



**STANDARD SPECIFICATION FOR  
SEAMLESS (SMLS) LINE PIPE (ONSHORE)**

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**STANDARD SPECIFICATION FOR  
SEAMLESS (SMLS) LINE PIPE (ONSHORE)**

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## 1. SCOPE

This specification establishes the minimum requirements for the manufacture of seamless steel line pipe for onshore service in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty-Fifth Edition, 2012 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 Spec 5L in order to facilitate reference. Additional requirements, which are not specified in API Spec 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 **"PSL 2"**.

The Manufacturer shall have a valid license to use API Monogram in accordance with the requirements of Specification 5L, Forty-Fifth Edition, 2012 for line pipe as Product Specification Level PSL 2.

### 1.1 Pipe Size

This Specification shall be applied to line pipe of size 4.5" OD thru 20" OD (both sizes included).

## 3. NORMATIVE REFERENCES

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

ASTM

ASTM E112: Standard Test Methods for Determining Average Grain size

## 6. PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

### 6.1 PIPE GRADE AND STEEL GRADE


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 (N or Q) that identifies the delivery condition as per Table 3 of this specification.

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

**Table 1- Pipe grades, steel grades and acceptable delivery conditions**

PSL	Delivery Condition	Pipe grade! steel grade <sup>a,b</sup>
PSL -2	Normalized	BN, X42N, X46N, X52N
	Quenched and tempered	BQ, X42Q, X46Q, X52Q, X56Q, X60Q, X65Q & X70Q

a Deleted  
b The suffix (N or Q) for PSL 2 grades belongs to steel grade

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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 Spec 5L and Table 3 of this specification.

Table 3 of API Spec 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
SMLS	Ingots, Bloom or billet	Normalising forming	Heat treating a of weld area only	N
		Hot forming	Normalising or Quenched & Tempered	N or Q
		Hot forming and cold finishing		N or Q

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 grain size number 7 or finer as per ASTM E 112.

8.9 COLD SIZING AND COLD EXPANSION

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

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 Spec 5L stands replaced by Table 5 of this specification.

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**Table 5 - Chemical composition for pipe**

Element	Mass fraction based upon heat and product analyses (%)	
C <sup>b</sup>	0.16	max.
Si	0.15 <sub>m(new)</sub>	min.
	0.40	max. (For Grade B to X46)
	0.45	max. (For Grade X52 to X70)
Mn <sup>b</sup>	1.20	max. (For Grade B to X42)
	1.40	max. (For Grade X46 & X70) for delivery condition N
	1.50	max. (For Grade X60 & X65) for delivery condition Q
	1.60	max. (For Grade X70) for delivery condition Q
P	0.020	max.
S	0.010	max.
V	<sup>c</sup>	(For Grade B)
	0.05	max. (For Grade X42 to X52)
	0.07 <sup>g</sup>	max. (For Grade X56)
	0.08 <sup>g</sup>	max. (For Grade X60 to X70)
Nb	<sup>c</sup>	(For Grade B)
	0.05 <sup>g</sup>	max. (For Grade X42 to X70)
Ti	0.04 <sup>g</sup>	max. (For Grade B to X60)
	0.06 <sup>g</sup>	max. (For Grade X65 & X70)
Al <sup>a (new)</sup>	0.07	max.
Cr	0.20	
Mo	0.10	
Cu	0.35	
Ni	0.20	
N <sup>n (new)</sup>	0.012	
B	0.0005	

a Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the CE<sub>Pcm</sub> limits apply if C ≤ 0.12% and CE<sub>nw</sub> limits apply if C > 0.12%. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:

CE<sub>Pcm</sub> ≤ 0.20 %

CE<sub>nw</sub> ≤ 0.40%

Boron content shall be considered in CE<sub>Pcm</sub> formula even if it is less than 0.0005%.

b Deleted

c Nb + V = < 0.06%

d Deleted

e Deleted

f Deleted

g Nb + V + Ti = < 0.15%

h Deleted.

l Deleted  
 j Deleted  
 k Deleted  
 l Deleted  
 (New) m Minimum for Si is not applicable for Al killed steel.  
 (New) n AllN shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel).  
 (New) o  $Cu + Ni = < 0.40\%$

9.2.3 For heat analysis and product analysis, all the elements listed in Table 5 of this specification shall be analysed 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 all heat treatment & sizing operations) shall conform to the requirements of Table 7 of API Spec 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:

API Spec 5L Grade	Permissible in excess of SMYS, MPa (psi)
Up to and including X46	131 (19,000)
X52 to X60	125 (18,000)
X65 to X70	120 (17,400)

The ratio of body yield strength and body tensile strength of each test pipe on which yield strength and ultimate tensile strength are determined, shall not exceed 0.90.

The minimum elongation of base metal shall be determined in accordance with the formula given in foot note (f) of Table 7 of API Spec 5L, however, minimum elongation shall be at least 20% for  $t \leq 12.7$  mm and 22% for  $t > 12.7$  mm.

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8 CVN IMPACT TEST FOR PSL 2 PIPE

9.8.1 General

9.8.1.2 From the set of three Charpy V-notch impact test pieces, only one is allowed to be below the specified average absorbed energy value and shall meet the minimum single absorbed energy value requirement as specified in Table 8 of 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 8 of this specification, based upon 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.

Table 8 of API Spec 5L stands replaced by Table 8 of this specification.

**Table 8 - CVN absorbed energy requirements  
for pipe body, weld and HAZ of PSL 2 pipe**

Pipe Grade	Full-size CVN absorbed energy (KvT) <sup>a,b</sup> [J]	
	Average	Minimum
B	40	33
X42	40	33
X46	40	33
X52	40	33
X56	40	33
X60	42	35
X65	45	38
X70	50	40

a. The required KvL (longitudinal direction test pieces) values shall be 50% higher than the required KvT values.  
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.

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9.8.2.2 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 OF) 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 Spec 5L.

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 Spec 5L.

9.10.5 Geometric deviations

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) 2 mm for types of dents and not encroaching upon the minimum specified wall thickness

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 Spec 5L. Acceptable cold-formed dents with sharp-bottom gouges shall be treated in accordance with clause C.2 of API Spec 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 248HV 10 shall be classified as defect and treated in accordance with clause C.3 of API Spec 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  $\leq 0.05 t$  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  $> 0.05 t$  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 Spec 5L and as modified in this specification or shall be treated in accordance with clause C.3 of API Spec 5L.

c) Imperfections that have a depth  $> 0.05 t$  and encroach on the minimum specified wall thickness shall be classified as defects and treated in accordance with clause C.3 of API Spec 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.

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

**Table 10 - Tolerances for diameter and out-of-roundness**

Specified outside Diameter (D) mm (inch)	Diameter tolerances <sup>a</sup>		Out-of-roundness	
	Pipe except the end <sup>a</sup>	Pipe end <sup>a,c</sup>	Pipe except the end <sup>a</sup>	Pipe end <sup>a,c</sup>
114.3 (4 1/2) =< D = < 168.3 (6 3/8)	± 0.0075 D	-0.4 mm to + 1.6mm	0.020D	2.0mm
168.3 (6 3/8) < D = < 273.1 (10 3/4)		±0.005 D, but maximum of ± 1.6mm	0.020D	2.0mm
273.1 (10 3/4) < D > 406.4 (16)			0.020D	3.0mm

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).  
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 Out-of-roundness tolerances apply to maximum and minimum diameters as (New) 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 Spec 5L stands replaced by Table 11 of this specification.

**Table 11- Tolerances for wall thickness**

Wall thickness (mm)	Tolerances c, d (mm)
t < 10.0	+0.225 t -0.05 t
10.0 = < t < 15.0	+0.20 t -0.05 t
t ≥ 25.0	+5.00 -1.25

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 Spec 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 Spec 5L stands deleted.

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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 Spec 5L.

b) The local deviation from straight line in 1.0 m (3.0 ft) portion at each pipe end shall be  $\leq 3.0$  mm (0.120 in), as shown in Figure 2 of API Spec 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.

## 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 Spec 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 <sup>a</sup>	One analysis per heat of steel
2	Product analysis <sup>d</sup>	Two pipes per lot (maximum 100 pipes) per heat
3	Tensile testing of the pipe body	Two pipes per test unit of not more than 100 pipes per heat

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4	CVN impact testing of the pipe body	Once per test unit of not more than 100 pipes
5	Vickers hardness testing of Pipe body	Once per test unit of not more than 50 pipes
6	Hydrostatic testing	Each pipe
7	Visual inspection	Each pipe
8	Pipe diameter and out-of roundness <sup>d</sup>	Each pipe
9	Wall thickness measurement <sup>d</sup>	Each pipe
10	Straightness <sup>d</sup>	At least 3 times per operating shift (12 hours maximum)
11	Other dimensional testing	Random testing, with the details left to the discretion of the manufacturer
12	Weighing of pipe	Each pipe shall be measured and recorded
13	Non-destructive inspection	In accordance with Annex E of API Spec 5L and as modified herein
14	Length	Each length of pipe shall be measured and recorded

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.

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.

c Deleted.

d Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum).

e "Test unit" is as defined in clause 4.62 of API Spec 5L.

#### 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.

#### 10.2.3 Samples and test pieces for mechanical tests

##### 10.2.3.1 General

In addition to API Spec 5L requirements, samples and test pieces for various types of tests shall be taken from Figure 5 a) of API Spec 5L and Figure 10.2.4.8.1 of this specification, whichever is applicable, and as given in Table 20 of this specification.

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

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**Table 20 - Number, orientation and location of test pieces per sample for mechanical tests**

Sample Location	Type of test	Number, Orientation and location of test pieces per sample a
Pipe body	Tensile	IL, IT <sup>b</sup>
	CVN	3T
	Hardness	IT
<p>A See figure 5 (b) of API Spec 5L for an explanation of the symbols used to designate orientation and location.</p> <p>B The transverse tensile tests shall be carried out on pipes of D &gt;= 219.1 mm.</p>		

10.2.3.2 Test pieces for the tensile test

Tensile test specimens shall be taken from finished pipes only. Heating or artificial ageing of tests pieces is not permitted.

Transverse test pieces shall have a round cross-section and shall be obtained from non - flattened samples prepared according to ASTM A370.

Longitudinal tensile tests shall be carried out on a strip specimen representing full wall thickness of the pipe prepared according to ASTM A370.

10.2.3.3 Test pieces for the CVN impact test

In addition to the API Spec 5L requirements, following shall also be applicable:

The test pieces shall be prepared in accordance with ASTM A370. Non-flattened test pieces shall be used. Test specimen shall be taken from the body of the finished pipe only. The axis of the notch shall be perpendicular to the pipe surface.

Charpy V-notch impact testing shall be performed on full-sized test pieces. However, if preparation of full size test piece is not possible, then standard sub-sized test pieces shall be prepared as per ASTM A370.

In case of lower pipe sizes wherein preparation of transverse sub-sized specimen is not possible, CVN impact testing shall be carried out on longitudinal test specimen [see Note 'a' of Table 8 of this specification].

10.2.3.8 Samples for hardness tests

(New) Samples for hardness tests shall be taken transverse to the pipe body [see Figure 5 a) key 2] from the pipe ends.

10.2.4 Test methods

10.2.4.3 CVN impact test

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

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10.2.4.8 Hardness test

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

Vickers hardness tests shall be carried out in accordance with ISO 6S07-1. The resulting Vickers hardness value at any point shall not exceed 248 HV<sub>10</sub>. Hardness test locations shall be as shown in Figure 10.2.4.8.1 of this specification.

Modalities of retest shall be in accordance with clause 10.2.12.7 of API Spec 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 Spec 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 pressurization 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 Spec 5L. Table 26 of API Spec 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.

10.2.8.7 The measuring equipment requiring calibration or verification under the provisions of API Spec 5L shall be calibrated with manual instruments at least once per operating shift (12 hours maximum). Such calibration records shall be furnished to Purchaser's Representative on request.

10.2.10 Non-destructive inspection


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

10.2.11 Reprocessing

This clause of API Spec 5L stands cancelled.

10.2.12 Retesting

10.2.12.1 Recheck analyses

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Modalities of recheck analysis shall be as per API Spec 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.

## 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 Spec 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 (New) and heat number.

### 11.2 Pipe markings

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

11.2.2 c) (New) 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.

11.2.3 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

11.2.7 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 Spec 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.

## 14 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

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- 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 Spec 5L and as modified herein.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- Information on production and shipping
- 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 Spec 5L and as modified herein and other test reports/results required as per this specification.

**15 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 percent 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.

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## 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 Spec 5L and as modified herein.

Note: In the event of small quantities of pipes 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 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.

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b. **Ultrasonic Examination**

The weld seam of all pipes shall be examined ultrasonically by automatic ultrasonic equipment.

c. **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. Tensile test

Tensile tests as per Table 20 and clause 10.2.3.2 of this specification shall be conducted on:

- Two (2) transverse test pieces for pipe of D < 219.1 mm (8.625 inch):
- Two (2) longitudinal test pieces

ii. CVN impact testing

Four sets of three transverse specimens shall be extracted from base metal for CVN impact tests including fracture toughness testing. The specimen shall be tested at - 40°C, - 10°C, 0°C, +20°C for shear area and absorbed energy to produce full transition curve. The value for shear area and absorbed energy at the test temperature specified in clause 9.8 and Table 8 of this specification respectively shall be complied with. For other temperatures, test values shall be for information only.

iii. Hardness test

Hardness test shall be conducted on selected pipes as per requirement of clause 10.2.4.8 of this specification.

In addition to the above tests, all the tests and inspections required to be conducted as per this specification shall be conducted on all the pipes selected for testing during MPQT.

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## Annex C

### Treatment of surface imperfections and defects

#### C.1 TREATMENT OF SURFACE IMPERFECTIONS

Surface imperfection not classified as defect as per this specification 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.

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## Annex E

### Non-destructive inspection for other than sour service or offshore service

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 steelmaking 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-IA 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.3.1.2 All SMLS pipes shall be non-destructively inspected full length (100%) in accordance with applicable methods given in Table E.2 of API Spec 5L using automatic ultrasonic equipment in accordance with clause E.5 and as modified herein.

E.3.3 Pipe End Inspection - Welded Pipe

E.3.3.1 Pipe ends including weld at the 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 Spec 5L shall be maintained.

E.3.3.2 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.

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E.3.3.3 Bevel face of each pipe end shall be magnetic particle inspected for the detection (New) of laminar imperfections in accordance with ISO 10893-S

**E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

**E.5.1 Equipment**

E.5.1.1 In addition to the API Spec 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. All ultrasonic testing equipment shall be provided with recording device.

**E.5.2. Ultrasonic and electromagnetic inspection reference standards**

E.5.2.1 The reference standard shall be, according to the cases, taken from the production to be controlled, and of such dimensions as to allow the static and dynamic calibration of the control system.

**E.5.2.3 Reference standards**

The primary reference sensitivity level shall be adjusted on the following reference reflectors:

Examination Type	Seamless
Lamination Detection	FBH (6.4mm)
Surface defect detection	Notch N5
Defect detection of body and pipe ends	Notch N5

Flat Bottomed Holes (FBH) for lamination detection shall have 6.4 mm (V4inch) diameter and 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 Spec 5L and as modified herein) under the same inspection conditions of pipes of normal production 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 coils already inspected after the previous verification shall be inspected again at Manufacturer's cost.

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E.5.5 Acceptance limits

E.5.5.2 For all examination types, indications exceeding the acceptance limit signals are unacceptable. For lamination detection in seamless pipe body and pipe ends, the acceptance limits shall be based on the lamination size and frequency as given below:

Any lamination in the body of the pipe exceeding both of the following is considered a defect:

- a) Greater than or equal to 12.0 mm in the minor dimension.
- b) Greater than or equal to 5000 mm<sup>2</sup> in area.

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 specified in (e) or (f) of E.10 of API Spec 5L.

E.5.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY

(New) The individual laminations exceeding the acceptance limits as given in clause E.5.5.1 of this specification shall be classified as defects.

Compliance with such requirements shall be verified by ultrasonic inspection in accordance with ISO IO893-8 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  $\geq 25\%$  of the pipe surface.

E.5.9 Suspect pipe

Pipe giving rise to indications producing a trigger/ alarm condition as a result of the specified non-destructive inspection operation shall be deemed suspect. Locations showing indications above the acceptance limits during ultrasonic inspection shall be re-examined by radiography. If no defects are located during re-examination, the original findings may be ignored. Additional scanning may be requested by the Purchaser Representative to check questionable areas.

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.

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**E.10 DISPOSITION OF PIPES CONTAINING DEFECTS**

c) 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 (e) or (f) of clause E.10 of API Spec 5L.

**E.11 SUPPLEMENTARY NON-DESTRUCTIVE INSPECTION (New)**

E.11.1 Pipe shall be 100% ultrasonically inspected for the detection of transverse imperfections and inclined embedded defects in accordance with ISO 10893-10 acceptance level U2/C.

E.11.2 Pipe shall be full-body inspected using the flux leakage method in accordance with ISO 10893-3 acceptance level F2 for the surface testing of the pipes for longitudinal and transverse imperfections.

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## 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.

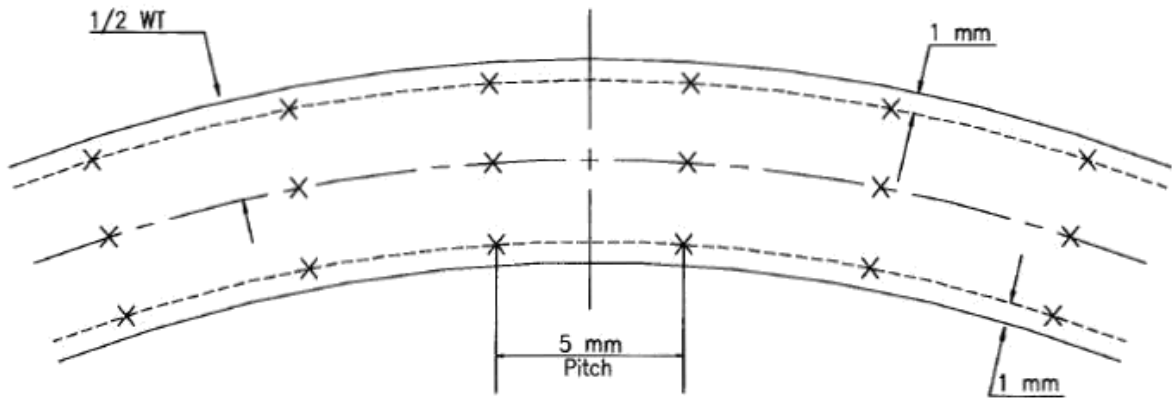
#### Q.3 COMPLIANCE

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.

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Notes:

1. Number of hardness measurement required on each specimen shall be min. 12.

FIGURE: 10.2.4.8.1

LOCATIONS FOR HARDNESS MEASUREMENT

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