
	<b>Offshore Design Section</b> <b>Engineering Services</b> <b>ISO – 9001:2008</b>	<b>Functional Specification</b> <b>for Longitudinal Submerged Arc</b> <b>Welded Line Pipe for</b> <b>Submarine Pipelines ( Sour</b> <b>Service)</b>	<b>Spec. No.</b>	<b>2020D</b>
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**SPECIFICATION**  
**FOR**  
**LONGITUDINAL SUBMERGED ARC WELDED LINE PIPE**  
**FOR**  
**SUBMARINE PIPELINES**  
**(SOUR SERVICE)**

**OIL AND NATURAL GAS CORPORATION LTD.**  
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## 1. SCOPE

This specification establishes the minimum requirements for the materials, fabrication, inspection, testing and supply of Longitudinal Seam Submerged Arc Welded (LSAW) carbon steel line pipe to be used for submarine pipelines and risers transporting sour hydrocarbons. Line pipes furnished in accordance with this specification shall meet the requirements of **API Specification 5L, Forty-Fifth Edition and the supplementary requirements stated herein.**

All carbon steel pipes made according to this specification shall be PSL2. All material shall be suitable for sour service and shall be in accordance with NACE MR-01-75 / ISO 15156.

This specification covers LSAW line pipes of pipe sizes 406.4 mm (16 inches) thru 1219 mm (48 inches) OD and grades up to L450 (X-65). The Manufacturer shall have the license to use API monogram for manufacturing of **PSL2** pipes in accordance with the requirements of API Spec 5L, **Forty-Fifth Edition along with Annexure H and Annexure J.**

“COMPANY” means “Oil and Natural Gas Corporation Ltd.”, wherever used in this specification.


### NOTE

The sections, paragraphs contained herein have the same numbering as the sections and paragraphs of API 5L, in order to facilitate reference.

In this Specification, amendments to API 5L fall into the following Categories:

<b>ADD</b>	Where additions have been made to the API 5L clause or paragraph.
<b>AMEND</b>	Where the API 5L clause has been modified. Only the modified portions will be detailed in this Specification
<b>DELETE</b>	Where the complete clause or paragraph is to be disregarded.
<b>SUBSTITUTE</b>	Where the text has been substituted for the complete clause or paragraph in API5L.
<b>NEW</b>	Where a New Clause is Added.

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## 6 PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

### 6.1 Pipe Grade and Steel Grade

#### 6.1.2 ADD

Maximum pipe grade shall be up to Grade L450 (X65), where 450 represents the Yield Strength in MPa.

### 6.2 Delivery Condition

#### 6.2.2 ADD

The pipes shall be produced from plates which shall be quenched and tempered or Thermo mechanical rolled to impart uniformly fine ferritic grain structure to the finished steel. Acceptable pipe manufacturing routes are as follows:

Starting Material	Pipe Forming	Final Heat Treatment	Delivery Condition
Thermo-Mechanical Rolled plate or strip	Cold Forming	None, Unless Required due to degree of Cold Forming	M
QT Plate or Strip			Q

Temperature of furnace shall be controlled and recorded and such records shall be made available to the Company.


## 7 INFORMATION TO BE SUPPLIED BY THE PURCHASER

### 7.1 General Information

The purchase order shall include the following information:

#### SUBSTITUTE

S.no	Information to be provided as per API 5L	Information provided by the COMPANY to be incorporated in PO/PS.
a)	quantity(e.g. total mass or total length of pipe)	As per provisions of the Contract.
b)	PSL (1 or 2)	PSL2
c)	type of pipe (see Table 2)	SAWL
d)	reference to API 5L	API Spec 5L, Forty-Fifth Edition
e)	steel grade (see 6.1, H.4.1.1 or J.4.1.1, whichever is applicable)	H.4.1.1 shall be applicable
f)	outside diameter and wall thickness (see 9.11.1.2)	As per provisions of the Purchase Specification.

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g)	length and type of length (random or approximate) (see 9.11.1.3, 9.11.3.3 and Table 12)	Refer J.6.3 of API 5L Forty Fifth edition.
h)	confirmation of applicability of Individual annexes.	The applicable Annexes as shown in the following supplementary Table:

#### Applicable Annexures:

	Service
Annex B(Amended)-Manufacturing procedure qualification for PSL 2 pipe	Offshore and Sour Service both.
Annex C (Amended) - Treatment of surface imperfections and defects	Offshore and Sour Service both.
Annex D (Amended) – Repair Welding Procedure	Offshore and Sour Service both
Annex H (Amended) - PSL 2 Pipe ordered for Sour Service	Offshore and Sour Service both.
Annex J (Amended) - PSL 2 pipe ordered for offshore service	Offshore and Sour Service both.
Annex K (Amended) - Non-destructive inspection for pipe ordered for sour service and/or offshore service	Offshore and Sour Service both.


**Note:** In case of any contradiction between different clauses of this Specification, the most stringent clause shall prevail upon.

## 7.2 ADDITIONAL INFORMATION

### SUBSTITUTE

a)	Items that are subject to mandatory agreement, if applicable:	
S.no.	Information to be provided as per API 5L	Information by the COMPANY to be incorporated in PO/PS.
1	pipe designation for intermediate grades [see Table 1, footnote a)]	Not applicable
2	chemical composition for intermediate grades (see 9.2.1 and 9.2.2)	Not applicable
3	chemical composition for pipe with $t > 25,0$ mm (0.984 in) (see 9.2.3)	For Quenched and Tempered Delivery Condition, Chemical Composition of Pipes shall be as per Table H.1 of API 5L, 45 <sup>Th</sup> Edition. For Thermo-mechanical rolled or


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		formed delivery condition, Chemical Composition of Pipes shall be as per Table H.1 of API 5L, 45 <sup>th</sup> Edition but the Carbon equivalent may be increased with 0.01.
4	carbon equivalent limits for PSL 2 pipe in Grade L415N or X60N (see Table 5)	Not Applicable
5	carbon equivalent limits for PSL 2 pipe in Grade L555Q or X80Q, L625Q or X90Q, and L690Q or X100Q (see Table 5),	Not applicable
6	carbon equivalent limits for PSL 2 SMLS pipe with $t > 20,0$ mm (0.787 in) [see Table 5, footnote a)],	Not applicable
7	diameter and out-of-roundness tolerances for pipe with $D > 1422$ mm (56.000 in) (see Table 10)	Not applicable
8	diameter and out-of-roundness tolerances for the ends of SMLS pipe with $t > 25,0$ mm (0.984 in) [see Table 10, footnote b)]	Not applicable
9	standard applicable to jointer welds (see A.1.2)	Not applicable. Joints are not permitted.

<b>b)</b>	<b>Items that apply as prescribed, unless otherwise agreed:</b>	
<b>S.no.</b>	<b>Information to be provided as per API 5L</b>	<b>Information by the COMPANY to be incorporated in PO/PS.</b>
1	range of sizing ratio for cold-expanded pipe (see 8.9.2)	As per Sections 8.9.2 of API Spec 5L, Forty-Fifth Edition
2	equation for sizing ratio (see 8.9.3)	As per Sections 8.9.3 of API Spec 5L, Forty-Fifth Edition
3	chemical composition limits for PSL 1 pipe [see Table 4, footnotes c), e) and f)]	Not applicable.
4	chemical composition limits for PSL 2 pipe [see Table 5, footnotes c), e), f), g), h), i), k), and l)],	Applicable as per Table H.1 of API 5L 45 <sup>th</sup> edition. For applicable of Footnotes to Table H.1, refer Annex. H Sl.no.H2 (f) of this spec.
5	yield/tensile ratio for grades L625Q or X90Q, L690 or X100 and L830 or X120 [see Table 7, footnotes g and h or Table J.2, footnotes h and i],	Not applicable


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6	estimation and reporting of Charpy shear area (see 9.8.2.3)	Not applicable
7	tolerances for random length pipe [see 9.11.3.3 a)]	Refer J.6.3 of API 5L 45 <sup>th</sup> edition.
8	type of thread compound (see 9.12.2.4)	Not applicable
9	type of end face (see 9.12.5.1 or 9.12.5.2)	As per Sections 9.12.5.1 or 9.12.5.2 of API Spec 5L, Forty-Fifth Edition
10	International Standard applicable to Charpy testing (see 10.2.3.3, 10.2.4.3, D.2.3.4.2 and D.2.3.4.3)	Charpy V- notch testing shall be done in accordance with ASTM A370.
11	product analysis method (see 10.2.4.1),	As per Section 10.2.4.1 of API Spec 5L, Forty-Fifth Edition
12	alternate method for diameter measurement for D ≥ 508 mm (20.000 in) (see 10.2.8.1),	As per Section 10.2.8.1 of API Spec 5L, Forty-Fifth Edition
13	jointer welding type (see A.1.1),	Not applicable
14	offset of longitudinal pipe weld seams at jointer welds (see A.2.4)	Not applicable
15	repairs in cold-expanded pipe (see C.4.2)	No repair of weld seam is permitted after cold expansion of pipes. Refer Section C.4.2, Annex C of this specification.
16	alternate IQI type (see E.4.3.1);	Not applicable.

<b>c)</b>	<b>Items that apply, if agreed:</b>	
<b>S.no.</b>	<b>Information to be provided as per API 5L</b>	<b>Information by ONGC to be incorporated in PO/PS.</b>
1	delivery condition (see 6.2 and Table 1)	Refer 6.2.2 of this specification.
2	supply of quenched and tempered PSL 1 Grade L245 or B SMLS pipe (see Table 1),	Not applicable.
3	supply of intermediate grades [see Table 2, footnote a)]	Not applicable.
4	supply of double-seam SAWL pipe [see Table 2, footnote c)]	Not applicable
5	alternative to specified seam heat treatment for PSL 1 pipe (see 8.8.1)	Not applicable.
6	supply of SAWH pipe with coil/plate end welds at the pipe ends (see 8.10.3),	Not applicable.
7	supply of jointers (see 8.11 and H.3.3.3)	Not applicable .Jointers are not permitted
8	CVN impact test temperature lower than 0°C (32°F) (see 9.8.2.1, 9.8.2.2 and 9.8.3)	CVN impact test temperature lower than 0°C (32°F) is not applicable.


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9	CVN impact test of the pipe body of PSL 2 welded pipe with $D < 508$ mm (20.000 in) for shear fracture area (see 9.8.2.2 and Table 18)	Agreed. Applicable as per 9.8.2.2( Amended) of this Specification and Table J.6 of API 5L , 45 <sup>th</sup> Edition
10	CVN impact test of the longitudinal seam weld of PSL 2 HFW pipe (see 9.8.3 and Table 18)	Not applicable.
11	DWT test of the pipe body of PSL 2 welded pipe with $D \geq 508$ mm (20.000 in) (see 9.9.1 and Table 18)	Agreed. As per Section 9.9.1(Amended) of this specification and table 18 of API 5L, Forty fifth edition.
12	DWT test temperature lower than 0°C (32°F) (see 9.9.1)	DWT test temperature lower than 0°C (32°F) is not applicable
13	fraction jointers comprising 2 or 3 pieces for 12 m (40 ft) nominal or 24 m (80 ft) nominal, respectively [see 9.11.3.3.c), d), and e)],	Not applicable.
14	power-tight make-up of couplings (see 9.12.2.3 and 10.2.6.1)	Not applicable.
15	special bevel configuration (see 9.12.5.3)	Special bevel configuration, if required, shall be provided in Purchase order.
16	removal of outside weld bead at pipe ends of SAW or COW pipe [see 9.13.2.2 e)]	Applicable ; Refer 9.13.2.2(e) of this specification
17	weldability data or tests for PSL 2 pipe (see 9.15)	For X65 Grade Pipe only ( As per 9.15 of this specification)
18	type of inspection document for PSL 1 pipe (see 10.1.2.1)	Not applicable.
19	manufacturing information for PSL 1 pipe (see 10.1.2.2)	Not applicable.
20	alternative type of inspection document for PSL 2 pipe (see 10.1.3.1)	Refer 10.1.3.1 (Amended) of this Specification.
21	use of transverse test pieces for tensile tests of SMLS pipe, not cold-expanded [see Table 20, footnote c)]	Not applicable
22	use of the ring expansion test for transverse yield strength determinations [see 10.2.3.2, Table 19 note c), and Table 20 note d)],	Ring expansion test is not applicable.
23	use of an alternative to macrographic examination (see 10.2.5.2)	Not applicable
24	hardness test during production of EW and LW pipe (see 10.2.5.3)	Not applicable

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25	specific condition to be used for hydrostatic tests for threaded and coupled pipe (see 10.2.6.1)	Not applicable
26	alternate hydro test pressure (see Table 26),	Refer 10.2.6 of this specification. (Table 26 of API 5L is Not applicable.)
27	use of minimum permissible wall thickness to determine hydrostatic test pressure (see 10.2.6.7)	Applicable
28	specific method to be used for determining pipe diameter (see 10.2.8.1)	Clause 10.2.8.1 is Applicable. Further, Caliper / properly sized go-no-go gauges shall be used to verify that diameter and out of roundness at pipe ends for each pipe is within the required tolerances as per J.6.1 of API 5L.
29	use of inside diameter measurements to determine diameter and out-of-roundness for expanded pipe with $D \geq 219,1$ mm (8.625 in) and for non-expanded pipe [see 10.2.8.3 and Table 10, footnote c)].	Acceptable. Refer Cl. J.6.1 and Cl.10.2.8.3 of API 5L.
30	specific method to be used for determining other pipe dimensions (see 10.2.8.7)	Proposed methods shall be subject to COMPANY approval.
31	paint-stencilled markings for couplings (see 11.1.2)	Not applicable
32	additional markings specified by the purchaser (see 11.1.4)	For segregation of pipes additional markings/colour bands may be decided by the LSTK contractors.
33	specific surface or location for pipe markings [see 11.2.2 b) and 11.2.6 b)]	Refer 11.2.2(b) of API 5L 45 <sup>th</sup> edition & 11.2.6(b) of this specification
34	die-stamping or vibro-etching of pipe (see 11.2.3)	Only low stress die stamping shall be permitted on the pipe bevel face at the opposite end to pipe stencilled markings. The low stress marking shall be the unique pipe number only. Cold die stamping is not permitted on the pipe body. In case low stress die-stamping on bevel face is technically not feasible, alternate measures shall be made for providing unique pipe number for ensuring traceability of pipes.


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35	alternative location for marking the pipe (see 11.2.4)	Marking shall be carried out at the pipe mill. Further, for pipes intended for subsequent coating, LSTK contractor shall submit the procedure for marking at coating yard ensuring the traceability of pipes.
36	alternative format for pipe length marking locations (see 11.2.6a),	Not applicable.
37	colour identification for pipe (see 11.2.7)	Applicable
38	multiple grade marking (see 11.4.1),	Not applicable.
39	temporary external coating (see 12.1.2)	Pipe shall be delivered with mill's standard temporary external coating throughout the external surface of pipe body to provide protection from rusting in storage and transit.
40	special coating (see 12.1.3)	Not applicable
41	lining (see 12.1.4),	Not applicable
42	manufacturing procedure qualification for PSL 2 pipe, in which case, Annex B shall apply (see B.2),	Applicable. Refer Annex B (Amended) of this specification.
43	radiographic inspection of SAW seam or coil/plate end seam (see Table E.1)	Required only for First Day Production Testing and repaired area as per Annex. B (Amended), Annex. C (Amended) and Annex. K ( Amended) of this Spec.
44	non-destructive inspection of PSL 1 SMLS pipe (see E.3.1.2),	Not applicable
45	NDT of EW seam welds after hydrotest [see E.3.1.3 b)],	Not applicable.
46	ultrasonic inspection of welded pipe for laminar imperfections at pipe ends (see E.3.2.3)	Required. Refer Annex. K ( Amended) of this Spec.
47	ultrasonic inspection of SMLS pipe for laminar imperfections at pipe ends (see E.3.3.2)	Not applicable
48	radiographic inspection in accordance with Clause E.4,	Required only for First Day Production Testing and repaired area as per Annex. B (Amended), Annex. C (Amended) and Annex. K( Amended)
49	use of both holes and notches in ultrasonic reference standard (see Table E.7),	Acceptable
50	alternative re-inspection technique for COW seams (see E.5.5.5)	Not applicable

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51	ultrasonic inspection for laminar imperfections in the pipe body of EW, SAW or COW pipe (see Clause E.8)	Required. Refer Annex.K (Amended) of this Spec.
52	ultrasonic inspection for laminar imperfections along the coil/plate edges or the weld seam of EW, SAW or COW pipe (see Clause E.9)	Required. Refer Annex. K(Amended) of this Spec.
53	supply of welded couplings on pipe with $D \geq 355,6$ mm (14.000 in) (see F.1.4)	Not applicable
54	application of Annex G to PSL 2 pipe where purchaser shall specify the toughness test temperature, the minimum energy for each test and the minimum average energy value required for the order (see G.2),	Not applicable
55	PSL 2 pipe for sour service, in which case, Annex H shall apply (see H.2),	Applicable. Refer Annex H (Amended) of this specification.
56	TFL pipe, in which case, Annex I shall apply (see I.2),	Not applicable
57	pipe for offshore service, in which case, Annex J shall apply (see J.2),	Applicable. Refer Annex J (Amended) of this specification
58	any other additional or more stringent requirements.	As included within this document.

## 8 MANUFACTURING

### 8.1 Process of Manufacture

#### ADD


This specification is applicable for Longitudinal submerged arc welded pipe only. Other types of pipes specified in Table 2 and pipe for intermediate grades (refer footnote a) of Table 2 are not applicable in this specification. The pipes shall be produced from plates/ skelp which shall be quenched and tempered or Thermomechanical-rolled to impart uniformly fine ferritic grain structure to the finished steel.

### 8.3 Starting Material

#### 8.3.2 AMEND

Pipes furnished to this specification shall be made to a clean steel practice using either basic-oxygen steel or electric arc furnace steel. Steel shall be vacuum degassed or alternative processes shall be applied. The material shall be treated for inclusion shape control to increase resistance to hydrogen-induced (blistering and stepwise) cracking. Steel shall be made by continuous casting only. Manufacturing procedure as mentioned in Annex B (Amended) of this specification shall be prepared and submitted to Company for approval prior to start of production.

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### 8.3.3 AMEND

The steel shall be fully killed and made with fine grain structure with a grain size of ASTM 7 or finer as per ASTM E 112.

### 8.9 Cold sizing and cold expansion

#### 8.9.1 DELETE

#### 8.9.2 ADD

The expansion shall be measured and recorded for one out of every 50 pipes.

### 8.11 Jointers

#### AMEND

Jointers shall not be permitted.

## 9. ACCEPTANCE CRITERIA

### 9.8 CVN Impact Test for PSL 2 Pipe

#### 9.8.1.3 AMEND

Tests shall be conducted at 0°C (32°F)

### 9.8.2 Pipe Body Tests


#### 9.8.2.1 AMEND

The minimum average (of a set of three test pieces) and minimum individual absorbed energy for each pipe body test shall be as given in Table 8 (substituted), based upon full-size test pieces and a test temperature of 0 °C (32 °F). Test temperature lower than 0°C (32°F) is not applicable.

**TABLE 8 (SUBSTITUTED)**

API 5L Table-8 is substituted as under:

Grade	Min. Average	Min. Individual
X-42	29J	22J
X-46	32J	24J
X-52	36J	27J
X-56	39J	29J
X-60	41J	31J
X-65	43J	33J

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Note: The average impact values are determined by finding the mean of the values of each group of three specimens from each sample taken separately. The minimum impact value is determined by considering the values of the individual specimens from the sample.

#### **9.8.2.2 AMEND**

The minimum average (set of three test pieces) shear fracture area for each test shall be at least 85 %, based upon a test temperature of 0 °C (32 °F).

#### **9.8.3 Pipe weld and HAZ tests**

##### **AMEND**

The minimum average (of a set of three test pieces) absorbed energy for each weld and HAZ test shall be as given in Table 8 (substituted), based upon full-size test pieces and a test temperature of 0 °C (32 °F).

#### **9.9 DWT test for PSL 2 welded pipe**

##### **9.9.1 AMEND**

For each test (of a set of two test pieces), the average shear fracture area shall be ≥ 85 %, based upon a test temperature of 0 °C (32 °F).

##### **9.9.2 DELETE**

#### **9.10 Surface Conditions, Imperfections and Defects**

##### **9.10.1 General**

##### **9.10.1.2 ADD**

No cracks shall be permitted. Section of the pipe containing cracks shall be cut off as per the requirement of clause C.3(b) or entire pipe length shall be rejected as per the requirement of clause C.3.(c) of API 5L.

##### **9.10.1.3 AMEND**


The acceptance criteria for imperfections found by non-destructive inspection shall be in accordance with Annex K (amended) of this specification.

##### **9.10.2**

##### **(c) AMEND**

Undercuts that exceed the limits specified in item b) shall be classified as defects and shall be treated in accordance with API 5L para C.3 (b) or (c).

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#### 9.10.4 Laminations

##### ADD

Refer Annex K (Amended).

#### 9.10.5 Geometric Deviations

##### 9.10.5.2 AMEND

Depth of dent shall not exceed 2 mm and length in any direction shall not exceed half of the pipe diameter, provided this dent does not give rise to a hard spot at the internal surface exceeding 235 HV10. Disposition of dents shall be carried out in accordance with API 5L para C.3.b) or C.3.c) of Annex C. Dents on weld and HAZ are not acceptable.

#### 9.10.6 Hard Spots

##### SUBSTITUTE

Any hard spot larger than 50 mm (2.0 in) in any direction shall be classified as a defect if its hardness exceeds 235 HV10 based upon individual indentations. Sections of pipes where hardness is greater than the allowable value shall be cut off as per requirements of API 5L para C.3.b) or C.3.c) of Annex C.

#### 9.10.7 Other Surface Imperfections

##### SUBSTITUTE


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

- Imperfections that have a depth  $\leq 0.05t$  and do not encroach on the minimum permissible wall thickness shall be classified as acceptable imperfections and shall be treated in accordance with Clause C.1.
- Imperfections that have a depth  $> 0.05t$  and do not encroach on the minimum permissible wall thickness shall be classified as defects and shall be dressed – out by grinding in accordance with Clause C.2 ( Amended) or shall be treated in accordance with Clause C.3.
- Imperfections that encroach on the minimum permissible wall thickness shall be classified as defects and shall be treated in accordance with Clause C.3.(b) or C3(c).

#### 9.11 Dimensions, Mass and Tolerances

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

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## **AMEND**

Tables 10, 11 & 12 of API 5L shall not be applicable.

### **9.11.3.1 SUBSTITUTE**

Tolerances for diameter and out-of-roundness shall be as per Table J.3 of API Specification 5L.

### **9.11.3.2 SUBSTITUTE**

Wall thickness tolerance shall be as per J6.2 (Substituted) of this specification. Table 11 shall not be applicable.

### **9.11.3.3 SUBSTITUTE**

**Refer J.6.3** of API 5L.

### **9.11.3.4 SUBSTITUTE**

The tolerances for straightness shall be as per **J.6.4** of API Specification 5L.

## **9.12 Finish of Pipe ends**

### **9.12.5 Plain ends**

#### **9.12.5.1 & 9.12.5.2**

#### **ADD**

Pipe ends shall be supplied with standard API bevel. However, in case of any specific requirement of bevel angle the same shall be provided in purchase order.

While removing the inside seam burrs at the pipe ends, care shall be taken neither to remove excess metal nor to form an inside cavity. Removal of excess metal beyond the minimum wall thickness as indicated in para 9.11.3.2 of this specification, shall be a cause for cutting and removal of defective section and rebeveling.


In case root face of bevel is less than specified, rebeveling shall be done and rectification shall not be made by filling or grinding.

## **9.13 Tolerances for the weld seam**

### **9.13.1 Radial offset of strip/plate edges (SUBSTITUTE)**

The inside and outside radial offsets of the strip/plate edges [see Figure 4 b)] shall not exceed the applicable value given in Table J.5.

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### 9.13.2.2 (e) ( Amend)

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

#### ADD

All pipes shall be checked for out-of-line weld bead and shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

Checking of the weld seam misalignment shall also be carried out on metallographic examination specimen.

## 9.15 Weldability Test for PSL2 Pipe

#### Amend

FOR GRADE X-65 ONLY Manufacturer shall carry out a weldability test to establish that quality girth welding meeting various requirements mentioned in this specification can be achieved under simulated site conditions. This test shall be carried out using pipes from any of the first three heats with highest carbon equivalent for each wall thickness and each grade of steel specified in the purchase order. In case more than one mill is proposed to manufacture pipes, the weldability test shall be carried out for each mill.

Welding procedure shall comply with the requirements of DNV-OS-F101. Procedure for field weldability test shall be submitted by the manufacturer in line with DNV-OS-F101 and approved by purchaser prior to commencement of test.


Weldability test shall include all tests listed in DNV-OS-F101 aimed at establishing the weld quality/ properties as per this specification. The acceptance criteria shall be as per the requirements of this specification. In case of failure of any test results to comply the specification requirements, manufacturer shall revise the welding procedure adopted and carry out the tests again to comply the specification requirements. Manufacturer shall submit the test results to purchaser to comply specification requirements prior to shipment of pipes.

## 10. INSPECTION

### 10.1.3. Inspection documents for PSL 2 pipe

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### 10.1.3.1 AMEND


Inspection certificate shall be issued and validated as per “3.1C” in accordance with ISO 10474 : 1991.

### 10.1.3.2 SUBSTITUTE

The manufacturer shall provide production report including acceptance test certificates as mentioned in 13 of API Specification 5L (as applicable for LSAW pipe) in six copies, which shall include the results of all testing required as per this specification and performed on raw material and delivered pipes giving details of, but not limited to the following for each pipe length:

- COMPANY's Name and Order Number;
- SUPPLIER's Identification;
- Name and location of facilities used for pipe manufacturing, plate rolling and steelmaking
- Pipe specified outside diameter, specified wall thickness, pipe grade
- Type of pipe, Product Specification Level ( PSL ) and delivery condition;
- Steelmaking Process;
- Identification of Steel Type and Grade;
- Slab number, as applicable;
- chemical composition (heat and product),Certificates of Ladle and Product Analysis;
- CE<sub>IIW</sub> / Pcm for both Product and Ladle Analysis;
- Pipe Identification number, Heat number, Pipe length and Pipe weight
- Certified measurements for Dimensional measurements/ tolerance
- tensile test results and the type, size, location and orientation of the test pieces,Mechanical Test Certificates.
- Yield/Tensile Ratio (based on R<sub>t0.5</sub>);
- % Elongation of pipe;
- Charpy Impact Results;
- Hardness Tests;
- DWT test results;
- Heat Treatment Condition including review of records of furnace temperature(s);
- specified minimum hydrostatic test pressure and specified test duration, Hydrostatic Test Certificate, or statement;
- the method of non-destructive pipe body and weld inspection (radiological, ultrasonic, MPI and electromagnetic) used; and the type and size of reference indicator or image quality indicator used,NDT Procedures, NDT Records and Reports;
- Surface Inspection;
- Dimensional Control Checks;
- Manufacturing Procedure Specification and Qualification Tests;
- Macrographic and Metallographic records

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- HIC including photomicrographs ; Four Point Bend Test , Hardness test and CTOD test records;
- SSC ,HIC and Four Point Bend Test records and reports for Mill Qualification
- Information on production & shipping
- All other reports and results as required as per this specification
- NDT Operator Qualification Certificates;
- Inspection certificate issued and validated by Authorized representative of Purchaser, as per “3.1C” of ISO 10474 : 1991, in accordance with this specification.
- COMPANY Authorized representative’s Pipe Inspection and Release Note.

Such documents shall indicate pipe identification number, the origin of each individual test specimen etc. and shall be written in English only. International system of units (SI) shall be adopted. The certificates shall be valid only when signed by Company Representative. Only those pipes which have been certified by Company Representative shall be dispatched from the pipe mill.

Manufacturer shall also provide information on test failure / rejected heats etc.

## **10.2 Specific Inspection**

### **10.2.1 Inspection frequency**

#### **10.2.1.2 AMEND**

The inspection frequency shall be as given in Table 18 of API 5L , 45<sup>th</sup> Edition modified by Table H.3 of API 5L , 45<sup>th</sup> Edition and Table H.3 ( Amended) of this Specification and Table J.6 of API 5L , 45<sup>th</sup> Edition

### **10.2.2 Samples and test pieces for product analysis.**

#### **ADD**

Product analysis shall be carried out from finished pipes.

### **10.2.6 Hydrostatic Test**


#### **10.2.6.1 SUBSTITUTE**

The test pressure for all sizes and grades of pipes shall not be less than the maximum pressure calculated based on either of the criteria mentioned at 10.2.6.5 (amended) and 10.2.6.6 (amended) .The test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipes.

#### **10.2.6.2 AMEND**

The Test pressure measuring device used for hydrostatic testing shall be calibrated with a Dead Weight tester and the record shall be maintained. Calibration records shall be

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furnished to Company Representative. The calibration shall be conducted at start of a run and after a hydrostatic burst/leak failure

#### **10.2.6.5 AMEND**

The required test pressure shall produce a hoop stress of at least 95% of the specified minimum yield strength for all the grades and sizes.

#### **10.2.6.6 AMEND**

In case, pressure testing involves end sealing ram, the required test pressure shall produce a hoop stress of at least 95% of the specified minimum yield strength for all the grades and size.

#### **10.2.7 Visual Inspection**

##### **10.2.7.1 AMEND**

Each pipe shall be visually inspected to detect surface defects, with an illuminance of at least 300 lx (28 fc). Such inspection shall be over the entire external surface and shall cover as much of the internal surface as is practical.

##### **10.2.7.2 DELETE**

##### **10.2.7.4 AMEND**

Maximum hardness in suspected hard spots shall be 235 HV10. Sections of pipes where hardness is greater than the allowable value shall be cut off as per requirements of API 5L para C.3.b) or C.3.c) of Annex C.

#### **10.2.8 Dimensional testing**

##### **10.2.8.1 ADD**

Further, Caliper / properly sized go-no-go gauges shall be used to verify that diameter and out of roundness at pipe ends for each pipe is within the required tolerances J.6.1 (Substituted) of this specification.

##### **10.2.8.5 AMEND**

The wall thickness at any location shall be within the tolerances specified in para 9.11.3.2 of this specification.


#### **10.2.10 Non-destructive inspection SUBSTITUTE**

Non-destructive inspection shall be in accordance with Annex K (AMENDED).

#### **10.2.11 Reprocessing SUBSTITUTE**

Reprocessing is not permitted.

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## **10.2.12 Retesting**

### **10.2.12.1 Recheck Analysis SUBSTITUTE**

If any parts of the full product analysis on any one of the fully analyzed pipes fail to meet the requirements of Table H.1 with foot notes thereof of API 5L 45<sup>Th</sup> Edition, either the whole heat shall stand rejected or each individual pipe shall be fully analyzed and all pipes failing to meet the requirements of Table H.1 with foot notes thereof API 5L , 45 th Edition shall be rejected.

### **10.2.12.2 To 10.2.12.8 Retests ADD**

In case one of the test specimens fails to conform to the specified requirements, a retest on four additional pipes from the same test unit shall be made. If all re-tests give positive result, then the pipe, which gave the negative result, shall be rejected and the balance pipes of the test unit shall be accepted.

In case of negative result of one of the re-test specimens, the test unit may be rejected or each of the remaining lengths shall be tested individually. The pipes, which give results as per requirement of this specification, shall only be accepted.

## **11.2 Pipe markings**

### **11.2.1 ADD**

Marking shall be in English using SI units. Markings shall also include API monogram, purchase order number, item number, heat number, wall thickness (mm), pipe number, weight and grade. Weight marked shall be the actual weight of the pipe.

## **12. Coatings and thread protectors**

### **12.1.2 AMEND**

Pipe shall be delivered with mill's standard temporary external coating throughout the external surface of pipe body to provide protection from rusting in storage and transit.

### **12.3 Bevel Protectors (New)**


Both pipe ends of all pipes shall be provided with metallic or high impact plastic bevel protectors as per Manufacturer's standard

## **13 Retention of Records**

### **ADD**


In addition to the records indicated in clause 13, the manufacturer shall retain the records of all additional tests mentioned in this specification including the ultrasonic testing carried out on pipe as well as pipe ends.

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## ANNEXES OF API 5L

<b>ANNEXURES</b>	<b>Service</b>
Annex B (Amended) -Manufacturing procedure qualification for PSL 2 pipe	Offshore and Sour Service both.
Annex C (Amended) - Treatment of surface imperfections and defects	Offshore and Sour Service both.
Annex D (Amended) – Repair Welding Procedure	Offshore and Sour Service both
Annex H (Amended) - PSL 2 Pipe ordered for Sour Service	Offshore and Sour Service both.
Annex J (Amended) - PSL 2 pipe ordered for offshore service	Offshore and Sour Service both.
Annex K (Amended) - Non-destructive inspection for pipe ordered for sour service and/or offshore service	Offshore and Sour Service both.

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## **Annex B (AMENDED)**

### **Manufacturing Procedure Qualification for PSL 2 Pipe**

#### **B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION**


##### **SUBSTITUTE**

A Manufacturing Procedure Specification (MPS) outlining the successive steps and associated inspection procedures from steelmaking to finished line pipe shall be prepared and submitted to Purchaser for approval prior to start of production. Manufacture of pipes shall start only after the approval of Manufacturing Procedure. The approved Manufacturing Procedure shall be strictly followed in all phases of the production of pipes.

The Manufacturing Procedure shall as a minimum include the following information:

- Steel & Plate/Skelp maker and plant at which steel & Plate/ skelp is produced.
- Type of Furnace , Equipment and process description including steel making process with details of secondary refining process and continuous casting process, nominal weight of each heat, deoxidation practices and inclusion shape control practices.
- Target chemistry, range of intentionally added elements and those listed in API 5L along with their service Annex. H and J , limits on heat and product analysis to be placed on steel maker.
- Steelmaking and casting process control.
- Hydrogen control practices for slabs used to make plate/skelp
- Product identification and traceability practices;
- Product rework/retest/release controls for non-conformances to manufacturer's documented practices including grade intermixes/transitions and process/chemistry deviations;
- Centerline segregation controls and acceptance criteria, as applicable.
- name/location of pipe manufacturing facility.
- equipment and process description of pipe manufacturing facility;
- Plate/skelp rolling procedure indicating number of passes, their temperature and thickness reduction in each pass required by Controlled Rolling Procedure and the finishing temperature.
- Heat treatment procedure document established as per para 8.12.
- Ultrasonic testing of plates/skelp and pipes using automatic and manual equipment including details of equipment, techniques, scanning pattern, probe frequency, scanning sensitivity, reference standard for calibration, dynamic calibration procedure, method of marking defects and indicating loss of coupling, inspection and recording.
- NDT Procedures and Equipment Calibration
- Pipe making procedure including plate edge preparation, forming and any other special process proposed.

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- Welding Procedure Specification including the details of welding process, brand name, classification, size and grade of filler metal and flux, speed of welding, number of electrodes and polarity of each electrode, welding current and voltage for each wire, edge preparation, tack welding method and spacing of tack weld, details of seam tracking system for both inside and outside welding, method of checking the setup of the system, limits of internal and external weld reinforcement etc.
- Method of weld defect removal.
- Detailed methodology of cold expansion.
- Testing of chemical, mechanical and corrosion, macrographic and metallographic properties
- Ultrasonic testing of longitudinal weld seam of pipe using automatic equipment including details of equipment, scanning pattern, probe efficiency, scanning sensitivity, calibration of pipe, extent of weld length at each pipe ends not covered by probes, method of marking defect and indicating loss of coupling, inspection and records.
- Full details of radiographic testing equipment including radiographic film including radiography procedure.
- Dimensional tolerances, frequency of checking, measurement and record in a tabular form including details of instruments and equipment proposed.
- end cropping practices;
- Detail of technique proposed for measurement of weld bead misalignment, offset, end squareness and peaking at the welds.
- Hydrostatic testing including details of testing equipment, procedure and the relevant test pressure calculations including calibration/verification of equipment.
- Marking, storage and transit protection coating procedures
- product traceability practices from slab receipt to plate/coil delivery;
- product rework/retest/release controls for non-conformances to manufacturer's documented
- practices (including process, chemical/ mechanical, and dimensional deviations),
- Handling, storage, loading and shipment procedure.
- Production report formats.
- Complete details of computerized pipe tracking system.
- Project specific quality control plan

## **B.5 Manufacturing procedure qualification tests**


### **B.5.1 (Amend)**

#### **Mill Qualification Tests**

Mills shall be considered qualified only subsequent to successful completion of all the tests as mentioned at B.6 (**NEW**) "**Mill Qualification Tests**" of this specification. Requirement of **Mill Qualification Tests** mentioned at B6 (New) of this specification may be waived by mutual agreement between Company and the Manufacturer in case Manufacturer possess records of successful performance of these **Tests** on a previous supply of line pipes produced by the same method of manufacture, similar chemical

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composition and grade of steel and subjected to similar heat treatment provided such tests had been performed not earlier than two years prior to this enquiry. Such test certificates duly witnessed and approved by an internationally reputed independent Inspection Agency along with a description of the tests performed shall be furnished by the Manufacturer in case Manufacturer desires a waiver of these tests

#### **MPQT/ FIRST DAY PRODUCTION TESTS**

The MPS shall be qualified for each pipe nominal diameter either as a part of first day production or as a separate MPQT prior to full scale production. Two lengths of completely finished pipes (in case of only one heat on first day) or two lengths from the first two heats i.e. one pipe from each heat (in case of more than one heat on first day) of first day's production shall be selected at random for testing to verify that the manufacturing procedure results in the quality of pipes which are in complete compliance with this specification. The MPQT/ first day production tests shall be carried out on pipes as per requirement of para B.5.1 (Substituted) of this specification..

The MPQT/ first day's production tests shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser Representative

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 Annexure.

##### **a. Visual Examination**

All pipes shall be examined visually for dimensional tolerances and apparent surface defects in accordance with 9, 10 & 11 respectively of this specification.

##### **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 Representative will select the places in pipe from where the test specimen shall be removed.

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The following tests shall be conducted:

- i. Four (4) weld guided bend test specimen transverse to the longitudinal weld shall be removed. Of the four specimen, two specimen shall be used for the face bend test and two for the root bend test.
- ii. Tensile tests shall be conducted on:
  - Two (2) transverse base material specimen.
  - Two (2) transverse weld material specimen of the longitudinal weld.
  - Two (2) longitudinal base material specimen.
- iii. Six (6) weld cross-section specimen, three (3) from each end of pipe joint shall be taken for metallographic examination. Two of these shall be tested for hardness at room temperature after etching.
- iv. Fracture toughness testing specimen shall be extracted as follows:
  - Four sets of three transverse specimens each from base metal
  - One set of 3 transverse specimens with weld in middle
  - One set of 3 transverse specimens with HAZ in middle

The base metal specimen shall be tested at -10, 0, +10, 20°C for absorbed energy. The value of absorbed energy at the test temperature as per para 9.8 of this specification shall be used to evaluate the test. The sets of weld and HAZ specimen shall be tested for absorbed energy only at the same test temperature applicable as per para 9.8 of this specification.
- v. Twelve (12) DWTT specimen shall be removed from base metal in a transverse direction. The sets of 3 base metal specimen shall be tested at -10, 0, 10, +20°C for shear area. The value at the test temperature specified in para 9.9 of this specification shall be used to evaluate the test. Full transition curve shall be established for the heat.

#### **e. CTOD Test**


CTOD testing shall be carried out in accordance with the requirements of BS7448:1991.

Two sets of specimens with each set consisting of three specimens shall be taken transverse to the longitudinal weld with the notch in the weld metal and in HAZ.

Two sets of specimen with each set consisting of three specimens shall be taken from the base metal with one set in longitudinal direction and other set in transverse direction . The test shall be carried out at 0 °C.

Minimum acceptable critical CTOD value shall be 0.2 mm for BM (Base Metal) as well as WM (Weld Metal). Average CTOD values of BM, WM and HAZ shall be reported. In addition, all the data on fatigue pre-cracking front are required. (Crack length at the following positions i.e. both surfaces 25%, 50% and 75% of the specimen thickness, the minimum and the maximum angle between the crack and the plane of the notch).

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#### **f. Corrosion Tests**

- i) HIC test shall be carried out as per clause H.7.3.1.1 of API 5L & H4.3 of this specification.
- ii) Four point bend test shall be carried out as per clause H.7.3.2.1 of this specification & H.4.5 of API 5L.

**g.** In addition, all the remaining tests and inspections required to be conducted as per this specification shall be conducted on all the pipes selected for testing during first day production test.

#### **B.6 (NEW) Mill Qualification Test**

Prior to start of regular production, the following tests shall be carried out, in order to qualify the Mill for regular production of pipes.

#### **Sulphide Stress Cracking Test.**

Manufacturer shall carry out NACE standard tensile test (Method A) for Sulphide Stress Cracking Test in accordance with NACE standard TM-0177 ( Latest). The test shall be carried out at 60, 72, 80, 90 and 100% SMYS stress levels to produce a curve. Minimum stress for failure after 720 hours shall be at least 72% of SMYS.


#### **Hydrogen Induced Cracking Test.**

The HIC test shall be carried out in accordance with NACE standard TM-0284 ( Latest), "Test Method of Pipeline Steel for Resistance to Stepwise Cracking" and as specified in clause H.7.3.1.1 of API 5L The acceptance criteria for crack sensitivity ratio (CSR) shall be 1.00%.

#### **Four Point Bend Test**

Manufacturer shall carry out Four Point Bend Test using NACE solution as specified in clause H.7.3.2.1 of this specification. The acceptance criteria shall be that the specimen shall not have any SSC cracks when examined visually as well as with wet magnetic particle method.

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## **Annex C (AMEND)**

### **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 methods as per Annexure K (amended). To be acceptable, the wall thickness in the ground area shall be in accordance with 9.11.3.2 of this specification. Further, the sum of all ground areas shall not exceed 10% of total internal and external surface area of each pipe.

### **C.4 Repair of defects by welding**

**C.4.2 ADD** No repair of weld seam is permitted after cold expansion.

No repair of weld seam is permitted at pipe ends up to a length of 300 mm.

Repair welding shall be executed only after specific approval by Purchaser Representative for each repair. The defective part of the weld shall be clearly marked on the pipe so that the defect can be easily located and repaired. The repair welding shall be performed with a minimum of two passes.

Repair Welding on the pipe Body is not allowed. Defects in the pipe material such as laminations may 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 pipe ends are tested for laminations as per requirements of this specification.

No repair of a repaired weld is permitted.


#### **C.4.6 AMENDED**

After weld repair, the total area of the repair shall be ultrasonically and Radiographically inspected in accordance with Annex K and Annex. E respectively. Before expansion or hydrotest, the type of UT may be at the option of the pipe manufacturer but, after expansion or hydrotest, inspection shall be by manual UT. It would also be acceptable to carry out combined automatic and manual UT after expansion or hydrotest.

#### **C.4.8 AMENDED**

Pipe that has been repair welded shall be hydrostatically tested after repair welding in accordance with 10.2.6 of this specification.

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## **Annex D (Amended) – Repair Welding Procedure**

### **D.2.4 NDT of weld repair procedure qualification test**

#### **Amend**

Repaired welds shall be inspected by Ultrasonic and Radiographic inspection techniques.

#### **D.2.5 (New)**

Hardness test as specified in para H-7.3.3 & H.4.4 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.


#### **D.2.6 (New)**

Hydrogen Induced Cracking Test as specified in para H-7.3.1 & H.4.3 of this specification shall be included in the procedure qualification.

#### **D.2.7 (New)**

Four Point Bend Test as specified in para H-7.3.2 & H.4.5 of this specification shall be included in the procedure qualification.

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## Annex H (AMENDED)


### PSL 2 pipe ordered for sour service

### H.2 Additional information to be supplied by the purchaser

#### Information Requirement

	Information sought as per API 5L	COMPANY's Requirement						
a)	steel casting method for strip or plate used for the manufacture of welded pipe (see H.3.3.2.1)	Strip or plate used for the manufacture of welded pipe shall be rolled from continuously (strand) cast or pressure cast slabs. The pipe shall be SAWL.						
b)	ultrasonic inspection of strip or plate for laminar imperfections (see H.3.3.2.4) for HFW pipes	Not Applicable						
c)	supply of helical-seam pipe containing coil/plate end welds (see H.3.3.2.5)	Not applicable						
d)	chemical composition for intermediate grades (see H.4.1.1)	Not applicable						
e)	chemical composition for pipe with $t > 25,0$ mm (0.984 in) (see H.4.1.2)	For Quenched and Tempered Delivery Condition, Chemical Composition of Pipes shall be as per Table H.1 of API 5L, 45 <sup>Th</sup> Edition. For Thermo-mechanical rolled or formed delivery condition, Chemical Composition of Pipes shall be as per Table H.1 of API 5L, 45 <sup>Th</sup> Edition but the Carbon equivalent may be increased with 0.01.						
f)	chemical composition limits [see Table H.1, footnotes c), d), e), f), i), j) and k)]	Chemical composition limits at footnotes of Table H.1 shall be as follows: <table><tr><td>Footnote</td><td>Acceptable/ Not Acceptable</td></tr><tr><td>c, d,f,i,j,k</td><td>Acceptable</td></tr><tr><td>e</td><td>Not Acceptable</td></tr></table>	Footnote	Acceptable/ Not Acceptable	c, d,f,i,j,k	Acceptable	e	Not Acceptable
Footnote	Acceptable/ Not Acceptable							
c, d,f,i,j,k	Acceptable							
e	Not Acceptable							
g)	frequency of hardness testing of the longitudinal seam weld of HFW or SAW pipe (see Table H.3)	Refer para 10.2.1.2 of this specification.						
h)	SSC test for manufacturing procedure qualification (see Table H.3)	SSC test is required in accordance with Annex B (Amended) of this specification.						
i)	alternative HIC/SWC test methods and associated acceptance criteria (see H.7.3.1.3)	Acceptance criteria shall be as per H.4.3 of this specification.						


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j)	photomicrographs of reportable HIC cracks (see H.7.3.1.4)	Photomicrographs of all the HIC test pieces shall be provided.
k)	alternative SSC test methods and associated acceptance criteria for manufacturing procedure qualification (see H.7.3.2.2)	SSC test is required in accordance with Annex B (Amended) of this specification. Alternate SSC test methods are not acceptable.
l)	deviation from hardness test (see H.7.3.3.2 and H.7.3.3.3);	Not applicable
m)	deviation from 4 hardness impressions [see H.7.3.3.2 c)];	Not applicable
n)	for pipe with $t \geq 5,0$ mm (0.197 in), ultrasonic inspection for laminar imperfections within extended length of 100 mm (4.0 in) at the pipe ends (see K.2.1.3)	Required
o)	supplementary end NDT lamination criteria (see K.2.1.3 and K.2.1.4);	Required
p)	magnetic particle inspection for laminar imperfections at each pipe end face/bevel (see K.2.1.4)	Required
q)	verification of lamination size/density (see K.3.2.2);	Applicable; refer K.5.2.1 (amended) of this specification
r)	increased coverage for ultrasonic thickness measurements for SMLS pipe (see K.3.3)	Not applicable
s)	application of one or more of the supplementary non-destructive inspection operations for SMLS pipe (see K.3.4)	Not applicable
t)	ultrasonic inspection of SMLS pipe for the detection of transverse imperfections (see K.3.4.1);	Not applicable
u)	full-body inspection of SMLS pipe the flux leakage method for the detection of longitudinal and transverse imperfections (see K.3.4.2);	Not applicable
v)	full-body inspection of SMLS pipe by the eddy current method (see K.3.4.3);	Not applicable
w)	full-body magnetic particle inspection of pipe (see K.3.4.4);	Not Applicable
x)	limitation of individual lamination size to 100 mm <sup>2</sup> (0.16 in <sup>2</sup> ) (see Table K.1)	Applicable
y)	acceptance level U2/U2H for nondestructive inspection of the weld seam of HFW pipe (see K.4.1)	Not Applicable
z)	alternate ISO 10893-10 HFW weld seam UT acceptance criteria [see K.4.1 b)];	Not Applicable

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aa)	ultrasonic inspection of the pipe body of HFW pipe for laminar imperfections (see K.4.2)	Not Applicable
bb)	ultrasonic inspection of the strip/plate edges or areas adjacent to the weld for laminar imperfections (see K.4.3)	Not Applicable
cc)	non-destructive inspection of the pipe body of HFW pipe using the ultrasonic or flux leakage method (see K.4.4)	Not Applicable
dd)	use of fixed depth notches for equipment standardization [see K.5.1.1 c)]	Applicable
ee)	radiographic inspection of pipe ends (non-inspected ends) and repaired areas [see K.5.3 a)]	Refer K 5.3 of this specification
ff)	magnetic particle inspection of the weld seam at the pipe ends of SAW pipe (see K.5.4)	Not Applicable

### **H.3 Manufacturing**

#### **H.3.1 Manufacturing procedure**

##### **SUBSTITUTE**

All pipes shall be manufactured in accordance with a manufacturing procedure that has been qualified in accordance with Annex B (Amended)

#### **H.3.3 Pipe manufacturing**

##### **H.3.3.3 Joints**

##### **SUBSTITUTE**

Joints are not permitted

#### **H.4.3 HIC/SWC TEST**

##### **AMEND**


The acceptance criteria for crack sensitivity ratio (CSR) shall be 1.00%.

#### **H.4.4 Hardness test**

##### **SUBSTITUTE**

Vickers hardness tests as per ASTM E 384 shall be carried out on samples of pipes at locations indicated in Figure H.1 a) to establish that the hardness shall not exceed 235 HV<sub>10</sub> for the base material of pipe and 250HV<sub>10</sub> for Weld &

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HAZ. Testing frequency shall be same as for tensile tests as specified in 10.2.1.2 of this specification. Modalities of retest shall be in accordance with 10.2.12 of this specification.

## **H.7 Inspection**


### **H.7.1 Specific inspection**

#### **SUBSTITUTE**

The frequency of inspection shall be as given in Table 18 of API 5L 45<sup>th</sup> Edition except as specifically modified in Table H.3 of API 5L 45<sup>th</sup> Edition and Table H.3 (Amended) of this specification.

**Table H.3 — Inspection frequency (Amended)**

<b>Type of Inspection</b>	<b>Frequency of inspection</b>
Product Analysis	Two pipes per heat of steel shall be analyzed for all elements listed in Table J.1 of API 5L, 45 <sup>th</sup> Edition. When more than 100 pipes are manufactured from one heat, additional product analysis for one pipe shall be carried out for every 100 pipes or less of the same heat.
hardness testing of the longitudinal-seam weld & HAZ of welded pipe with $D < 508$ mm (20.000 in)	Once per test unit of not more than 100 lengths of pipe with the same cold expansion ratio <sup>a</sup>
hardness testing of the longitudinal-seam weld & HAZ of welded pipe with $D < 508$ mm (20.000 in)	Once per test unit of not more than 50 lengths of pipe with the same cold expansion ratio <sup>a</sup>
Non-destructive inspection	In accordance with Annex K (Amended)
CTOD test for pipe of all Grades	As per Annex B (Amended) of this specification..
SSC test (mill qualification test)	Refer Annex B (Amended)
Four Point Bend Test	One test for each of the first three heats applied; thereafter, one test for each test unit of not more than ten heats of steel.
Mill Qualification and First Day Production Test	Mill Qualification, Manufacturing Procedure Qualification test (MPQT) / First Day Production Test As per Annex B (Amended) of this specification.

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### H.7.3 Test method

#### H.7.3.1 HIC/SWC test

##### H.7.3.1.1 SUBSTITUTE

The HIC test shall be carried out in accordance with NACE standard TM-0284, “Test Method for Pipeline Steels for Resistance to Stepwise Cracking”. Three specimens shall be taken from each test pipe (one across the weld, one 90° from the weld and one 180° from the weld) and shall be tested in the test solution A of NACE TM-0284 for 96 hours. The acceptance criteria for crack sensitivity ratio (CSR) shall be 1.00%. The HIC test shall be carried out on one pipe from each of the first three heats and then on one pipe from every ten subsequent heats. The selection of the specific sample heat shall be as per the decision of the Company Representative.

If one specimen fails to meet the acceptance criteria, three more specimens shall be taken from the same pipe for retests. If one of these fails, two additional pipes of the same heat shall be selected and from each of these two pipes three specimens shall be taken for retests. If one of these six specimens fails, the heat shall be rejected. If retest results are acceptable, only the pipes from which the earlier (failed) specimens were taken shall be rejected and all other pipes of the heat shall be accepted. Should a specimen fail to pass the retest, then Company Representative shall have the right to decide on the further testing to distinguish heats which can be accepted.

#### H.7.3.2 SSC test

##### H.7.3.2.1 SUBSTITUTE


SSC tests shall be performed in accordance with NACE TM0177 using test Solution A.

SSC test for mill qualification of 720 hrs test duration shall be in accordance with Annex B (Amended).

#### Four Point Bend Test

Four point bend test specimen preparation and size shall be as per ASTM G 39 except that thickness shall be minimum 5 mm. One set of three specimens from base metal and one set of three specimens from weld shall be machined from the middle of the pipe wall thickness. The specimen shall be machined transverse to the pipe axis. In case of specimen with weld, the specimen shall be taken with weld in the middle. The specimens shall be bent using Four point Loading jigs to reach a stress level of 72% SMYS and then immersed in NACE solution as per NACE standard TM-0177 for a period of 96 hours with the inner surface/ root in tension. Testing sequence shall be in accordance with NACE TM 0177. The acceptance criteria shall be that the specimen shall not have any SSC cracks when examined visually as well as with wet magnetic particle technique. Four point bend test shall be carried out on one pipe

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from each of the first three heats and then on one pipe from every ten subsequent heats. The selection of the specific sample heat out of every ten heats shall be as per the decision of Company's Representative.

If one specimen fails to meet the criteria, the retest and acceptance procedure shall be as mentioned in Clause H.7.3.1.1 above.

#### **H.7.3.2.2 DELETED**

#### **H.7.3.3 Hardness test**

##### **H.7.3.3.1 AMEND**


Hardness testing shall be performed using the Vickers test in accordance with ISO 6507-1 or ASTM E 384.

#### **H.7.5 HIC/SWC retests**

##### **SUBSTITUTE**

The retest and acceptance procedure shall be as mentioned in Clause H.7.3.1.1 above

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## Annex J (AMENDED)


### PSL 2 pipe ordered for offshore service

#### J.2 Additional information to be supplied by the purchaser

##### Information Requirement


	Information sought by API 5L	COMPANY's Requirement
a)	steel casting method for strip or plate used for the manufacture of welded pipe (see J.3.3.2.1)	strip and plate used for the manufacture of welded pipe shall be rolled from continuously (strand) cast or pressure cast slabs.
b)	ultrasonic inspection of strip or plate for laminar imperfections (see J.3.3.2.4)	strip and plate shall be inspected ultrasonically for laminar imperfections or mechanical damage in accordance with annex K, either before or after cutting the strip or plate, or the completed pipe shall be subjected to full-body inspection, including ultrasonic inspection.
c)	supply of helical-seam pipe containing coil/plate end welds (see J.3.3.2.5)	Not applicable
d)	chemical composition for intermediate grades (see J.4.1.1)	Not applicable
e)	chemical composition for pipe with $t > 25,0$ mm (0.984 in) (see J.4.1.2)	Refer 7.2a (3) of this specification.
f)	carbon equivalent limit for steel Grade L555QO or X80QO, L625QO or X90QO, and L690QO or X100QO (see Table J.1);	Not applicable
g)	Chemical composition limits [see Table J.1, footnote d]	Applicable.
h)	Acceptance criteria for tensile properties if determined at other than room temperature (see J.4.2.2)	Not applicable
i)	for grades equal to or greater than Grade L555 or X80, a lower maximum tensile strength limit may be agreed [see Table J.2, footnote b)];	Not applicable
j)	Minimum average length other than 12,1 m (39.7 ft) and/or different range (see J.6.3)	Refer J.6.3 of API 5L 45 <sup>th</sup> Edition.
k)	Diameter and out-of-roundness tolerances for SMLS pipe with $t > 25,0$ mm (0.984 in) [see Table J.3, footnote b)]	Not Applicable

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l)	Use of inside diameter to determine diameter and out-of-roundness tolerances for non-expanded pipe with $D \geq 219,1$ mm (8.625 in) [see Table J.3, footnote c)]	Acceptable
m)	hardness test of the pipe body seam weld and HAZ of EW and SAW pipe (see Table J.7);	Required
n)	hardness testing of pipe body for SMLS pipe (see Table J.7);	Not applicable
o)	CTOD testing (see J.8.2.2 and Table J.6);	Refer Annex B (Amended) of this specification.
p)	use of the ring expansion test for transverse yield strength determinations [see Table J.7, footnote c)];	Not applicable
q)	additional longitudinal tensile testing for deep-water pipelay [see Table J.7, footnote d)];	Not applicable
r)	deviation from hardness test [see J.8.3.2.2 c) and J.8.3.2.3];	Not applicable
s)	deviation from location of hardness test [J.8.3.2.2.c)];	Not applicable
t)	for pipe with $t \geq 5,0$ mm (0.197 in), ultrasonic inspection for laminar imperfections within extended length of 100 mm (4.0 in) at the pipe ends (see K.2.1.3);	Applicable
u)	supplementary end NDT lamination criteria (see K.2.1.3 and K.2.1.4);	Applicable
v)	magnetic particle inspection for laminar imperfections at each pipe end face/bevel (see K.2.1.4);	Applicable
w)	ultrasonic inspection to verify conformance with the applicable requirements given in Table K.1 (see K.3.2.2);	Applicable; refer K.5.2.1 (amended) of this specification.
x)	verification of lamination size/density (see K.3.2.2);	Applicable. refer K.5.2.1 (amended) of this specification.
y)	increased coverage for ultrasonic thickness measurements for SMLS pipe (see K.3.3);	Not applicable
z)	application of one or more of the supplementary non-destructive inspection operations for SMLS pipe (see K.3.4);	Not applicable
aa)	ultrasonic inspection of SMLS pipe for the detection of transverse imperfections (see K.3.4.1);	Not applicable
bb)	full-body inspection of SMLS pipe the flux leakage method for the detection of longitudinal and transverse imperfections (see K.3.4.2);	Not applicable

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cc)	full-body inspection of SMLS pipe by the eddy current method (see .3.4.3);	Not applicable
dd)	full-body magnetic particle inspection of pipe (see K.3.4.4);	Not applicable
ee)	Acceptance Level U2/U2H for non-destructive inspection of the weld seam of HFW pipe (see K.4.1);	Not applicable
ff)	alternate ISO 10893-10 HFW weld seam UT acceptance criteria [see K.4.1 b)];	Not applicable
gg)	ultrasonic inspection of the pipe body of HFW pipe for laminar imperfections (see K.4.2);	Not applicable
hh)	ultrasonic inspection of the strip/plate edges or areas adjacent to the weld for laminar imperfections (see K.4.3);	Not applicable
ii)	non-destructive inspection of the pipe body of HFW pipe using the ultrasonic or flux-leakage method (see K.4.4);	Not applicable
jj)	use of fixed-depth notches for equipment standardization [see K.5.1.1 c)];	Applicable
kk)	radiographic inspection of the pipe ends (non-inspected pipe ends) and repaired areas [see K.5.3 a)];	Applicable. Refer K.5.3 of this specification
ll)	magnetic particle inspection of the weld seam at the pipe ends of SAW pipe (see K.5.4).	Not Applicable
mm)	for grades L625QO or X90QO, and L690QO or X100QO, a lower $Rt_{0.5}/R_m$ (see Table J.2).	Not applicable

### **J.3 Manufacturing**

#### **J.3.1 Manufacturing procedure**

##### **SUBSTITUTE**

All pipes shall be manufactured in accordance with a manufacturing procedure that has been qualified in accordance with Annex B (Amended).

#### **J.3.3 Pipe manufacturing**

##### **J.3.3.3 Joints**


##### **SUBSTITUTE**

Joints are not permitted

#### **J.4.2 Tensile properties**

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#### **J.4.2.1 SUBSTITUTE**

The minimum Yield strength and minimum Tensile strength of finished pipes (after all heat treatment and sizing operations) shall conform to the requirements of Table-J.2 of API 5L. However, other requirements of Table-J.2 are not applicable.

The actual yield strength shall be as close as possible to the specified minimum yield strength but in no case it shall be more than 133% of the specified minimum yield strength.

The ratio between yield strength and ultimate tensile strength of finished pipes shall not be more than 0.90.

#### **J.4.2.2 DELETE**

#### **J.4.3 Hardness test**

##### **SUBSTITUTE**

Refer H.4.4 of this specification.

#### **J.6 Tolerances for diameter, wall thickness, length and straightness**

##### **J.6.2 SUBSTITUTE**

Wall thickness tolerance for all sizes shall be - 0.5 and +1.0 mm. Table J.4 shall not be applicable.

#### **J.8 Inspection**

##### **J.8.2 Samples and test pieces for mechanical and technological tests.**

##### **J.8.2.3 Samples for hardness tests**

##### **AMEND**

Refer H.7.2.4 of API 5L.


##### **J.8.3 Test method**

##### **J.8.3.1 CTOD Test**

##### **SUBSTITUTE**

CTOD testing shall be carried out in accordance with the requirements of BS7448:1991 Two sets of specimens with each set consisting of three specimens shall be taken transverse to the longitudinal weld with the notch in the weld metal and in HAZ.

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Two sets of specimen with each set consisting of three specimens shall be taken from the base metal with one set in longitudinal direction and other set in transverse direction. The test shall be carried out at 0°C.


Minimum acceptable critical CTOD value shall be 0.2 mm for BM (Base Metal) as well as WM (Weld Metal). Average CTOD values of BM, WM and HAZ shall be reported. In addition, all the data on fatigue pre-cracking front are required. (Crack length at the following positions i.e. both surfaces 25%, 50% and 75% of the specimen thickness, the minimum and the maximum angle between the crack and the plane of the notch).

### **J.8.3.2 Hardness test**

#### **J.8.3.2.1 AMEND**

**Refer H.7.3.3.1 of this specification.**

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## **Annex K (AMENDED)**

**Non-destructive inspection for pipe ordered for sour service and / or offshore service.**

### **K.1 Introduction**

#### **ADD**

If during the controls carried out in the mill, defects are found to occur at a rate over or equal to 5% for a specific type of defect or defects are found after inspection/clearance by manufacturer, the Company's Representatives shall have the right to request that the quality control program be increased to an appropriate level and maintained until the defect causes are identified and eliminated. All the tests and inspections shall be carried out in the Mill at the Manufacturer's care and account.

For UT at least one level III qualified inspector shall be available at the mill for overall supervision. A level II inspector is required for shift supervision, manual weld inspection, and calibration of all systems (both manual and automated).

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 hydrotesting but may take place before cropping , beveling and end sizing.

#### **K2.1.3 (AMEND)**

Ultrasonic inspection with automated/semi-automated systems in accordance with ISO 10893-8 or by manual methods, as specified in Annex A of ISO 10893-8 shall be used to verify that 100mm wide zone at each pipe end is free of laminar defects.

#### **K2.1.4 (Amend)**

The end face/bevel at each pipe end shall be magnetic particle inspected for the detection of laminar imperfections in accordance with ISO 10893-5 or ASTM E709. Laminar imperfections > 6.4 mm (0.25 in) in the circumferential direction shall be classified as defects.

Residual magnetism after MPI shall not exceed 20Gauss measured by Hall Effect Gauss Meter.

#### **K2.2.3 ( Amend)**

Repair by welding shall be in accordance with Clause C.4 of this specification.


### **K.5.2**

#### **Laminar imperfections in the pipe body and on the strip/plate edges**

##### **K.5.2.1 (AMEND)**

Entire strip/plate surface or 100% of the pipe body shall be ultrasonically inspected for the detection of laminar imperfections in accordance with ISO 10893-9.

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Acceptance criteria for laminar imperfections shall be as per table K.1 of API 5L 45<sup>th</sup> edition for the service condition “Sour, if agreed” for Pipe body and strip/plate surface. Such inspection shall be carried out in the pipe mill.

#### **K.5.2.2 (AMEND)**

100% of the strip/plate edges after cutting & beveling the strip/plate shall be inspected by ultrasonic testing for the detection of laminar imperfections in accordance with ISO 10893-9.

Acceptance criteria for laminar imperfections shall be as per table K.1 of API 5L 45<sup>th</sup> edition for the service condition “sour or offshore” for Strip/plate edges or areas adjacent to the weld seam with the amendment of “Minimum imperfection size considered” for length as 5mm.

The full circumference of both ends of each pipe after beveling shall be 100% ultrasonically tested for laminations, inclusions and cracks over circumferential bands of at least 100mm width.

Such inspection shall be carried out in the pipe mill.

#### **K.5.3 Non-destructive inspection of the weld seam at the pipe ends/repared areas (Amend)**

The length of weld seam at pipe ends that cannot be inspected by the automatic ultrasonic equipment and repaired areas of the weld seam (see Clause C.4 of this specification), shall be subjected to the following.

- a) For the detection of longitudinal imperfections, manual or semi-automatic ultrasonic inspection using the same inspection sensitivity and inspection parameters as is specified in K.5.1.1.
- b) For the detection of transverse imperfections, a manual/semi-automatic ultrasonic inspection using the same inspection sensitivity and parameters as is specified in K.5.1.1  
For manual ultrasonic inspection, the scanning speed shall be  $\leq 150$  mm/s (6 in/s).
- c) The repaired areas of the weld seam shall be inspected by Radiography as per clause E.4 in addition to UT (as given at a & b above) for detection of longitudinal and transverse imperfections.

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