase Order. The colour code band shall be 50 mm wide and shall be marked at a distance of 150 mm from the pipe ends.

12 COATINGS AND THREAD PROTECTORS

12.1.1 Unless otherwise specified in the Purchase Order, the pipes shall be delivered bare, free of any trace of oil, stain, grease and paint. Varnish coating shall be applied on the marking area. Bevels shall be free of any coating.

13 RETENTION OF RECORDS

In addition to the records indicated in API Specification 5L, the Manufacturer shall retain the records of all additional tests and calibration records mentioned in this specification including the hard copy records of ultrasonic testing carried out on pipe/plate as well as pipe ends.

15 PRODUCTION REPORT

(New) The Manufacturer shall provide one electronic copy and six hard copies of production report in English language indicating at least the following for each pipe. International system of units (SI) shall be adopted.

- Pipe number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade

The Manufacturer shall provide one electronic copy and six hard copies of acceptance certificates which shall include the results of all tests required as per this specification and performed on delivered material giving details of, but not limited to, the following:



- All test certificates as per clause 10.1.3 of API Specification 5L and as modified herein.
- Records of qualification of welders and procedures for repair welding.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- All other reports and results required as per this specification.

The certificates shall be valid only when signed by the Purchaser's Representative. Only those pipes, which have been certified by the Purchaser's Representative, shall be dispatched from the pipe mill.

In the event of small quantities of pipes supplied against this specification, the production report may consist of only test certificates required as per clause 10.1.3 of API Specification 5L and as modified herein and other test reports/results required as per this specification.

16 INSPECTION OF FIELD TESTS & WARRANTY

(New) Purchaser shall be reimbursed by Manufacturer for any pipe furnished on this order that fails under field hydrostatic test if such failure is caused by a material/ manufacturing defect in the pipe. The reimbursement cost shall include pipe, labour and equipment rental for finding, excavating, cutting out and installation of replaced pipe in position. The field hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 95% of specified minimum yield strength.

In case Manufacturer so desires, he will be advised at least two weeks in advance so that his Representative may witness the hydrostatic test in field, however, the testing and leak (if any) finding and repair operation shall not be postponed because of absence of the Manufacturer's Representative.

Annex B

Manufacturing Procedure Qualification for PSL 2 Pipe

B.1 INTRODUCTION

B.1.1 This annex specifies additional provisions that apply for the PSL 2 pipes ordered as per this specification.

B.1.2 Two lengths each of completely finished pipes from two different heats (i.e. a total of four pipe lengths) shall be selected at random for testing as per clause B.5.1 of this specification to verify that the manufacturing procedure results in the quality of pipes which are in complete compliance with this specification. The pipes thus tested shall be considered to be the test pipes required per heat or per lot as per relevant clauses of this specification.

These manufacturing procedure qualification tests (MPQT) shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser's Representative. The manufacturing procedure qualification tests shall be carried out on pipes for each wall thickness, each diameter and each grade of steel.

B.1.3 Verification of the manufacturing procedure shall be by qualification in accordance with clause B.3, B.4 and B.5 of API Specification 5L and as modified herein.

Note: In the event of small quantities of pipes (i.e. less than 50 numbers) ordered against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the manufacturing procedure qualification test as per clause B.5.1 of this specification shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION

Before pipe production commences, Manufacturing Procedure Specification (MPS) for manufacturing of pipes and Statistical process control charts shall be prepared by pipe manufacturer (including all information as per clause B.3 a), b) and e) of API Specification 5L) and submitted for approval of the Purchaser.

B.5 MANUFACTURING PROCEDURE QUALIFICATION TESTS (MPQT)

B.5.1 For the qualification of the manufacturing procedure, all tests & inspections specified in Table 18 and clause B.5.2 of this specification shall be conducted on all the pipes selected for testing as per clause B.1.2 of this specification.

B.5.2 The Manufacturer shall submit to Purchaser a report giving the results of all tests mentioned below. The report shall be agreed and signed by Purchaser's Representative, prior to start of regular production.

The various tests to be conducted on each pipe shall be as follows. The test method and acceptance values shall be as per this specification unless specified differently in this Annex.

a. Visual Examination

All pipes shall be examined visually for dimensional tolerances and apparent surface defects.

b. Ultrasonic Examination

The weld seam of all pipes shall be examined ultrasonically by automatic ultrasonic equipment. All ultrasonic indications suggesting imperfections in the weld shall be carefully investigated against the corresponding points on the radiographs. If the ultrasonic

indication cannot be fully explained from the radiograph, a cross section of the weld, at the location of the above-mentioned ultrasonic indication shall be made in such a way that the nature of the imperfection can definitely be established.

c. **Radiographic Examination**

The weld seam of all pipes shall be examined radiographically for the entire length.

d. **Mechanical Properties**

The mechanical properties of all pipes shall be tested and shall meet the requirements of this specification. Purchaser's Representative will select the places in pipe from where the test pieces shall be extracted.

The following tests shall be conducted:

i. Guided bend test

Four (4) weld guided bend test pieces transverse to the longitudinal weld shall be extracted. Out of the four (4) test pieces, two (2) test pieces shall be used for the face bend test and two (2) test pieces for the root bend test.

ii. Tensile test

Tensile tests shall be conducted on:

- Two (2) transverse test pieces from base metal.
- Two (2) transverse weld material test pieces from longitudinal weld.
- Two (2) cylindrical all—weld test pieces from longitudinal weld.

Cylindrical all weld tensile test shall be carried out to determine the yield strength, tensile strength and elongation during MPQT and whenever there is change in the batch of electrode or wire & flux combination.

The results of the test shall meet the minimum requirements of the plate with regard to yield strength and tensile strength.

The minimum elongation shall be determined in accordance with the formula given in foot note (f) of Table 7 of API Specification 5L; however, minimum elongation in no case shall be less than 20%.

iii. Metallographic tests

Six (6) weld cross-section test pieces, three (3) from each end of pipe weld seam shall be taken for metallographic examination. Two (2) of these shall be tested for hardness at room temperature after etching, one from each pipe.

iv. CVN impact testing

CVN impact test shall be performed on test pieces extracted as follows:

- Five (5) sets of three (3) transverse specimen each from base metal
- One (1) set of three (3) transverse specimen with weld in middle
- One (1) set of three (3) transverse specimen with HAZ in middle

The minimum average (set of three test pieces) absorbed energy value (KvT) at the test temperature specified in clause 9.8 and Table G of this specification shall be complied with for test pieces extracted from Base Metal, Weld Metal and HAZ.

v. Fracture toughness testing

For pipe with specified outside diameter, $D < 508.0$ mm (20.0 inch):



Five (5) sets of CVN Base Metal test pieces shall be tested at -40°C , -20°C , -10°C , 0°C and $+20^{\circ}\text{C}$ for shear area and absorbed energy to produce full transition curve. The minimum average (set of three test pieces) shear fracture area at the test temperature specified in clause 9.8 of this specification shall be complied with. For other temperatures, the value shall be for information only.

For pipe with specified outside diameter, $D \geq 508.0 \text{ mm}$ (20.0 inch):

Five (5) sets of DWTT test pieces shall be extracted from base metal in a transverse direction at points selected by Purchaser. Each set shall consist of two (2) test pieces taken from same test coupon. The sets of Base Metal test pieces shall be tested at -40°C , -20°C , -10°C , 0°C and $+20^{\circ}\text{C}$ for shear area to produce full transition curve. The value at the test temperature specified in clause 9.9 of this specification shall be complied with. For other temperatures, the value shall be for information only.

Annex C

Treatment of Surface Imperfections and Defects

C.1 TREATMENT OF SURFACE IMPERFECTIONS

Surface imperfection not classified as defect shall be cosmetically dressed-out by grinding.

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

C.2.3 Complete removal of defects shall be verified by local visual inspection and by suitable non-destructive inspection. To be acceptable, the wall thickness in the ground area shall be in accordance with clause 9.11.3.2 of this specification.

C.4 REPAIR OF DEFECTS BY WELDING

C.4.2 In addition to the API Specification 5L, following requirements shall also be complied with for repair welding:

- a. No repair of weld seam is permissible after cold expansion.
- b. No repair of weld seam is permissible at pipe ends up to a length of 300 mm.
- c. Through thickness repair of weld seam is not permitted.
- d. No repair of a repaired weld is permitted.
- e. Repair welding shall be executed only after specific approval by Purchaser Representative for each repair.

C.4.3 The cumulative length of weld seam repairs on one pipe shall be $\leq 5\%$ of the total weld length.

C.4.6 After weld repair, the total repaired area shall be radiographically inspected in accordance with clause E.4 of API Specification 5L and as modified in this specification.

C.4.9 The defective part of the weld shall be clearly marked on the pipe so that the defect can be easily located and repaired. Approval for each repair shall be taken from inspection authority before proceeding further.

C.4.11 The Manufacturer shall also maintain a record of repairs carried out. The records shall include repair number, pipe identification number, welding procedure applicable and NDT details.

Annex D

Repair Welding Procedure

D.2 REPAIR WELDING PROCEDURE QUALIFICATION

C.2 Mechanical Testing

D.2.3.2 Transverse Tensile Test

D.2.3.2.1 In addition to the API Specification 5L requirements, the test piece edge shall be machine cut. Oxygen cut is not allowed.

D.2.3.3 Transverse Guided Bend Test

The radius of curvature of the Jig used for guided bend tests shall be $r_a = 2.25 t$.

D.2.3.4 Charpy (CVN) Impact Test

D.2.3.4.2 The CVN impact test shall be carried out in accordance with the requirements of clause 9.8 and clause 10.2.4.3 of this specification.

D.2.3.4.4 The minimum average absorbed energy (set of three test pieces) for each repaired pipe weld and its associated HAZ, based on full size test pieces at a test temperature of 0°C (32°F), or at a lower temperature as specified in Purchase Order, shall not be less than that specified in clause 9.8.3 of this specification for pipe seam weld metal and HAZ.

D.2.3.5 Hardness Testing

Hardness test as specified in clause 10.2.5.3 of this specification shall be included in the procedure qualification. The location of the hardness measurements is to be indicated taking into account the new HAZ of the repaired area.

Annex E

Non-destructive Inspection for Pipe

The Purchaser reserves the right to depute its Representative(s) to perform inspection and witness tests in all phases of manufacturing and testing starting from steel-making to finished line pipe ready for shipment. Manufacturer shall comply with the provisions regarding inspection notice, plant access, compliance and rejection mentioned in the Annex Q (New) of this specification. The Manufacturer shall give the Purchaser reasonable notice of the starting date of normal production and the work schedule. Any action or omission on part of Purchaser's Representative shall not relieve the Manufacturer of his responsibility and obligation to supply material in strict accordance with this specification.

E.1 QUALIFICATION OF PERSONNEL

E.1.1 All personnel performing NDT activities shall be qualified in the technique applied, in accordance with latest edition of ISO 9712, ISO 11484 or ASNT No. ASNT-TC-1A or equivalent.

All NDT shall be performed in accordance with written procedures. These procedures shall have prior approval of the Purchaser.

Inspector Qualification

Acceptable qualification for NDT inspectors shall be as specified below:

(i) For UT

For UT, at least one Level III qualified inspector shall be available to the mill for overall supervision. Level III inspectors shall be ASNT Level III or ACCP Professional Level III and certified in applicable method.

A level II inspector is required for shift supervision, manual weld inspection and calibration of all systems (both manual and automated).

(ii) For all other NDT methods

Evaluation of indications: Level II & Level III inspector

E.3 METHODS OF INSPECTION

E.3.1 General

E.3.1.1 The weld seams of the pipe shall be inspected by ultrasonic methods (Refer Table E.1 of API Specification 5L) for full length (100%) for the entire thickness, using automatic ultrasonic equipment in accordance with clause E.5 of API Specification 5L and as modified in this specification.

E.3.1.3 Location of NDT equipment in the manufacturer's facility shall be such that final inspection of weld seam of cold expanded pipe shall be performed after cold expansion and hydrostatic testing.

E.3.2 Pipe End Inspection - Welded Pipe

E.3.2.1 Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment, or, such non-inspected pipe end shall be cut-off. Records in accordance with E.5.4 of API Specification 5L shall be maintained.

E.3.2.2 The weld at each end for a minimum distance of 200 mm (8.0 inch) shall be inspected by the radiographic method. The results of such radiographic inspection shall be recorded.

- E.3.2.3 Ultrasonic inspection in accordance with the method described in ISO 10893-8 shall be used to verify that the 50 mm (2.0 in) wide zone at each pipe end is free of any laminar imperfections in the circumferential direction.

In addition, full circumference of both ends of each pipe shall be 100 % ultrasonically tested over a circumferential width of at least 50 mm with angular probes to detect cracks. In case of non-availability of angular probes at the mill, the full circumference of both ends of each pipe shall be inspected with magnetic particle technique over a circumferential width of at least 50 mm to detect surface cracks.

- E.3.2.4(New) Bevel face of each pipe end shall be magnetic particle inspected for the detection of laminar imperfections in accordance with ISO 10893-5.

E.4 RADIOGRAPHIC INSPECTION OF WELD SEAMS

E.4.2 Radiographic Inspection Equipment

- E.4.2.2 The radiographic films used shall be in accordance with ISO 11699-1, class C4 or C5 or ASTM E 94, class 1 or 2 of Table 2, and shall be used with lead screens.

- E.4.2.3 The density of the radiograph shall be greater than 2.0 (excluding weld seam) and shall be chosen such that:

- a) The density through the thickest portion of the weld seam is not less than 1.8.
- b) The maximum contrast for the type of film used is achieved.
- c) Sensitivity of at least 1.8 % of the nominal wall thickness.

E.4.3 IQIs

- E.4.3.1 The reference standard shall be ISO wire—type IQI as per clause E.4.3.2 of API Specification 5L.

E.4.5 Acceptance Limits for Imperfections Found by Radiographic Inspection

In addition to the requirement of API Specification 5L, slag-inclusion-type and/or gas-pocket-type imperfections in the weld, upto 200 mm length from each pipe end, are not acceptable and shall be treated as per clause E.4.6 of this specification i.e. 200 mm length from each pipe end shall be defect free zone.

E.4.6 Defects Found by Radiographic Inspection

Defects in the weld such as cracks, lack of complete penetration and lack of complete fusion, in the pipe material shall be removed by cutting off the section of pipe containing these defects. The remaining defect—free section of the pipe will be acceptable provided its length is within the specified minimum length and the weld at the new pipe end contains no such defects.

E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION

E.5.1 Equipment

- E.5.1.2 In addition to the API Specification 5L requirements, all automatic ultrasonic equipment shall have an alarm device, which continuously monitors the effectiveness of the coupling. The equipment for the automatic inspection shall allow the localization of both longitudinal and transverse defects corresponding to the signals exceeding the acceptance limits of the reference standard. The equipment shall be fitted with a paint spray or automatic marking device and alarm device for areas giving unacceptable ultrasonic indications and probe de-coupling. All ultrasonic testing equipment shall be provided with recording device. In addition, an automatic weld tracking system shall be provided for correct positioning of the probes with respect to weld centre.

E.5.2 Ultrasonic and Electromagnetic Inspection Reference Standards



E.5.2.1 The reference standard (calibration pipe) shall have the same specified diameter and wall thickness as specified for the production pipe being inspected.

E.5.2.2 Reference standards shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in normal production.

The reference standard (calibration pipe) shall also be of the same material, type and have the same surface finish as the pipe being inspected.

E.5.2.3 Reference Standards for Ultrasonic Testing

E.5.2.3.1 Reference Standards for Pipe weld UT:

(New) Reference standard shall contain as reference indicators i.e. machined notches or radially drilled holes as given in Table E.7 of this specification

Table E.7 of API Specification 5L stands replaced by Table E.7 of this specification.

Table E.7 — Reference Indicators

Item	Reference Indicators ^a			
	Number of Notches and Orientation		Notch Type ^b	Dia of Radially Drilled Hole mm(in)
	OD	ID		
Weld Seam Edge	2L	2L	N5	d
Weld Seam Centre	1L, 1T	1L, 1T	N5	1.6(0.063) ^e
<p>a. The symbol indicates the orientation of the notch i.e. L = Longitudinal and T = Transverse. Reference indicators shall be located as per Figure E.1 of this specification.</p> <p>b. Dimensions of Notch type N5 shall be 0.05t x 50 mm x 1 mm (Depth x maximum Length x maximum width), where, 't' is the specified wall thickness. The depth tolerance is ± 15% of the specified notch depth or ± 0.05 mm, whichever is greater.</p> <p>c. Through thickness hole shall be drilled in the centre of the weld seam.</p> <p>d. Not required.</p>				

E.5.2.3.2 Reference Standards for Plate UT

(New) Reference standard for the ultrasonic inspection of plate (except the plate edges/pipe ends) shall contain continuous machined notch of following dimension:

a) width, w : 8 mm, with a tolerance +0.8/ - 0.0 mm

b) depth, d : 0.25 t < d < 0.5 t, where 't' is the specified wall thickness

Reference standard for the ultrasonic inspection of plate edges/ pipe ends shall have 6.4 mm (1/4 inch) diameter FBH of a depth 0.5 t, where 't' is the specified wall thickness.

E.5.3 Instrument Standardization



E.5.3.2 The instrument shall be calibrated with appropriate reference standard (refer E.5.2 of API Specification 5L and as modified herein) at following intervals:

- Once at the beginning of each operating shift (12 hours maximum).
- Once in between of each operating shift i.e. 3 hrs to 4 hrs after the first
- Every time there is change in probes or working condition of the UT machine.
- Every time the running of the system gives rise to doubts on its efficiency.

If during the above calibration verification, it is found that the equipment has not functioned satisfactorily in the opinion of the Purchaser's Representative, all the pipes or plate already inspected after the previous verification shall be inspected again at Manufacturer's cost.

E.5.5 **Acceptance Limits**

E.5.5.2 For ultrasonic inspection of pipe/plate, any imperfection that produces an imperfection greater than the acceptable limits shall be treated as following:

a) For pipe weld seam inspection

Locations showing indications above the allowable limits during automatic ultrasonic inspection shall be re-examined by manual ultrasonic method. If no defects are located during re-examination by manual UT, the original findings may be ignored. In case of ultrasonic indications during manual UT, then it shall be further inspected by radiography.

If during production, repeated ultrasonic indications occur requiring re—inspection by radiography and it appears from radiographs that the nature of defects causing the ultrasonic indications cannot be definitely established, the Manufacturer shall prove by making some cross-sections in accordance with clause 10.2.5.3 of this specification at locations where such indications occur near the end of the pipe to the satisfaction of Purchaser that it is not injurious defects as stipulated in this specification.

b) For plate inspection

Locations showing indications above the acceptance limits may be re-examined by manual ultrasonic method. If no defects are located during re-examination, the original findings may be ignored. Additional scanning may be requested by Purchaser's Representative to check questionable areas.

E.5.6 **Disposition of Defects Found by Ultrasonic and Electromagnetic Inspection**

Disposition of any imperfection in pipe/plate that produces an indication greater than the acceptable limits as specified in Table E.9 (New) of this specification shall be classified as defect and shall be given disposition as specified in (c) or (d) of E.10 of API Specification 5L.

E.7 **RESIDUAL MAGNETISM**

E.7.2 The longitudinal magnetic field shall be measured on all sizes of pipes. Measurement on pipe in stack shall not be considered valid. Such measurements shall be taken on the root face or square cut face of finished plain-end pipes.

E.7.3 Measurements shall be made using Hall - effect gaussmeter only.

E.7.4 Measurements shall be made on each end of a pipe for 5% of the pipes produced but at least once per 4 hr per operating shift (12 hrs maximum).

E.7.6 Four readings shall be taken approximately 90° apart around the circumference of each end of the pipe. The average of the four readings shall not exceed 2.0 mT (20 gauss) and

no single reading shall exceed 2.5 mT (25 gauss). All residual magnetism measurements shall be recorded.

E.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY OF EW, SAW AND COW PIPE

E.8.1 The plate, except the longitudinal edges, shall be ultrasonically tested for laminations using an oscillating or straight running pattern of probes in accordance with ISO 10893-9 amended as follows:

- The distance between adjacent scanning tracks shall be sufficiently small to ensure detection of minimum allowed imperfection size. The minimum coverage during automatic ultrasonic inspection shall be $\geq 20\%$ of the plate surface uniformly spread over the area.
- Acceptance limit for laminar imperfection in the plate, except the longitudinal edges, shall be as per Table E.9 (New) of this specification. Disposition of defects shall be as per clause E.5.6 of this specification.

Table 3 of ISO 10893-9 stands replaced by Table E.9 (New) of this specification.

E.9 LAMIMAR IMPERFECTIONS ALONG THE STRIP/ PLATE EDGES OR PIPE WELD SEAM OF EW, SAW AND COW PIPE

The longitudinal edges of the plate shall be 100% ultrasonically inspected in accordance with ISO 10893-9 amended as follows:

- UT shall be performed over 25 mm wide zone along each side of the trimmed plate edges.
- Acceptance limit for laminar imperfection in the longitudinal edges of the plate shall be as per Table E.9 (New) of this specification. Disposition of defects shall be as per clause E.5.6 of this specification.

Table 2 of ISO 10893-9 stands replaced by Table E.9 (New) of this specification.

Table E.9 - Acceptance Criteria for Laminar Imperfection in Plates (New)

Location	Maximum Individual Imperfection		Minimum Imperfection Size Considered			Maximum Population Density ^a
	Area mm ²	Length ^b mm	Area mm ²	Length ^b mm	Width ^c mm	
Plate edges excluding	1000	100 ^d	300	35	8	10 [per 1.0 m x 1.0m)
Longitudinal edges of the plate	500	40	----	20	--	4 [per 1.0 m x 1.0m)
<p>a. Number of imperfections of size smaller than the maximum imperfection size and greater than the minimum imperfection size.</p> <p>b. Length is the dimension at right angles to the scan track.</p> <p>c. Width is the dimension parallel to the scan track.</p> <p>d. Any planar imperfection which is not parallel to the plate surface is not acceptable.</p> <p>e. For an imperfection to be larger than the minimum imperfection size, the minimum area, minimum length and minimum width given for the plate, all have to be exceeded.</p>						

E.10 DISPOSITION OF PIPES CONTAINING DEFECTS

- a) The repaired area shall be 100% rechecked by magnetic particle or ultrasonic inspection to ensure complete removal of defects. However for repair of cosmetic type of defects, MPI may not be conducted if so directed by Purchaser's Representative on case to case basis. The pipes having a thickness less than the minimum allowed in accordance with this specification, after repair by grinding shall be treated for disposition in accordance with (c) or (d) of clause E.10 of API Specification 5L.

Annex G

PSL 2 Pipe with Resistance to Ductile Fracture Propagation

G.1 INTRODUCTION

G.1.1 This annex specifies additional provision that apply for pipes ordered as per this specification.

G.2 ADDITIONAL INFORMATION TO BE SUPPLIED BY THE PURCHASER

G.2.1 CVN minimum average absorbed energy value (based on full-sized test pieces) for each test as per G.3.2 of API Spec 5L shall be as per table G of this specification for BM, weld and HAZ.

Table G.1, G.2 & G.3 of API specification 5L stands replaced by Table G of this specification.

Table G – Minimum CVN absorbed energy requirements

Specified outside diameter, D ^c Mm (inch)	Full-size CVN average absorbed energy, minimum KvT ^{a,b} [J]							
	Pipe Grade							
	B to X 42	> X42 to X46	> X46 to X52	> X52 to X56	> X56 to X60	> X60 to X65	> X65 to X70	> X70 to X80
457.0(18)	40	40	40	40	40	45	50	80
508.0(20)	40	40	40	40	42	47	53	80
610.0(24)	40	40	40	41	46	51	58	80
711.0(28)	40	40	40	45	49	56	62	80
813.0(32)	40	40	42	48	53	59	66	80
914.0(36)	40	40	45	51	56	63	70	83
1016.0(40)	40	40	47	54	59	66	74	90
1118.0(44)	40	42	50	56	62	70	78	96
1219.0(48)	40	44	52	59	64	73	81	102

a. The required KvL (longitudinal direction specimens) values shall be 50% higher than the required KvT values for BM, weld and HAZ.

b. Testing shall be performed at a test temperature of 0°C (32°F) or at a lower temperature as specified in the Purchase Order.

c. For intermediate specified outside diameter and pipe with D < 457.0 mm (18 inch), CVN average absorbed energy value (KvT) shall be same value as given in the Table for next higher specified outside diameter.

Annex Q (New)

Purchaser Inspection

Q.1 INSPECTION NOTICE

Advance notice shall be given by the manufacturer prior to the start of production to the purchaser to inspect/witness the manufacturing activities including tests.

Q.2 PLANT ACCESS

The inspector representing the purchaser shall have unrestricted access, at all times while work of the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the pipe is being manufactured in accordance with this specification. All inspections should be made at the place of manufacture prior to shipment, unless otherwise specified on the purchase order, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Q.3 COMPLIANCE

The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser may make any investigation necessary to be satisfied of compliance by the manufacturer and may reject any material that does not comply with this specification.

Q.4 REJECTION

If the Purchaser Representative rejects pipes repeatedly for any recurring cause, this shall be adequate reason to refuse final inspection of subsequent pipes until the cause has been investigated and corrective action taken by the Manufacturer.

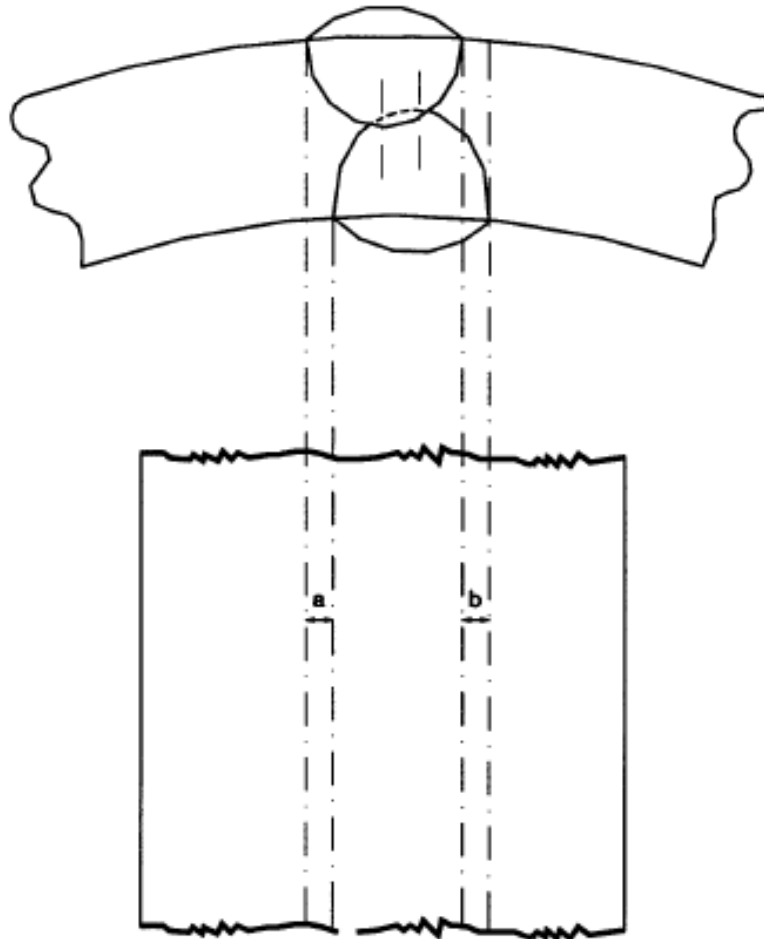


FIGURE: 4 d)

X-RAY FILM

**PROCEDURE FOR MEASUREMENT OF
OUT OF LINE WELD BEAD**

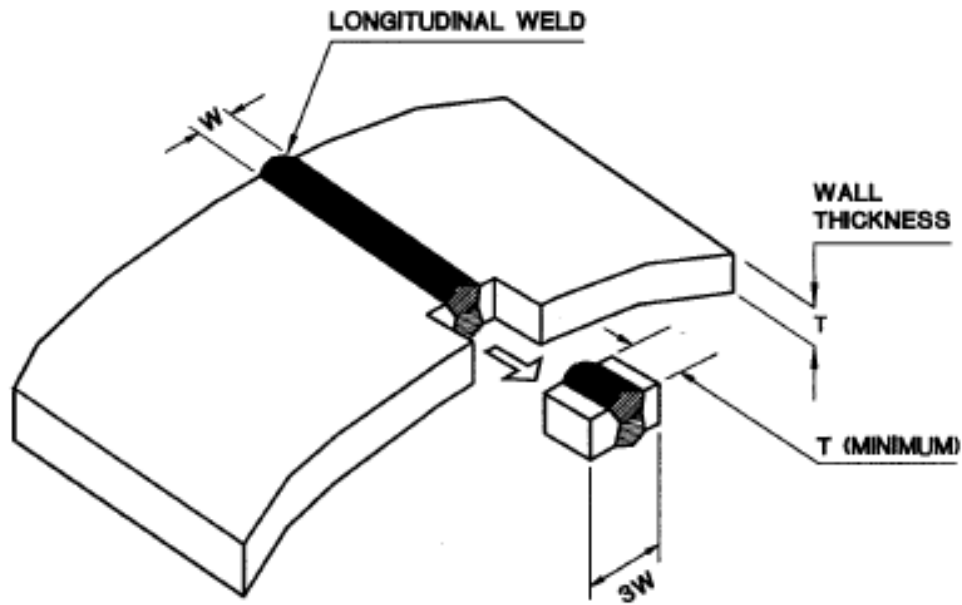
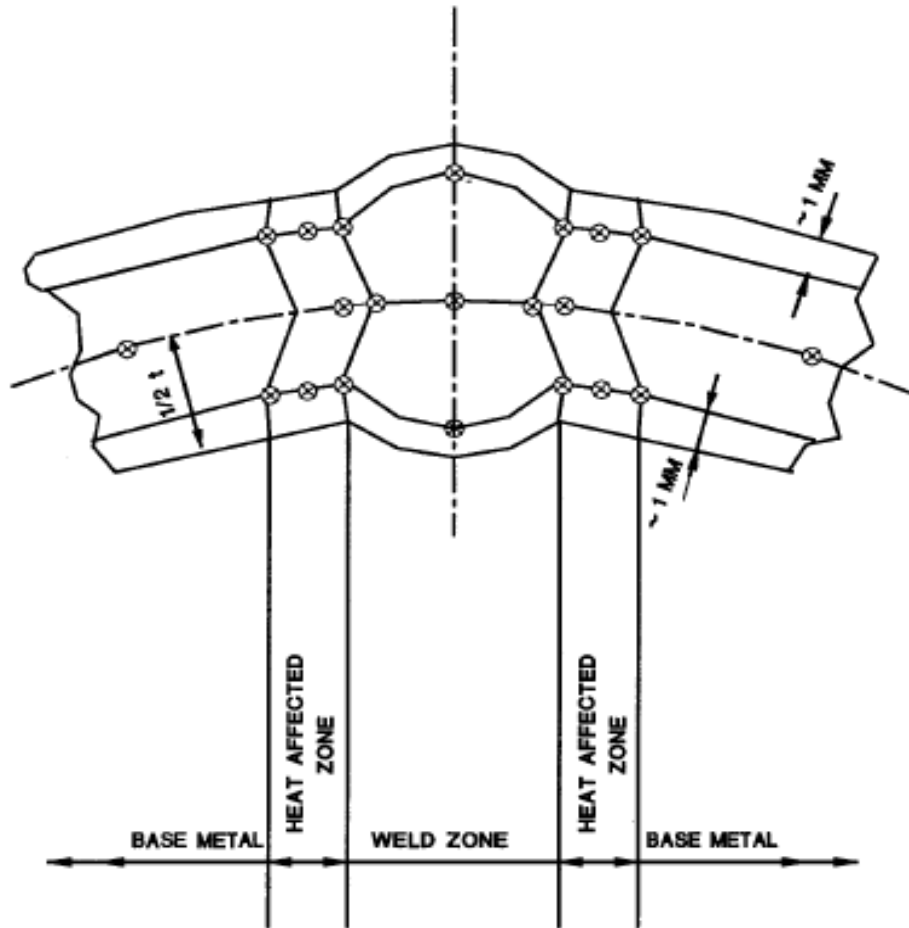


FIGURE: 10.2.5.3.1

METALLOGRAPHIC SPECIMEN EXTRACTION PLAN



⊗ - LOCATIONS WHERE HARDNESS MEASUREMENT TO BE CARRIED OUT

FIGURE: 10.2.5.3.2

LOCATIONS FOR HARDNESS MEASUREMENT

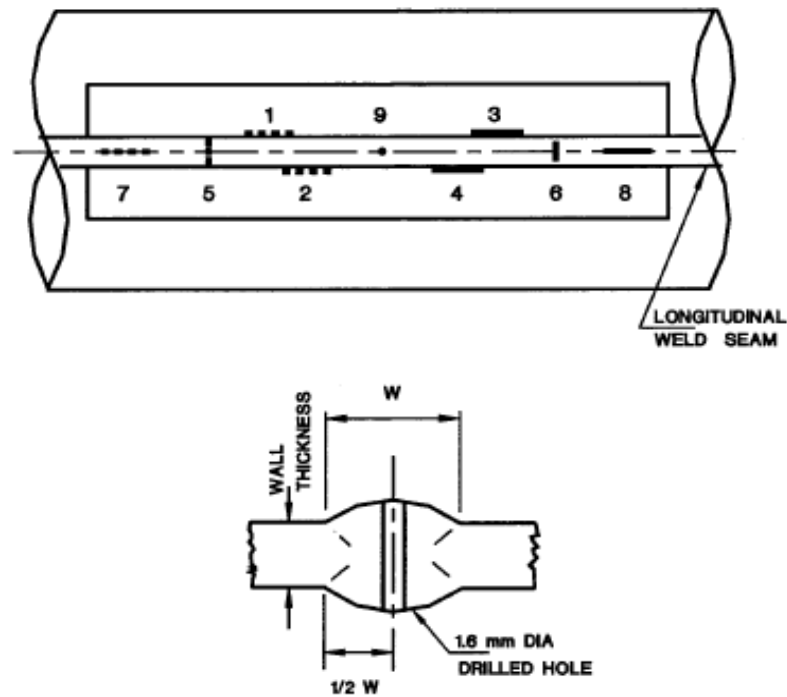


FIGURE: E.1

REFERENCE STANDARD FOR UT OF LONGITUDINAL WELD SEAM

- | | | |
|------|---|--|
| 1, 2 | - | Longitudinal inside notch at the weld seam edge |
| 3, 4 | - | Longitudinal outside notch at the weld seam edge |
| 5 | - | Transverse inside notch across the weld seam |
| 6 | - | Transverse outside notch across the weld seam |
| 7 | - | Longitudinal inside notch at weld seam centre |
| 8 | - | Longitudinal outside notch at weld seam centre |
| 9 | - | 1.6 mm dia. through thickness hole. |



ENERGISING QUALITY

VCS QUALITY SERVICES PVT. LTD.
STANDARD SPECIFICATION FOR
SUBMERGED ARC HELICAL WELDED
(SAWH) LINE PIPE (ONSHORE)

DOC NO: VCS-SS-PP-2056

01	15.06.2023	HT	AK	SKN	GW
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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Abbreviations

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
BM	Base Metal
CE	Carbon Equivalent
CVN	Charpy V-Notch
FBH	Flat Bottomed Holes
HAZ	Heat Affected Zone
ID	Inside Diameter
KvL	Charpy value in pipe longitudinal direction
KvT	Charpy value in pipe transversal direction
MPQT	Manufacturing Procedure Qualification Tests
MPS	Manufacturing Procedure Specification
NDT	Non Destructive Testing
ODID	Outside Diameter, Specified
SAWH	Submerged Arc Helical Welded
SMAW	Shielded Metal Arc Welding
<i>t</i>	Wall Thickness, Specified
UT	Ultrasonic testing



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1. SCOPE

1.1 COVERAGE

This specification establishes the minimum requirements for the manufacture of submerged arc helical welded steel line pipe in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty-Sixth Edition, April 2018 and makes restrictive amendments to API Specification 5L. Unless modified and/or deleted by this specification, the requirements of API Specification 5L shall remain applicable.

The sections, paragraphs and annexes contained herein have the same numbering as that of API Specification 5L in order to facilitate reference. Additional requirements, which are not specified in API Specification 5L, have also been numbered and marked as "(New)".

The coverage by this specification is limited to line pipe to be used in onshore pipelines transporting non-sour hydrocarbons in liquid or gaseous phase. The product specification level for line pipe to be supplied as per this specification shall be "PSL2".

1.2 APPLICATION OF THE API MONOGRAM

The Manufacturer shall have a valid license to use API Monogram and line pipes supplied as per this specification shall bear API monogram in accordance with the requirements of Annex A of API Specification 5L, Forty-Sixth Edition, April 2018 for Product Specification Level PSL 2.

1.3 PIPE SIZE

This Specification shall be applied to line pipe of size 18" (457.0 mm) OD thru 48" (1219.0 mm) OD (both sizes included).

2. NORMATIVE REFERENCES

The latest edition (edition enforce at the time of issue of enquiry) of following additional references are included in this specification:

ASTM E112-12: Standard Test Methods for Determining Average Grain size

6. PIPE GRADES AND STEEL GRADES, AND DELIVERY CONDITION

6.1 PIPE GRADES AND STEEL GRADES

6.1.2. Line pipe supplied to this specification shall conform to Product Specification Level 2 (PSL 2) as given in Table 1 of this specification 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 (M) that identifies the delivery condition as per Table 3 of this specification.

Table 1 of API Specification 5L stands replaced by Table I of this specification.

Table 1 - Pipe Grade and Steel Grades, and Acceptable Delivery Conditions

PSL	Delivery Condition	Pipe grade/ steel grade a,b
PSL2	Thermo mechanical rolled	BM, X42M, X46M, X52M, X56M, X60M, X65M, X70M & X80M
a	Deleted	
b	The suffix (M) for PSL 2 grades belongs to steel grade	

6.2 DELIVERY CONDITION

6.2.2. The delivery condition for starting material shall be in accordance with Table 1 of this specification.

8. MANUFACTURING

8.1 PROCESS OF MANUFACTURE

Pipe furnished to this specification shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 of API Specification 5L and Table 3 of this specification.

Table 3 of API Specification 5L stands replaced by Table 3 of this specification.

Table 3 -Acceptable Manufacturing Routes for PSL 2 Pipe

Type of pipe	Starting Material	Pipe forming	Pipe heat treatment	Delivery condition
SAWH	Thermomechanical-rolled coil	Cold forming	—	M

8.3. STARTING MATERIAL

8.3.2 Line pipe furnished to this specification shall be made from steel produced in basic oxygen or electric arc furnace. Steel shall be made by continuous casting only.

8.3.3 The steel used for manufacture of pipe shall be fully killed and fine grained as per ASTM E112 with following:

- ASTM grain size number 7 or finer for grades up to X70M
- ASTM grain size number 8 or finer for grade X80M

8.4 TACK WELDS

8.4.3 (New) Tack welds shall be made by a continuous process only. Any repair in tack welds shall be performed before start of Submerged Arc Welding (SAW) of seam.

8.6 Weld Seams in SAW Pipe

For the production of weld seams in SAW pipe, at least one submerged-arc welding pass shall be made on the inside of the pipe (ID welding) and at least one submerged-arc welding pass shall be made on the outside of the pipe (OD welding).

The welding equipment shall have an automatic weld seam tracking system capable of ensuring accurate positioning of welding heads for both ID-OD welding and the welding edges of the coil, during all stages of welding process including tack-welding.

Continuous data logger shall be used at all welding stations. For each welding station, current versus voltage graphs shall be submitted for both ID-OD welding in each shift.

8.9 Cold Sizing and Cold Expansion

8.9.1 Pipes furnished to this specification shall be non-expanded.

8.10 Coil/ Plate End Welds

8.10.2 Junctions of coil end welds and helical seam welds shall not be permitted in finished pipe.

8.11 Jointers

8.11.1 Jointers on pipes are not permitted.

9 ACCEPTANCE CRITERIA

9.2 Chemical Composition

9.2.2 For pipes supplied as per this specification, the chemical composition of each heat of steel on product analysis shall be as given in Table 5 of this specification.

Table 5 of API Specification 5L stands replaced by Table 5 of this specification.

Table 5 – Chemical Composition for Pipe

Element	Mass fraction based upon heat and product analyses(%)	
C ^b	0.16	max. (For Grade BM to X56M)
	0.12f	max. (For Grade X60M to X80M)
Si	0.15 _{m(New)}	min.
	0.45	max.
Mn ^b	1.20	max. (For Grade BM to X46M)
	1.40	max. (For Grade X52M & X56M)
	1.60	max. (For Grade X60M & X65M)
	1.70	max. (For Grade X70M)
	1.85	max. (For Grade X80M)
P	0.020	max.
S	0.015	max.
V	0.05	max. (For Grade BM to X46M)
	^d	(For Grade X52M to X80M)
Nb	0.05	max. (For Grade BM to X46M)
	^d	(For Grade X52M to X80M)
Ti	0.04	max. (For Grade B to X46M)
	^d	(For Grade X52M to X80M)
Al _{n(New)}	0.02 _{o(New)}	min.
	0.07	max.
Cr	0.20	max.
Mo	0.10	max. (For Grade BM to X65M)
	0.20	max. (For Grade X70M)
	0.25	max. (For Grade X80M)
Cu	0.35	max.
Ni	0.20	max.
N _{n(New)}	0.012	max.
B	0.0005	max.

Table 5 – Chemical Composition for Pipe

a	Based on product analysis as per clause 9.2.4 and 9.2.5 of API Specification 5L, the CE_{Pcm} limits apply if $C \leq 0.12\%$ and CE_{IIW} limits apply if $C > 0.12\%$. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:									
	<table border="0"> <tr> <td></td> <td style="text-align: center;"><u>For Gr. BM to Gr. X70M</u></td> <td style="text-align: center;"><u>For Gr. X80M</u></td> </tr> <tr> <td style="text-align: center;">CE_{Pcm}</td> <td style="text-align: center;">$\leq 50.20\%$</td> <td style="text-align: center;">$\leq 50.23\%$</td> </tr> <tr> <td style="text-align: center;">CE_{IIW}</td> <td style="text-align: center;">$\leq 50.40\%$</td> <td></td> </tr> </table>		<u>For Gr. BM to Gr. X70M</u>	<u>For Gr. X80M</u>	CE_{Pcm}	$\leq 50.20\%$	$\leq 50.23\%$	CE_{IIW}	$\leq 50.40\%$	
	<u>For Gr. BM to Gr. X70M</u>	<u>For Gr. X80M</u>								
CE_{Pcm}	$\leq 50.20\%$	$\leq 50.23\%$								
CE_{IIW}	$\leq 50.40\%$									
	Boron content shall be considered in CE_{Pcm} formula even if it is less than 0.0005%.									
b	Deleted									
c	Deleted									
d	$Nb+V+Ti \leq 0.15\%$									
e	Deleted									
f	Deleted									
g	Deleted									
h	Deleted.									
i	Deleted									
j	Deleted									
k	Deleted									
l	Deleted									
(New) m	Minimum for Si is not applicable for AI killed steel.									
(New) n	Al/N shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel).									
(New) o	Applicable for AI killed steel only.									

9.2.3 For heat analysis and product analysis, all the elements listed in Table 5 of this specification shall be analyzed and reported, even if those are not purposely added but are present as residuals only.

If alloying elements other than those specified in Table 5 of this specification are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

9.3 Tensile Properties

9.3.2 The finished pipe shall conform to the requirements of Table 7 of API Specification 5L and as modified herein.

The actual yield strength shall be as close as possible to the specified minimum yield strength (SMYS) but in no case it shall exceed the limits specified here under:

<u>API Specification 5L Grade</u>	<u>Permissible in excess of SMYS, MPa (psi)</u>
Upto and including X46M	131 (19,000)
X52MtoX60M	125 (18,000)
X65MtoX80M	120 (17,400)

The ratio of body yield strength and body tensile strength of each test pipe on which yield strength and tensile strength are determined, shall not exceed 0.90 when tested using flattened test specimen. The ratio between yield strength and tensile strength for weld metal of finished pipe shall not exceed 0.90, when tested using cylindrical all weld specimen.

The tensile strength of the weld shall be equal to or higher than the specified minimum tensile strength of the base metal.

The minimum elongation of base metal shall be determined in accordance with the formula given in foot note (f) of Table 7 of API Specification 5L, however, minimum elongation in no case shall be less than 20%.

9.8 CVN Impact Test for PSL 2 Pipe

9.8.1 General

9.8.1.2 Individual test value for any test piece shall not be less than 80% of the required minimum average absorbed energy value as per this specification.

9.8.2 Pipe Body Tests

9.8.2.1 The average (set of three test pieces) absorbed energy value (Kv7) for each pipe body test shall be as specified in Table G of this specification, based on full sized test pieces at a test temperature of 0°C (32°F) or at a lower test temperature as specified in the Purchase Order.

9.8.2.2 For pipe with $D < 508$ mm (20 inch), the minimum average (set of three test pieces) shear fracture area shall be at least 85% with one minimum value of 75%, based at a test temperature of 0°C (32 °F) or at a lower test temperature as specified in the Purchase Order.

Note: For pipe with $D \geq 508$ mm (20 inch), the shear fracture area on CVN specimen shall be estimated and reported for information only. For ensuring avoidance of brittle fracture propagation and control of ductile fracture propagation, DWT testing as per clause 9.9 of this specification shall be performed for pipe with $D \geq 508$ mm (20 inch), also see Table 18 of this specification.

9.8.3 Pipe Weld and HAZ Tests

The average (set of three test pieces) absorbed energy value (Kv7) for each pipe weld and HAZ test shall be as specified in Table G of this specification, based on full-size test pieces at a test temperature of 0 °C (32°F) or at a lower test temperature as specified in the Purchase Order.

9.9 DWT Test for PSL 2 Welded Pipe

9.9.1 For each test (set of two test pieces), the average shear fracture area shall be $\geq 85\%$ based on a test temperature of 0°C (32 °F) or at a lower test temperature as specified in the Purchase Order.

9.10 Surface Conditions, Imperfections and Defects

9.10.1 General

9.10.1.2 All pipes shall be free from cracks, sweats, leaks and slivers. Pipe containing such defects shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.10.2 Undercuts

Undercut in the pipes shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L except it meets below specified limits:

- a) Undercuts that have a depth ≤ 0.4 mm and not encroaching upon minimum specified wall thickness are acceptable and shall be treated in accordance with clause C.1 of this specification.
- b) Undercut that have a depth > 0.4 mm but ≤ 0.8 mm and not encroaching upon the minimum specified wall thickness are acceptable and shall be treated in accordance with clause C.2 of API Specification 5L and as modified in this specification, provided that:
 - Individual length is $0.5 t$.
 - There are no more than two such undercuts in any 300 mm (12.0 in) length of weld.

9.10.4 **Laminations**

Any lamination or inclusion either extending into the face or bevel of the pipe or present within 50 mm from pipe ends shall be classified as defect. Pipes that contain such defects shall be rejected or cut back until no lamination or inclusion is present at the pipe ends and shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.10.5 **Geometric Deviations**

9.10.5.1 For other than dents, geometric deviations from the normal cylindrical contour of the pipe, such as flat spots and peaks, that exceed 3.2 mm in depth at the pipe body and 1.6 mm at the pipe ends (up to 100 mm), measured as the gap between the extreme point of the deviation and the prolongation of the normal contour of the pipe, shall be considered as defects and shall be treated in accordance with C.3 b) or C.3 c) of API Specification 5L.

9.10.5.2 For dents, the length in any direction shall be $\leq 0.5 D$ and the depth, measured as the gap between the extreme point of the dent and the prolongation of the normal contour of the pipe, shall not exceed the following:

- a) 3.2 mm for cold-formed dents with sharp-bottom gouges and not encroaching upon the specified minimum wall thickness.
- b) 6.4 mm for other dents.
- c) 1 mm at the pipe ends, i.e. within a length of 100 mm at each of the pipe ends.
- d) Any dent on weld and heat affected zone (HAZ).

Dents that exceed the above specified limits shall be considered as defect and shall be treated in accordance with C.3 b) or C.3 c) of API Specification 5L. Acceptable cold-formed dents with sharp-bottom gouges shall be treated in accordance with clause C.2 of API Specification 5L & as modified in this specification.

9.10.6 **Hard Spots**

Any hard spot larger than 50 mm (2.0 in) in any direction and hardness greater than 248HV₁₀ for material grade up to Gr. X70M and 270HV₁₀ for Gr. X80M shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L.

9.10.7 **Other Surface Imperfection**

Other surface imperfections found by visual inspection or non-destructive inspection shall be investigated, classified and treated as follows:

- a) Imperfections that have a depth $\leq 0.05t$ and do not encroach on the minimum specified wall thickness shall be classified as acceptable imperfections and shall be treated in accordance with Clause C.1 of this specification.
- b) Imperfections that have a depth $> 0.05t$ and do not encroach on the minimum specified wall thickness shall be classified as defects, and shall be dressed-out by grinding in accordance with Clause C.2 of API Specification 5L and as modified in this specification or shall be treated in accordance with Clause C.3 b) or C.3 c) of API Specification 5L.
- c) Imperfections that encroach on the minimum specified wall thickness shall be classified as defects and treated in accordance with Clause C.3 of API Specification 5L.

9.11 **Dimensions, Mass and Tolerances**

9.11.3 **Tolerances for Diameter, Wall Thickness, Length and Straightness**

9.11.3.1 The diameter and out-of-roundness shall be within the tolerances given in Table 10 of this specification.

Table 10 of API Specification 5L stands replaced by Table 10 of this specification.

Table 10-Tolerances for Diameter and Out-of-roundness

Specified Outside Diameter (D) mm (in)	Diameter Tolerances ^d		Out-of-roundness Tolerance ^{e(new)}	
	Pipe Except the End ^a	Pipe End ^{a,c}	Pipe Except the End ^a	Pipe End ^{a,c}
$D < 508 (20)$	$\pm 3.0\text{mm}$	$\pm 1.6 \text{ mm}$	$0.020D$	$0.005 D$
$508 (20) \leq D \leq 610(24)$	$+3\text{mm}, - 0.0025 D$	$\pm 1.6\text{mm}$	$0.020D$	$0.005 D$
$610(24) < D \leq 914 (36)$	$+3\text{mm}, -0.0025 D$	$\pm 1.6 \text{ mm}$	$0.015 D$	$0.005 D$
$D > 914 (36)$	$\pm 3.0\text{mm}$	$\pm 1.6\text{mm}$	$0.015 D$ but a maximum of 15mm	5mm

a The pipe end includes a length of 100 mm at each of the pipe extremities.
b Deleted
c The diameter tolerance and out-of-roundness tolerance shall apply on inside diameter. The inside diameter, based on circumferential measurement, shall be calculated as $ID = (D - 2t)$. Diameter measurements shall be taken at both ends of the pipe with a circumferential tape.
d For determining compliance to the diameter tolerances, the pipe diameter is defined as the circumference of the pipe in any circumferential plane divided by Pi (π).
e (New) Out-of-roundness tolerances apply to maximum and minimum diameters as measured with bar gage, caliper, or device measuring actual, maximum and minimum diameters.

9.11.3.2 In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 O' clock, 3 O' clock, 6 O' clock and 9 O' clock positions. The tolerances for wall thickness shall be as given in Table 11 of this specification.

Table 11 of API Specification 5L stands replaced by Table 11 of this specification.

Table 11-Tolerances for Wall Thickness

Wall thickness (mm)	Tolerances ^{c,d} (mm)
$5.0\text{mm} < t < 15.0\text{mm}$	$+ 0.20 t$ $- 0.0 t$
$t \geq 15.0 \text{ mm}$	$+3.0\text{mm}$ $- 0.0\text{mm}$

a Deleted
b Deleted
c The + ve tolerance for wall thickness does not apply to the weld area.
d See 9.13.2 of API Specification 5L and as modified herein for additional restrictions.

9.11.3.3 All pipes shall be supplied with length between 11.5 m and 12.5 m. However pipe with length between 10.0 m and 11.5 m can also be accepted for a maximum of 5% of the ordered quantity. The minimum average length of the entire ordered quantity in any case shall be 12.0 m. Overall length tolerance shall be (-) Zero and (+) One pipe length to complete the ordered quantity. Table 12 of API Specification 5L stands deleted.

9.11.3.4 The tolerances for straightness shall be as follows:

- a) The total deviation from a straight line over the entire pipe length shall not exceed 12 mm, as shown in Figure 1 of API Specification 5L.
- b) The local deviation from straight line in 1.0 m (3.0 ft) portion at each pipe end shall be::; 3.0 mm (0.120 in), as shown in Figure 2 of API Specification 5L.

9.12 **Finish of Pipe Ends**

9.12.5 **Plain Ends**

9.12.5.6 (New) During removal of inside burrs at the pipe ends, care shall be taken not to remove excess metal and not to form an inside cavity on bevel. Removal of excess metal beyond the minimum wall thickness as indicated in clause 9.11.3.2 of this specification shall be a cause for re-bevelling. In case root face of bevel is less than that specified, the pipe ends shall be re-bevelled and rectification by filing or grinding shall not be done.

9.12.5.7 (New) **Bevel Protectors**

Both pipe ends of each pipe shall be provided with metallic or high impact plastic bevel protectors as per Manufacturer's standard. Bevel protectors shall be of a design such that they can be re-used by coating applicator for providing on externally anti-corrosion coated pipes subsequent to coating of line pipe.

9.13 **Tolerances for the Weld Seam**

9.13.1 **Radial Offset of Strip/ Plate Edges**

Forming and welding operations shall be conducted to minimize coil edge offset and distortion and peaking at the helical or spiral seams. The manufacturer shall provide the appropriate tooling with 'Vee' blocks and calibrated dial indicators needed to measure the distortion and misalignment at the seam. In case of unacceptable offsets, the manufacturer shall adjust the forming and welding equipment.

The radial offset of the strip edges, as per figure 4 b) of API Specification 5L, shall not exceed the applicable value specified in Table 14 of API Specification 5L.

9.13.2 **Height of the Flash or Weld Bead/Reinforcement**

- 9.13.2.2 c) For a distance of at least 100 mm (4.0 in) from each pipe end, the inside weld bead shall be removed by grinding such that it does not extend above the adjacent pipe surface by more than 0.5 mm (0.020 in). For the remainder of the pipe, the inside weld bead shall not extend above the adjacent pipe surface by more than 3.2 mm (1/8 in.) for all specified wall thicknesses. Table 16 of API Specification 5L stands modified accordingly.
- d) The outside weld bead shall not extend above the adjacent pipe surface by more than 3.2 mm (1/8 in.) for all specified wall thicknesses. Table 16 of API Specification 5L stands modified accordingly.

- e) For a distance of at least 150 mm (6.0 in) from each pipe end, the outside weld bead shall be removed by grinding such that it does not extend above the adjacent pipe surface by more than 0.5 mm (0.020 in).

9.13.3 Misalignment of the weld beads of SAW pipes

Misalignment of weld seam exceeding 3.0 mm shall be treated in accordance with clause C.3 b) or C.3 c) of API Specification 5L. The misalignment shall be measured on radiographic film and calculated using the formula $(a + b)/ 2$ where 'a' and 'b' are the relative offsets of the outside edges of the seam [see Figure 4 d) of this specification]. Checking of the weld seam misalignment shall also be carried out on metallographic examination specimen as per clause 10.2.5 of this specification.

9.15 Weldability of PSL 2 Pipe

9.15.1 (New) Weldability tests are applicable only for pipes manufactured as per this specification with material grade X80M. Manufacturer shall carry out weldability tests to demonstrate that the pipe is suitable for field welding using established manual welding and/or mechanised (automatic) and/or semi-automatic welding processes, as applicable, and the properties of the field girth weld is equivalent/ superior to the properties of pipe longitudinal weld.

9.15.2 (New) The acceptance criteria for the tests, indicated in clause 10.2.4.9 of this specification, shall be as per the requirements of this specification.

Manufacturer shall submit the test results to Company in compliance with the requirements of this specification prior to shipment/ dispatch of pipes.

9.16 Residual Stress Test
(New)

All pipes shall meet the testing and minimum acceptance criteria for Residual Stress Test. The residual stress test shall be carried out on the pipe after hydrostatic test. The computed residual stress shall not exceed 10% of the specified minimum yield strength (SMYS) of the pipe when calculated as per clause 10.2.4.10 (New) of this specification.

10 INSPECTION

10.1 Types of Inspection and Inspection Documents

10.1.3 Inspection Documents for PSL 2 Pipes

10.1.3.1 Inspection certificate 3.2 in accordance with EN 10204 shall be issued for each dispatched pipe by Purchaser's authorized representative.

10.2 Specific Inspection

10.2.1 Inspection frequency

10.2.1.2 For PSL 2 pipe, the inspection frequency shall be as given in Table 18 of this specification.

Table 18 of API Specification 5L stands replaced by Table 18 of this specification.

Table 18- Inspection Frequency of Pipe

Sl. no.	Type of Inspection	Frequency of Inspection
1.	Heat analysis ^a	One analysis per heat of steel

Sl. no.	Type of Inspection	Frequency of Inspection
2.	Product analysis ^b	Two pipes per lot (maximum 100 pipes) per heat
3.	Tensile testing of the pipe body	Once per test unit of not more than 100 pipes
4.	Tensile testing of the helical seam weld of pipe ^c	Once per test unit of not more than 100 pipes
5.	Tensile testing of all weld test specimen	Once; during manufacturing procedure qualification tests (MPQT) and whenever, batch of electrode or wire & flux combination is changed (see Annex B)
6.	CVN impact testing of the pipe body	Once per test unit of not more than 50 pipes
7.	CVN impact testing of the helical seam weld and HAZ of pipe	Once per test unit of not more than 50 pipes
8.	DWT testing of the pipe body of pipe with $D \geq 508$ mm (20.0 in)	Once per test unit of not more than 50 pipes
9.	Hardness testing	Any hard spot exceeding 50 mm in any direction
10.	Guided-bend testing of the helical seam weld of pipe	Once per test unit of not more than 50 lengths of pipe
11.	Hydrostatic testing	Each pipe
12.	Wall thickness measurement ^d	Each pipe
13.	Macrographic & metallographic testing (including Vicker's hardness test) of the helical seam weld of pipe as defined in clause 10.2.5 of this specification	At least one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs max.) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered and at the beginning of the production of each combination of specified outside diameter and specified wall thickness
14.	Visual inspection	Each pipe
15.	Pipe diameter and out-of-roundness ^d	Each pipe
16.	Other dimensional testing	Random testing, with the details left to the discretion of the manufacturer
17.	Weighing of pipe	Each pipe shall be measured and recorded

Table 18- Inspection Frequency of Pipe

Sl. no.	Type of Inspection	Frequency of Inspection
18.	Length	Each pipe shall be measured and recorded
19.	Straightness ^d	Each pipe
20.	Non-destructive inspection	In accordance with Annex E of API Specification 5L and as modified herein
21.	Geometric deviations ^d	Each pipe
22.	Radial offset of strip edges ^d	Each pipe ^e
23.	Height of the flash or weld bead/reinforcement ^d	Each pipe ^f
24.	Misalignment of the weld beads of SAW ^d	Each pipe (including specimen for macrographic examination)
25.	Residual Stress Test	At least once per test unit and one test at the beginning of each shift (12 hours maximum) and whenever the production line settings are changed, the first produced pipe shall be tested for residual stress
<p>a Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of pipe production.</p> <p>b Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented.</p> <p>c Pipe produced by each welding machine shall be tested.</p> <p>d Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum).</p> <p>e Measurements shall be taken at two locations (at a distance of one to two diameters from each end) on each pipe joint.</p> <p>f Measurement shall be performed by welding gauge and/or by using template having cut out for weld bead.</p> <p>g "Test unit" is as defined in clause 3.1.60 of API Specification 5L.</p>		

10.2.2 Samples and Test Pieces for Product Analysis

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806. Samples used for product analysis shall be taken from finished pipes only. Samples for product analysis from coil may be used provided the traceability of samples is guaranteed.

10.2.3 Samples and Test Pieces for Mechanical Tests

10.2.3.1 General

In addition to API Specification 5L requirements, samples and test pieces for various types of tests shall be taken from Figure 5 c) of API Specification 5L and Figure 10.2.5.3.1 & 10.2.5.3.2 of this specification, whichever is applicable, and as given in Table 20 of this specification.

Table 20 of API Specification 5L stands replaced by Table 20 of this specification.

Table 20-Number, Orientation and Location of Test Pieces per Sample for Mechanical Tests for PSL2 Pipe

Sample Location	Type of Test	Number, Orientation and Location of Test Pieces per Sample ^a	
		Specified Outside Diameter, <i>D</i> mm (in)	
		< 508 (20.000)	≥508 (20.000)
Pipe body	Tensile	1T	1T
	CVN	3T	3T
	DWT	—	2T
Seam Weld	Tensile	1W ^b	1W ^b
	CVN	3Wand3HAZ	3Wand3HAZ
	Guided – bend	2Wc	2Wc
<p>a See Figure 5 c) of API Specification 5L for an explanation of the symbols used to designate orientation and location of samples and test pieces.</p> <p>b Test specimen shall be tested for ultimate tensile strength only.</p> <p>c One face and one root guided bend weld test shall be conducted on the samples prepared from the finished pipe.</p>			

10.2.3.2 Test Pieces for the Tensile Test

Rectangular test pieces, representing the full wall thickness of the pipe, shall be taken in accordance with ASTM A370 and as shown in Figure 5 c) of API Specification 5L.

Transverse tensile test for pipe body shall be carried out on flattened rectangular test specimens only.

For tensile test of helical seam weld, both inside and outside weld beads shall be ground flushed and local imperfections shall be removed from the test piece.

For all weld tensile test during MPQT, round cross-section test piece shall be prepared in accordance with ASTM A370. As an alternate, all weld tensile test shall be carried out as per ASME Section II, Part-C and test piece shall have gauge length, $L = 5d$, where, 'L' is the gauge length (mm) and 'd' is the diameter (mm) of the test piece.

10.2.3.3 Test Pieces for the CVN Impact Test

In addition to the API Specification 5L requirements, the test pieces shall be prepared in accordance with ASTM A370. Non-flattened test pieces shall be used. The axis of the notch shall be perpendicular to the pipe surface.

For pipe weld and HAZ tests, each test piece shall be etched prior to notching in order to enable proper placement of the notch.

CVN impact-test combinations of specified outside diameter and specified wall thickness not covered by Table 22 of API Specification 5L shall also be tested.

10.2.3.4 Test Pieces for the DWT Test

Drop weight tear test shall be carried out in accordance with API RP 5L3. Full thickness specimens shall be used.

The specimens shall be taken transverse to the rolling direction or pipe axis, with the notch perpendicular to the surface.

10.2.3.8 Test Pieces for Macrographic and Metallographic Tests
(New)

Test piece for metallographic testing shall be taken transverse to the helical weld. The test piece extraction shall be as per Fig. 10.2.5.3.1 of this specification. The test piece shall be suitably ground, polished and etched to reveal the macro-structure.

10.2.3.9 Test Pieces for Weldability of PSL2 Pipe (for steel Gr. X-80 only)
(New)

Weldability tests shall be carried out as per clause 10.2.4.9 (New) of this specification using pipes from heat with highest carbon equivalent among the first three heats for each pipe size and each wall thickness specified in the purchase order. If Manufacturer proposes more than one mill for manufacturing the pipes, then weldability tests shall be carried out for each mill.

10.2.3.10 Test Pieces for Residual Stress Test
(New)

Residual stress test shall be carried out as per clause 10.2.4.10 (New) of this specification. The test piece shall be 150 mm wide ring cut from one end of the pipe. The test piece shall be cut either by flame cutting torch or by sawing.

10.2.4 Test Methods

10.2.4.3 CVN Impact Test

The Charpy test shall be carried out in accordance with ASTM A370.

10.2.4.4 DWT Test

The drop-weight tear test shall be carried out in accordance with API RP 5L3. The testing temperature reduction given in API RP 5L3 shall apply.

10.2.4.6 Guided-bend Test

The guided-bend test shall be carried out in accordance with ASTM A370.

The mandrel dimension, A_{gb} , shall not exceed 4.0 times the thickness of the specimen.

Both test pieces shall be bent 180° in a jig as shown in Figure 9 of API Specification 5L. One test piece shall have the root of the weld directly in contact with the mandrel; the other test piece shall have the face of the weld directly in contact with the mandrel.

10.2.4.9 Weldability of PSL2 Pipe (for steel Gr. X-80 only)
(New)

Procedure for field weldability test shall be prepared by the Manufacturer and submitted to Company for approval in accordance with API RP 1104 and welding chart enclosed with the Purchase Order. Weldability testing shall commence only after approval of the welding procedure by the Company.

In addition to the testing requirements of API RP 1104 for validating the quality of the girth weld, following tests shall also be carried out as per the requirements of this specification:

Tensile test of girth weld.

CVN impact testing of the girth weld and HAZ of pipe

Guided-bend testing for girth weld

Macrographic & metallographic testing (including Vicker's hardness test) of the girth weld of pipe as defined in clause 10.2.5 of this specification.

10.2.4.10 Residual Stress Test
(New)

The test ring prepared as per clause 10.2.3.10 (New) of this specification shall be severed by flame cutting or sawing parallel to the longitudinal axis of the pipe. The severing shall be performed 180 degree from the spiral weld. The test ring shall be allowed to cool down to ambient temperature prior to severing.

The increase in circumference, if any, after severing shall be measured using fiducial marks of known separation on the specimen prior to severing. The residual stress then shall be calculated

$$S = \frac{E \cdot C \cdot t}{12.556 \times R^2} - \frac{F \cdot R^2}{t}$$

Using following formula.

Where,

<i>S</i>	Residual Stress, kPa (psi)
<i>C</i>	Increase in circumference, mm (in)
<i>t</i>	Specified wall thickness, mm (in)
<i>E</i>	Young's Modulus of Elasticity, 2 × 10 ⁸ kPa, (29 × 10 ⁶ psi)
<i>R</i>	Pipe Radius, mm (0.5 × <i>D</i>), mm (in)
<i>F</i>	0.1154 in SI units, (0.425 in conventional units)

10.2.5 **Macrographic and Metallographic Tests**

10.2.5.3 Metallographic tests shall be performed on pipes supplied as per this specification. The test piece shall be visually examined using a minimum 10X magnification to provide evidence that proper fusion has been obtained for the full thickness, and there is proper interpretation of passes, their alignment and texture of weld zone. In case imperfections or defects are observed, it will become a cause for re-evaluation of welding parameters as deemed necessary by Purchaser's Representative.

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3.2 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 HV10 for material grade upto Gr. X70M and 270HV10 for Gr. X80M. Modalities of retest shall be in accordance with clause 10.2.12.7 of API Specification 5L.

10.2.6 **Hydrostatic Test**

10.2.6.1 Test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipes.

10.2.6.2 In addition to the requirements of API Specification 5L, following shall also be applicable:

The pressure gauge used for hydrostatic testing shall have a minimum range of 1.5 times and maximum range of 4 times the test pressure. The test-pressure measuring device shall be calibrated by means of a dead-weight tester only. The test configuration shall permit bleeding of trapped air prior to pressurisation of the pipe.

10.2.6.5 The test pressure for all sizes and grades of pipe shall be such that hoop stress (fibre stress) generated is at least 95% of SMYS, computed based on the Equation (6) indicated in clause 10.2.6.5 of API Specification 5L. Table 26 of API Specification 5L stands deleted.

10.2.7 Visual Inspection

10.2.7.1 Each pipe shall be visually examined for entire external surface and internal surface to the extent feasible and shall be free of defects in finished condition. Visual examination shall be carried out in a sufficiently illuminated area; minimum 1000 lx. If required additional lights shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

10.2.8 **Dimensional Testing**

10.2.8.1 Diameter measurements shall be made with a circumferential tape only.

10.2.10 **Non-destructive Inspection**

Non-destructive inspection shall be performed in accordance with Annex E of API Specification 5L and as modified herein.

10.2.11 **Reprocessing**

This clause of API Specification 5L stands cancelled.

10.2.12 **Retesting**

10.2.12.1 **Recheck Analyses**

Modalities of recheck analysis shall be as per API Specification 5L as applicable to the lot being tested (see Table 18 of this specification). However, during individual testing, each pipe shall be fully analysed to meet the requirements of Table 5 of this specification.

10.2.12.9 **Weldability of PSL2 Pipe Retests (for steel Gr. X-80 only)**

(New)

If any test, as per clause 10.2.4.9 (New) of this specification, fails to meet the acceptance criteria, Manufacturer shall revise the welding procedure adopted and carry out all tests again to meet the specification requirements.

10.2.12.10 **Residual Stress Retests**

(New)

If any specimen fails to meet the requirements of clause 9.16 (New) of this specification, the pipe may be retested once. The retest specimen shall be obtained from the same end of the pipe from where the failed specimen was obtained. If the results obtained from the retest specimen are acceptable, normal test schedule shall be resumed. If the results obtained from retest specimen are not acceptable, the pipe shall be rejected and testing shall resume on the next pipe in the production line. If this test also fails, all pipes upto the last acceptable test shall be individually tested and the pipes which pass the test shall be accepted. All pipes that fail to pass the test shall be rejected. The manufacturer shall evaluate the reasons for the failure of the test and rectify the same prior to start of production again. The regular production shall be resumed only after acceptable test result is achieved.

11 **MARKING**

11.1 **General**

11.1.1 Pipe manufactured in accordance with this specification shall be marked by the manufacturer as per the requirements of API Specification 5L and as modified herein. Marking shall be in English language and International System (SI) of Units.

11.1.5 Marking shall also include Purchase Order number, item number, pipe number and heat
(New) number.

11.2 Pipe Markings

11.2.1 k) Actual length in metres and actual pipe weight in kilogram shall be marked.

(New)

11.2.3 c) Paint used for stencil marking shall withstand a temperature up to 250°C expected to
(New) be experienced during further external anti-corrosion coating operations of line pipe by coating applicator.

11.2.4 The pipe number shall be placed by cold rolling or low stress dot marking or vibro-etching on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of non-availability of either cold rolling or low stress dot marking facility in pipe mill, an alternative marking scheme of a permanent nature may be proposed by the Manufacturer.

11.2.8 A colour code band shall be marked on inside surface of finished pipe for identification of pipes of same diameter but different wall thickness, as indicated in the Purchase Order.

The colour code band shall be 50 mm wide and shall be marked at a distance of 150 mm from the pipe ends.

12 COATINGS AND THREAD PROTECTORS

12.1.1 Unless otherwise specified in the Purchase Order, the pipes shall be delivered bare, free of any trace of oil, stain, grease and paint. Varnish coating shall be applied on the marking area. Bevels shall be free of any coating.

13 RETENTION OF RECORDS

In addition to the records indicated in API Specification 5L, the Manufacturer shall retain the records of all additional tests and calibration records mentioned in this specification including the hard copy records of ultrasonic testing carried out on pipe/coil as well as pipe ends.

15 PRODUCTION REPORT

(New)

The Manufacturer shall provide one electronic copy and six hard copies of production report in English language indicating at least the following for each pipe. International system of units (SI) shall be adopted.

- Pipe number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade

The Manufacturer shall provide one electronic copy and six hard copies of acceptance certificates which shall include the results of all tests required as per this specification and performed on delivered material giving details of, but not limited to, the following:

- All test certificates as per clause 10.1.3 of API Specification 5L and as modified herein.
- Records of qualification of welders and procedures for repair welding.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- All other reports and results required as per this specification.

The certificates shall be valid only when signed by the Purchaser's Representative. Only those pipes, which have been certified by the Purchaser's Representative, shall be dispatched from the pipe mill.

In the event of small quantities of pipes supplied against this specification, the production report may consist of only test certificates required as per clause 10.1.3 of API Specification 5L and as modified herein and other test reports/results required as per this specification.

16 (New) INSPECTION OF FIELD TESTS & WARRANTY

Purchaser shall be reimbursed by Manufacturer for any pipe furnished on this order that fails under field hydrostatic test if such failure is caused by a material/manufacturing defect in the pipe. The reimbursement cost shall include pipe, labour and equipment rental for finding, excavating, cutting out and installation of replaced pipe in position. The field hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 95 % of specified minimum yield strength.

In case Manufacturer so desires, he will be advised at least two weeks in advance so that his Representative may witness the hydrostatic test in field, however, the testing and leak (if any) finding and repair operation shall not be postponed because of absence of the Manufacturer's Representative.

Annex B

Manufacturing Procedure Qualification for PSL 2 Pipe

B.1 INTRODUCTION

B.1.1 This annex specifies additional provisions that apply for the PSL 2 pipes ordered as per this specification.

B.1.2 Two lengths each of completely finished pipes from two different heats (i.e. a total of four pipe lengths) shall be selected at random for testing as per clause B.5.1 of this specification to verify that the manufacturing procedure results in the quality of pipes which are in complete compliance with this specification. The pipes thus tested shall be considered to be the test pipes required per heat or per lot as per relevant clauses of this specification.

These manufacturing procedure qualification tests (MPQT) shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser Representative. The manufacturing procedure qualification tests shall be carried out on pipes for each wall thickness, each diameter and each grade of steel. In addition, change of width of coil shall also call for manufacturing procedure qualification tests.

B.1.3 Verification of the manufacturing procedure shall be by qualification in accordance with clause B.3, B.4 and B.5 of API Specification 5L and as modified herein.

Note: In the event of small quantities of pipes (i.e. less than 50 numbers) ordered against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the manufacturing procedure qualification test as per clause B.5.1 of this specification shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION

Before pipe production commences, Manufacturing Procedure Specification (MPS) for manufacturing of pipes and Statistical process control charts shall be prepared by pipe manufacturer (including all information as per clause B.3 a), b) and e) of API Specification 5L) and submitted for approval of the Purchaser.

B.5 MANUFACTURING PROCEDURE QUALIFICATION TESTS (MPQT)

B.5.1 For the qualification of the manufacturing procedure, all tests & inspections specified in Table 18 and clause B.5.2 of this specification shall be conducted on all the pipes selected for testing as per clause B.1.2 of this specification.

B.5.2 The Manufacturer shall submit to Purchaser a report giving the results of all tests mentioned below. The report shall be agreed and signed by Purchaser Representative, prior to start of regular production.

The various tests to be conducted on each pipe shall be as follows. The test method and acceptance values shall be as per this specification unless specified differently in this Annex.

a. Visual Examination

All pipes shall be examined visually for dimensional tolerances and apparent surface defects.

b. Ultrasonic Examination

The weld seam of all pipes shall be examined ultrasonically by automatic ultrasonic equipment. All ultrasonic indications suggesting imperfections in the weld shall be carefully investigated against the corresponding points on the radiographs. If the ultrasonic indication cannot be fully explained from the radiograph, a cross section of the weld, at the location of the above-mentioned ultrasonic indication shall be made in such a way that the nature of the imperfection can definitely be established.

c. Radiographic Examination

The weld seam of all pipes shall be examined radiographically for the entire length.

d. Mechanical Properties

The mechanical properties of all pipes shall be tested and shall meet the requirements of this specification. Purchaser's Representative will select the places in pipe from where the test specimen shall be extracted.

The following tests shall be conducted:

1. Guided bend test

Four (4) weld guided bend test pieces transverse to the helical weld shall be extracted. Out of the four (4) test pieces, two (2) test pieces shall be used for the face bend test and two (2) test pieces for the root bend test.

ii. Tensile test

Tensile tests shall be conducted on:

- Two (2) transverse test pieces from base metal.
- Two (2) transverse weld material test pieces from the helical weld.
- Two (2) cylindrical all-weld test pieces from the helical weld.

Cylindrical all weld tensile test shall be carried out to determine the yield strength, tensile strength and elongation during MPQT and whenever there is change in the batch of electrode or wire & flux combination.

The results of the test shall meet the minimum requirements of the coil with regard to yield strength and tensile strength.

The minimum elongation shall be determined in accordance with the formula given in foot note (f) of Table 7 of API Specification 5L; however, minimum elongation in no case shall be less than 20%.

iii. Metallographic tests

Six (6) weld cross-section test pieces, three (3) from each end of pipe joint shall be taken for metallographic examination. Two (2) of these shall be tested for hardness at room temperature after etching, one from each end of pipe.

iv. CVN impact testing

CVN impact test shall be performed on test pieces extracted as follows:

- Five (5) sets of three (3) transverse specimen each from base metal
- One (1) set of three (3) transverse specimen with weld in middle
- One (1) set of three (3) transverse specimen with HAZ in middle

The minimum average (set of three test pieces) absorbed energy value (KvT) at the test temperature specified in clause 9.8 and Table G of this specification shall be complied with for test pieces extracted from Base Metal, Weld Metal and HAZ.

v. Fracture toughness testing

For pipe with specified outside diameter, $D < 508.0$ mm (20.0 inch):

Five (5) sets of CVN Base Metal test pieces shall be tested at -40°C , -20°C , -10°C , 0°C and $+20^{\circ}\text{C}$ for shear area and absorbed energy to produce full transition curve. The minimum average (set of three test pieces) shear fracture area at the test temperature specified in clause 9.8 of this specification shall be complied with. For other temperatures, the value shall be for information only.

For pipe with specified outside diameter, $D \geq 508.0$ mm (20.0 inch):

Five (5) sets of DWTT test pieces shall be extracted from base metal in a transverse direction at points selected by Purchaser. Each set shall consist of two (2) test pieces taken from same test coupon. The sets of Base Metal test pieces shall be tested at -40°C , -20°C , -10°C , 0°C and $+20^{\circ}\text{C}$ for shear area to produce full transition curve. The value at the test temperature specified in clause 9.9 of this specification shall be complied with. For other temperatures, the value shall be for information only.

vi. One test piece from one pipe end shall be taken for Residual Stress test.

Annex C

Treatment of Surface Imperfections and Defects

C.1 TREATMENT OF SURFACE IMPERFECTIONS

Surface imperfection not classified as defect shall be cosmetically dressed-out by grinding.

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

C.2.3 Complete removal of defects shall be verified by local visual inspection and by suitable non-destructive inspection. To be acceptable, the wall thickness in the ground area shall be in accordance with clause 9.11.3.2 of this specification.

C.4 REPAIR OF DEFECTS BY WELDING

C.4.2 In addition to the API Specification 5L, following requirements shall also be complied with for repair welding:

- a No repair of weld seam is permissible after hydrostatic testing.
- b No repair of weld seam is permissible at pipe ends up to a length of 300 mm.
- c Through thickness repair of weld seam is not permitted.
- d No repair of a repaired weld is permitted.
- e Repair welding shall be executed only after specific approval by Purchaser Representative for each repair.

C.4.3 The cumulative length of weld seam repairs on one pipe shall be $\leq 5\%$ of the total weld length.

C.4.6 After weld repair, the total repaired area shall be radiographically inspected in accordance with clause E.4 of API Specification 5L and as modified in this specification.

C.4.9 (New) The defective part of the weld shall be clearly marked on the pipe so that the defect can be easily located and repaired. Approval for each repair shall be taken from inspection authority before proceeding further.

C.4.10 (New) The Manufacturer shall also maintain a record of repairs carried out. The records shall include repair number, pipe identification number, welding procedure applicable and NDT details.

Annex D

Repair Welding Procedure

D.2 REPAIR WELDING PROCEDURE QUALIFICATION

D.2.3 Mechanical Testing

D.2.3.2 Transverse Tensile Test

D.2.3.2.1 In addition to the API Specification 5L requirements, the test piece edge shall be machine cut. Oxygen cut is not allowed.

D.2.3.3 Transverse Guided bend test

The radius of curvature of the Jig used for guided bend tests shall be $r_a = 2.25 t$.

D.2.3.4 Charpy (CVN) Impact Test

D.2.3.4.2 The CVN impact test shall be carried out in accordance with the requirements of clause 9.8 and clause 10.2.4.3 of this specification.

D.2.3.4.4 The minimum average absorbed energy (set of three test pieces) for each repaired pipe weld and its associated HAZ, based on full size test pieces at a test temperature of 0°C (32°F), or at a lower temperature as specified in Purchase Order, shall not be less than that specified in clause 9.8.3 of this specification for pipe seam weld metal and HAZ.

D.2.3.5 Hardness Testing

(New)

Hardness test as specified in clause 10.2.5.3 of this specification shall be included in the procedure qualification. The location of the hardness measurements is to be indicated taking into account the new HAZ of the repaired area.

Annex E

Non-destructive Inspection for Pipe

The Purchaser reserves the right to depute its Representative(s) to perform inspection and witness tests in all phases of manufacturing and testing starting from steel-making to finished line pipe ready for shipment. Manufacturer shall comply with the provisions regarding inspection notice, plant access, compliance and rejection mentioned in the Annex Q (New) of this specification. The Manufacturer shall give the Purchaser reasonable notice of the starting date of normal production and the work schedule. Any action or omission on part of Purchaser's Representative shall not relieve the Manufacturer of his responsibility and obligation to supply material in strict accordance with this specification.

E.1 QUALIFICATION OF PERSONNEL

E.1.1 All personnel performing NDT activities shall be qualified in the technique applied, in accordance with latest edition of ISO 9712, ISO 11484 or ASNT No. ASNT-TC-1A or equivalent.

All NDT shall be performed in accordance with written procedures. These procedures shall have prior approval of the Purchaser.

Inspector Qualification

Acceptable qualification for NDT inspectors shall be as specified below:

(i) *For UT*

For UT, at least one Level III qualified inspector shall be available to the mill for overall supervision. Level III inspectors shall be ASNT Level III or ACCP Professional Level III and certified in applicable method.

A level II inspector is required for shift supervision, manual weld inspection and calibration of all systems (both manual and automated).

(ii) *For all other NDT methods*

Evaluation of indications Level II & Level III inspector

E.3 METHODS OF INSPECTION

E.3.1 **General**

E.3.1.1 The weld seams of the pipe shall be inspected by ultrasonic methods (Refer Table E.1 of API Specification 5L) for full length (100%) for the entire thickness, using automatic ultrasonic equipment in accordance with clause E.5 of API Specification 5L and as modified in this specification.

E.3.1.3 Location of NDT equipment in the manufacturer's facility shall be such that final inspection of weld seam of pipe shall be performed after hydrostatic testing.

E.3.2 **Pipe End Inspection-Welded Pipe**

E.3.2.1 Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment, or, such non-inspected pipe end shall be cut-off. Records in accordance with clause E.5.4 of API Specification 5L shall be maintained.

E.3.2.2 The weld at each pipe end for a minimum distance of 200 mm (8.0 inch) shall be inspected by the radiographic method. The results of such radiographic inspection shall be recorded.

E.3.2.3 Ultrasonic inspection in accordance with the method described in ISO 10893-8 shall be used to verify that the 50 mm (2.0 inch) wide zone at each pipe end is free of any laminar imperfections in the circumferential direction.

In addition, full circumference of both ends of each pipe shall be 100 % ultrasonically tested over a circumferential width of at least 50 mm with angular probes to detect cracks. In case of non availability of angular probes at the mill, the full circumference of both ends of each pipe shall be inspected with magnetic particle technique over a circumferential width of at least 50 mm to detect surface cracks.

E.3.2.4 (New) Bevel face at each pipe end shall be magnetic particle inspected for the detection of laminar imperfections in accordance with ISO 10893-5.

E.4 **RADIOGRAPHIC INSPECTION OF WELD SEAMS**

E.4.2 **Radiographic Inspection Equipment**

E.4.2.2 The radiographic films used shall be in accordance with ISO 11699-1, class C4 or C5 or ASTM E 94, class 1 or 2 of Table 2, and shall be used with lead screens.

E.4.2.3 The density of the radiograph shall be greater than 2.0 (excluding weld seam) and shall be chosen such that:

- a) the density through the thickest portion of the weld seam is not less than 1.8.
- b) the maximum contrast for the type of film used is achieved.
- c) sensitivity of at least 1.8 % of the nominal wall thickness.

E.4.3 **Image quality indicator (IQIs)**

E.4.3.1 The reference standard shall be ISO wire-type IQI as per clause E.4.3.2 of API Specification 5L.

E.4.5 **Acceptance Limits for Imperfections Found by Radiographic Inspection**

In addition to the requirement of API Specification 5L, slag-inclusion-type and/or gas-pocket-type imperfections in the weld, upto 200 mm length from each pipe end, are not acceptable and shall be treated as per clause E.4.6 of this specification i.e. 200 mm weld length, at each end of pipe, shall be defect free zone.

E.4.6 **Defects Found by Radiographic Inspection**

Defects in the weld such as cracks, lack of complete penetration and lack of complete fusion, in the pipe material shall be removed by cutting off the section of pipe containing these defects. The remaining defect-free section of the pipe will be acceptable provided its length is within the specified minimum length and the weld at the new pipe end contains no such defects.

E.5 **ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1 **Equipment**

E.5.1.2 In addition to the API Specification 5L requirements, all automatic ultrasonic equipment shall have an alarm device, which continuously monitors the effectiveness of the coupling. The equipment for the automatic inspection shall allow the localization of both longitudinal and

transverse defects corresponding to the signals exceeding the acceptance limits of the reference standard. The equipment shall be fitted with a paint spray or automatic marking device and alarm device for areas giving unacceptable ultrasonic indications and probe de-coupling. All ultrasonic testing equipment shall be provided with recording device. In addition, an automatic weld tracking system shall be provided for correct positioning of the probes with respect to weld centre.

E.5.2 Ultrasonic and Electromagnetic Inspection Reference Standards

E.5.2.1 The reference standard (calibration pipe) shall have the same specified diameter and wall thickness as specified for the production pipe being inspected.

E.5.2.2 Reference standards shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in normal production.

The reference standard (calibration pipe) shall also be of the same material, type and have the same surface finish as the pipe being inspected.

E.5.2.3 Reference Standards for Ultrasonic Testing

E.5.2.3.1 Reference Standards for Pipe Weld Seam UT

(New)

Reference standard shall contain as reference indicators i.e. machined notches or radially drilled holes as given in Table E.7 of this specification.

Table E.7 of API Specification 5L stands replaced by Table E.7 of this specification.

Table E.7 –Reference Indicators

Item	Reference indicators			
	Number of notches and orientation ^a		Notch Type ^b	Diameter of radially drilled hole mm(in)
	OD	ID		
Weld Seam Edge	2L	2L	N5	^d
Weld Seam Center	1L, 1T	1L, 1T	N5	1.6 (0.063) ^c
<p>^a The symbol indicates the orientation of the notch i.e. L =Longitudinal and T =Transverse. Reference indicators shall be located as per Figure E.1 of this specification.</p> <p>^b Dimensions of Notch type N5 shall be $0.05t \times 50 \text{ mm} \times 1 \text{ mm}$ (Depth \times maximum Length \times maximum width), where, 't' is the specified wall thickness. The depth tolerance is $\pm 15\%$ of the specified notch depth or $\pm 0.05 \text{ mm}$, whichever is greater.</p> <p>^c Through thickness hole shall be drilled in the centre of the weld seam.</p> <p>^d Not required.</p>				

E.5.2.3.2 Reference Standards for Coil/ Pipe Body UT:

(New)

Reference standard for the ultrasonic inspection of coil or pipe body (except the coil edges/ pipe ends) shall contain continuous machined notch of following dimension:

- a) width, w : 8 mm, with a tolerance $+0.8/-0.0 \text{ mm}$
- b) depth, d : $0.25 t < d < 0.5 t$, where ' t ' is the specified wall thickness

Reference standard for the ultrasonic inspection of coil edges/ pipe ends shall have 6.4 mm (1/4 inch) diameter FBH of a depth $0.5 t$, where ' t ' is the specified wall thickness.

E.5.3 Instrument Standardization

E.5.3.2 The instrument shall be calibrated with appropriate reference standard (refer E.5.2 of API Specification 5L and as modified herein) at following intervals:

- Once the beginning of each operating shift (12 hours maximum).
- Once in between of each operating shift i.e. 3 hrs to 4 hrs after the first
- Every time there is change in probes or working condition of the UT machine.
- Every time the running of the system gives rise to doubts on its efficiency.

If during the above calibration verification, it is found that the equipment has not functioned satisfactorily in the opinion of the Purchaser's Representative, all the pipes or coils already inspected after the previous verification shall be inspected again at Manufacturer's cost.

E.5.5 Acceptance Limits

E.5.5.2 For ultrasonic inspection of pipe/coil, any imperfection that produces an imperfection greater than the acceptable limits shall be treated as following:

a) For pipe weld seam inspection:

Locations showing indications above the allowable limits during automatic ultrasonic inspection shall be re-examined by manual ultrasonic method. If no defects are located during re-examination by manual UT, the original findings may be ignored. In case of ultrasonic indications during manual UT then it shall be further inspected by radiography.

If during production, repeated ultrasonic indications occur requiring re-inspection by radiography and it appears from radiographs that the nature of defects causing the ultrasonic indications cannot be definitely established, the Manufacturer shall prove by making some cross-sections in accordance with clause 10.2.5.3 of this specification at locations where such indications occur near the end of the pipe to the satisfaction of Purchaser that it is not injurious defects as stipulated in this specification.

b) For coil/ pipe body inspection:

Locations showing indications above the acceptance limits may be re-examined by manual ultrasonic method. If no defects are located during re-examination, the original findings may be ignored. Additional scanning may be requested by Purchaser's Representative to check questionable areas.

E.5.6 Disposition of Defects Found by Ultrasonic and Electromagnetic Inspection

Disposition of any imperfection in pipe/coil that produces an indication greater than the acceptable limits as specified in Table E.9 (New) of this specification shall be classified as defect and shall be given disposition as per (c) or (d) of E.10 of API Specification 5L.

E.7 RESIDUAL MAGNETISM

E.7.2 The longitudinal magnetic field shall be measured on all sizes of pipes. Measurement on pipe in stack shall not be considered valid. Such measurements shall be taken on the root face or square cut face of finished plain-end pipes.

E.7.3 Measurements shall be made using Hall – effect gaussmeter only.

E.7.4 Measurements shall be made on each end of a pipe for 5% of the pipes produced but at least once per 4 hr per operating shift (12 hrs maximum).

E.7.6 Four readings shall be taken approximately 90° apart around the circumference of each end of the pipe. The average of the four readings shall not exceed 2.0 mT (20 gauss) and no single reading shall exceed 2.5 mT (25 gauss). All residual magnetism measurements shall be recorded.

E.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY OF EW, SAW AND COW PIPES

E.8.2 The coil or the pipe body, except the coil edges or side of the pipe weld seam, shall be ultrasonically tested for laminations using an oscillating or straight running pattern of probes in accordance with ISO 10893-9 amended as follows:

- The distance between adjacent scanning tracks shall be sufficiently small to ensure detection of minimum allowed imperfection size. The minimum coverage during automatic inspection shall be 20% of the coil surface uniformly spread over the area.
- Acceptance limit for laminar imperfection in the coil or the pipe body shall be as per Table E.9 (New) of this specification. Disposition of defects shall be as per clause E.5.6 of this specification.

Table 3 ISO 10893-9 stands replaced by Table E.9 (New) of this specification.

E.9 LAMINAR IMPERFECTIONS ALONG THE STRIP/ PLATE EDGES OR PIPE WELD SEAM OF EW, SAW AND COW PIPES

The coil edges (in case of inspection before pipe forming) or each side of pipe weld seam (in case of inspection after seam welding) shall be 100% ultrasonically inspected in accordance with ISO 10893-8 or ISO 10893-9, as applicable, amended as follows:

- UT shall be performed over 25 mm wide zone along each side of pipe weld seam or along each of the trimmed coil edges.
- Acceptance limit for laminar imperfection in the coil edges or side of the pipe weld seam shall be as per Table E.9 (New) of this specification. Disposition of defects shall be as per clause E.5.6 of this specification

Table 2 of ISO 10893-8 or ISO 10893-9, as applicable, stands replaced by Table E.9 (New) of this specification.

Table E.9-Acceptance Criteria for Laminar Imperfection in Coil/ Pipe Body (New)

Location	Maximum individual imperfection		Minimum imperfection size considered			Maximum population density ^a
	Area mm ²	Length ^b mm	Area mm ²	Length ^b mm	Width ^c mm	
Coil or the pipe body	1000	100 ^d	300	35	8	10 [per 1.0 m x 1.0 m]
Coil edges or side of pipe weld seam	500	40	—	20	—	4 [per 1.0 m length]
<p>a Number of imperfections of size smaller than the maximum imperfection size and greater than the minimum imperfection size.</p> <p>b Length is the dimension at right angles to the scan track.</p> <p>c Width is the dimension parallel to the scan track.</p> <p>d Any planar imperfection which is not parallel to the coil surface is not acceptable.</p> <p>e For an imperfection to be larger than the minimum imperfection size, the minimum area, minimum length and minimum width given for the coil/ pipe body, all have to be exceeded.</p>						



E.10 DISPOSITION OF PIPES CONTAINING DEFECTS

- a) The repaired area shall be 100% rechecked by magnetic particle or ultrasonic inspection to ensure complete removal of defects. However for repair of cosmetic type of defects, MPI may not be conducted if so directed by Purchaser's Representative on case to case basis. The pipes having a thickness less than the minimum allowed in accordance with this specification, after repair by grinding shall be treated for disposition in accordance with (c) or (d) of E.10 of API Specification 5L.

Annex G

PSL 2 Pipe with Resistance to Ductile Fracture Propagation

G.1 INTRODUCTION

G.1.1 This annex specifies additional provisions that apply for pipes ordered as per this specification.

G.2 ADDITIONAL INFORMATION TO BE SUPPLIED BY THE PURCHASER

G.2.1 CVN minimum average absorbed energy value (based on full-sized test pieces) for each test as per clause G.3.2 of API Specification 5L shall be as per Table G of this specification for BM, weld and HAZ.

Table G.1, G.2 & G.3 of API Specification 5L stands replaced by Table G of this specification.

Table G– Minimum CVN absorbed energy requirements

Specified outside diameter, D_C mm (inch)	Full-size CVN average absorbed energy, minimum $KvT^{a,b}$ [J]							
	Pipe grade							
	B to X42	>X42 to X46	>X46 to X52	>X52 to X56	>X56 to X60	>X60 to X65	>X65 to X70	>X70 to X80
457.0 (18)	40	40	40	40	40	45	50	80
508.0 (20)	40	40	40	40	42	47	53	80
610.0 (24)	40	40	40	41	46	51	58	80
711.0 (28)	40	40	40	45	49	56	62	80
813.0 (32)	40	40	42	48	53	59	66	80
914.0 (36)	40	40	45	51	56	63	70	83
1016.0 (40)	40	40	47	54	59	66	74	90
1118.0 (44)	40	42	50	56	62	70	78	96
1219.0 (48)	40	44	52	59	64	73	81	102
<p>a The required KvL (longitudinal direction specimens) values shall be 50% higher than the required KvT Values for BM, weld and HAZ.</p> <p>b Testing shall be performed at a test temperature of 0°C (32°F) or at a lower temperature as specified in the Purchase Order.</p> <p>c For intermediate specified outside diameter, CVN average absorbed energy value ($Kv7$) shall be same value as given in the table for next higher specified outside diameter.</p>								

Annex Q (New)

Purchaser Inspection

Q.1 INSPECTION NOTICE

Advance notice shall be given by the manufacturer prior to the start of production to the purchaser to inspect/ witness the manufacturing activities including tests.

Q.2 PLANT ACCESS

The inspector representing the purchaser shall have unrestricted access, at all times while work of the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the pipe is being manufactured in accordance with this specification. All inspections should be made at the place of manufacture prior to shipment, unless otherwise specified on the purchase order, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Q.3 COMPLIANCE

The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser may make any investigation necessary to be satisfied of compliance by the manufacturer and any reject any material that does not comply with this specification.

Q.4 REJECTION

If the Purchaser Representative rejects pipes repeatedly for any recurring cause, this shall be adequate reason to refuse final inspection of subsequent pipes until the cause has been investigated and corrective action taken by the Manufacturer.

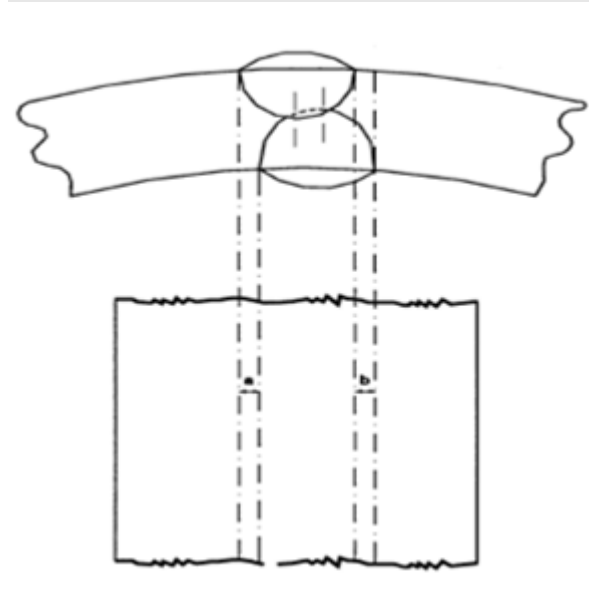
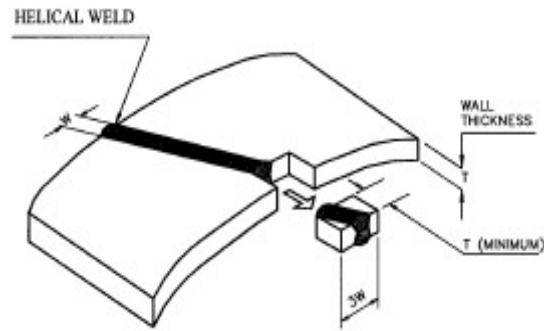


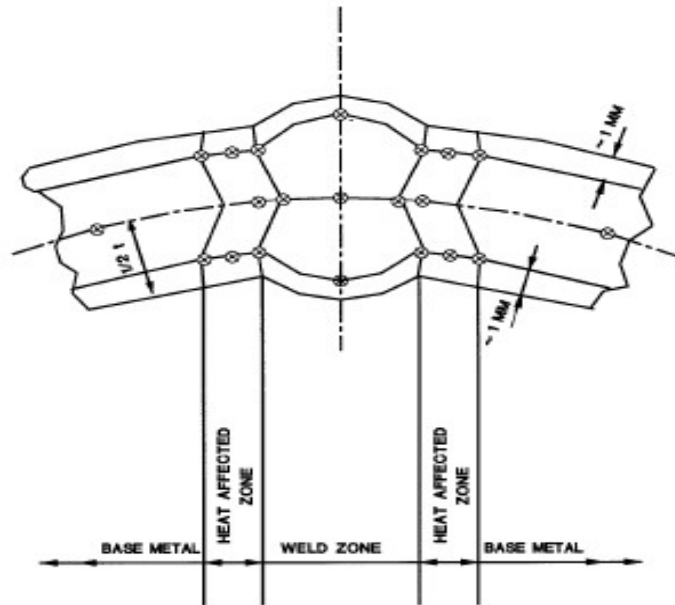
FIGURE: 4d)

X-RAY FILM

**PROCEDURE FOR MEASUREMENT
OF OUT OF LINE WELD BEAD**



**FIGURE: 10.2.5.3.1
METALLOGRAPHIC SPECIMEN EXTRACTION PLAN**



®-LOCATIONS WHERE HARDNESS MEASUREMENT TO BE CARRIED OUT

FIGURE: 10.2.5.3.2

LOCATIONS FOR HARDNESS MEASUREMENT

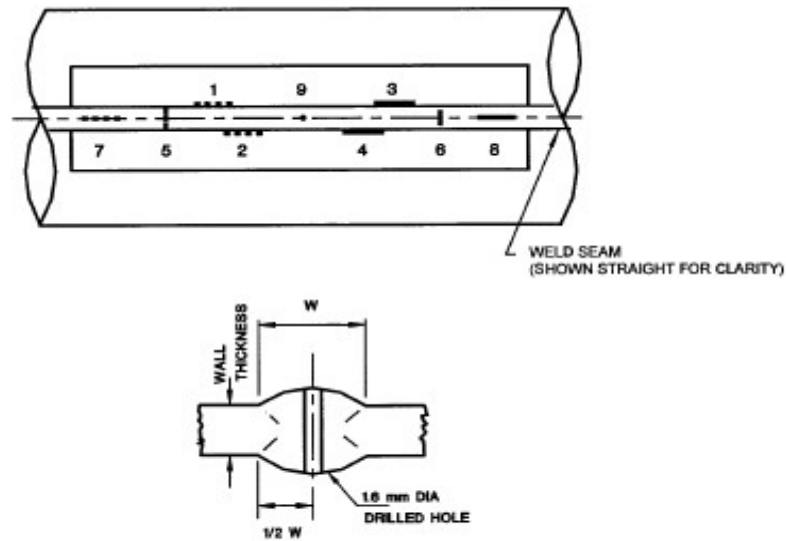


FIGURE: E.1

REFERENCE STANDARD FOR UT OF HELICAL WELD SEAM

- 1, 2 - Longitudinal inside notch at weld seam edge
- 3, 4 - Longitudinal outside notch at weld seam edge
- 5 - Transverse inside notch across the weld seam
- 6 - Transverse outside notch across the weld seam
- 7 - Longitudinal inside notch at weld seam centre
- 8 - Longitudinal outside notch at weld seam centre
- 9 - 1.6 mm dia. through thickness hole.



UNPRICED SCHEDULE OF RATES (SOR), Revision - 1

TENDER FOR SUPPLY OF 172.5 KM STEEL LINEPIPE TO MEET PROJECTS REQUIREMENT FOR STRETCHES OF GR.NOIDA & HAPUR AND BANDA GA EXPANSION



TENDER NO. IGL/ET2/CP/CP17510

Name of Bidder:							
Design, Manufacturing, Inspection, Testing, Supply, Transportation, Unloading & Stacking of 3LPE Coated CS Line Pipes at IGL's Store as specified in bid document.							
Item No.	Brief Description	Method	Unit	Total Qty.	HSN/SAC Code	Unit Price including Packing and Forwarding, Freight including insurance & unloading at IGL site /store and TPIA charges (INR)	Applicable GST rate (%)
						Quoted / Not Quoted	%
C	Steel Pipe With PE Coating - 16"	HFW/SMLS/LSAW/HSAW	Mtr	1,41,500			

Note:

1. Bidder to clearly indicate 'Quoted' / 'Not Quoted' against each Item No. in the price column in the un-priced Schedule of Rates and submit the same in Un-priced part of the bid.
2. Bidder to mandatorily indicate HSN / SAC Code & % (percentage) of GST applicable in Un-priced bid.



PRICED SCHEDULE OF RATES (SOR), Revision - 1

TENDER FOR SUPPLY OF 172.5 KM STEEL LINEPIPE TO MEET PROJECTS REQUIREMENT FOR STRETCHES OF GR.NOIDA & HAPUR AND BANDA GA EXPANSION



TENDER NO. IGL/ET2/CP/CP17510

Name of Bidder:									
Design, Manufacturing, Inspection, Testing, Supply, Transportation, Unloading & Stacking of 3LPE Coated CS Line Pipes at IGL's Store as specified in bid document.									
Item No.	Brief Description	Method	Unit	Total Qty.	HSN/SAC Code	Unit Price including Packing and Forwarding, Freight including insurance & unloading at IGL site /store and TPIA charges	Applicable GST	Unit Price including Packing and Forwarding, Freight including Insurance, Unloading at IGL site/store and TPIA charges including GST	Total amount including Packing and Forwarding, Freight including Insurance, Unloading and Staking at FOT IGL site/store and TPIA charges including GST
						Amount (INR)	%	Amount (INR)	Amount (INR)
C	Steel Pipe With PE Coating - 16"	HFW/SMLS/LSAW/H SAW	Mtr	1,41,500				Not Quoted	Not Quoted
I/We have read the complete Tender Document including Schedule of Rates and understood the complete scope of work. We are submitting our prices as above and the same are binding on me/us.									

Note:

- Bidder to quote price for above item (i.e. Unit & Total price) and ensure that total prices quoted is for complete scope and terms and conditions of Tender document.
- Quoted prices shall be inclusive of all other testing & inspection charges as required in Job Specification.
- Prices quoted at column I are all inclusive of packing, forwarding, Third Party Inspection Charges, applicable taxes & duties, freight, unloading and other incidental charges. Purchaser shall not be liable for any extra payment against the scope defined in this tender.
- Bidder to note that once quoted and finally submitted, no price change shall be allowed.
- Bidder shall quote prices in the given format of Schedule of Rates and shall not modify the format in any form.
- Owner reserves the right to place the order for all items as mentioned in the SOR or delete any item from the bidder's scope of supply / scope of work.
- Quoted Prices as such will remain Firm & Fixed till complete execution of Contract except for statutory variations against documentary evidence on the rates of GST in the contract Price and also imposition of any fresh statutory levy/ tax.
- In case of discrepancy between unit price - and total, the unit price shall prevail.
- Bidders to submit Price part of above Schedule of Rates in their Priced Bid.
- Bidder to quote full quantities of quoted items. Bid with part quantities shall be liable for rejection.
- Bidder to mandatorily indicate HSN / SAC Code & % of GST applicable