**INDRADHANUSH GAS GRID LIMITED**
(Joint Venture of IOCL, ONGC, GAIL, OIL and NRL)
**GUWAHATI, ASSAM**

# CORRIGENDUM 2

# FOR

# LAYING & CONSTRUCTION OF STEEL GAS PIPELINE AND TERMINALS ALONG WITH ASSOCIATED FACILITIES FOR SECTION- 4, 6, 7, 8, 13 & 14 UNDER NORTH EAST GAS GRID OF M/S IGGL OPEN DOMESTIC COMPETITIVE BIDDING

## Tender no.: 05/51/23UU/IGGL/001-i-3

**Visit:** www.tenderwizard.com/MECON
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## PREPARED AND ISSUED BY

**MECON LIMITED**
(A Govt. of India Undertaking)
Delhi, India

| IGGL | CORRIGENDUM # 2<br>LAYING & CONSTRUCTION OF STEEL GAS PIPELINE AND TERMINALS ALONG WITH ASSOCIATED FACILITIES FOR SECTION-4, 6, 7, 8, 13 & 14 OF<br>NORTH EAST GAS GRID (NEGG) PROJECT<br><br>Tender No. 05/51/23UU/IGGL/001-i-3 | MECON LIMITED |
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| | | Date: 31.12.2021 |

| Sl. No. | Description | Volume | Page No. | Clause / Para / Section | Amendment / Addition / Modification / Deletion | |
|---|---|---|---|---|---|---|
| 1 | Technical Specification for ERW/ HSAW/ LSAW Linepipe | I of IV (Part 1 of 4) | - | - | Addition | Enclosed as Annexure-1 to Corrigendum # 2 |
| **2** | Annexure 9A to SCC | I of IV (Part 1 of 4) | 334 of 500 | Note 1 | Modification | Note 1 of Annexure 9A to SCC shall be read as:<br><br>"Bidders, who quote for any two sections shall meet the qualifying Equipment Deployment Criteria of BEC (Technical) requirement on cumulative basis.<br>Further, if a bidder quotes for more than two sections, then the bidder shall meet the qualifying Equipment Deployment Criteria of BEC (Technical) requirement on cumulative basis of any two quoted sections having maximum number of equipment requirement." |

**All other terms & conditions of tender document remain unaltered.**

# ANNEXURE-I to CORRIGENDUM 2

# STANDARD SPECIFICATION
# FOR
# SEAMLESS LINE PIPE
# (ONSHORE)

## SPECIFICATION NO.: MEC/TS/05/21/012A

## (OIL & GAS SBU)
## MECON LIMITED
## DELHI 110 092

| PREPARED BY: | CHECKED BY: | APPROVED BY: | ISSUE DATE: |
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Abbreviations:

| | |
|---|---|
| API | American Petroleum Institute |
| ASTM | American Society for Testing and Materials |
| CE | Carbon Equivalent |
| CVN | Charpy V-Notch |
| SMLS | Seamless |
| ID | Inside Diameter |
| $K_v$ *L* | Charpy value in pipe longitudinal direction |
| $K_v$T | Charpy value in pipe transverse direction |
| MPQT | Manufacturing Procedure Qualification Tests |
| MPS | Manufacturing Procedure Specification |
| PSL | Product Specification Level |
| MPT | Magnetic Particle Testing |
| NDT | Non Destructive Testing |
| OD/*D* | Outside Diameter, Specified |
| *t* | Wall Thickness, Specified |
| UT | Ultrasonic Testing |

## CONTENTS

## 1 SCOPE

This specification establishes the minimum requirements for the manufacture of seamless carbon steel line pipe 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 (New) Pipe Size

This Specification shall be applied to line pipe of size 4½" OD thru 20" OD (both sizes included).

### 1.2 (New) Grades

This specification is applicable to line pipes of Grade B through X-70.

## 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 E112-12: Standard Test Methods for Determining Average Grain Size
ASTM A370 : Standard Test Methods and Definitions for Mechanical Testing of Steel Products

## 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

(PSL 2) as given in Table 1 of this specification and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (M) that identifies the delivery condition as per Table 3 of this specification.

Table 1 of API 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[a b] |
|---|---|---|
| PSL 2 | Normalizing or quenched and tempered | BM, X42M, X46M, X52M, X56M, X60M, X65M, X70M |
| a Deleted<br>b The suffix (M) for PSL 2 grades belongs to steel grade | | |

**6.2 Delivery condition**

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

**8 MANUFACTURING**

**8.1 Process of Manufacture**

Pipe furnished to this specification shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 of API 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 | Ingot, bloom or billet | Hot forming and cold finishing | Normalized or quenching and tempering | 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.

**Table 5 - Chemical composition for pipe**

| Element | Mass fraction, based upon heat and product analyses (%) | |
|---|---|---|
| | For Grades B to X70 | |
| C [b] | 0.16 | max. (For Grade B to X56) |
| | 0.12 [f] | max.(For Grade X60 to X70) |
| Si | 0.15 [m (New)] | min. |
| | 0.45 | max. |
| Mn[b] | 1.20 | Max. (For Grade B) |
| | 1.30 | max. (For Grade 42 & X46) |
| | 1.40 | max. (For Grade X52 & X56) |
| | 1.60 | max. (For Grade X60 to X70) |
| P | 0.020 | max. |
| S | 0.010 | max. |
| V[d] | 0.05 | max. (For Grade B to X56) |
| | 0.08 | max. (For Grade X60 to X70) |
| Nb[d] | 0.05 | max. (For Grade B to X46) |
| | 0.10 | max. (For Grade X52 to X70) |
| Ti[d] | 0.04 | max. |
| Al [n (New)] | 0.02 [0(New)] | min. |
| | 0.07 | max. |

| Element | Mass fraction, based upon heat and product analyses (%) | |
|---|---|---|
| Cr | 0.20 | max. |
| Mo | 0.28 | max. |
| Cu [p (New)] | 0.35 | max. |
| Ni [p (New)] | 0.20 | max. |
| N [n (New)] | 0.012 | max. |
| B | 0.0005 | max. |
| Ca | 0.006 | max. |

**Notes to Table 5:**

| | |
|---|---|
| a | Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the $CE_{Pcm}$ limits apply if C ≤ 0.12% and $CE_{IIW}$ limits apply if C > 0.12%. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:<br>$CE_{Pcm} \leq 0.23$<br>$CE_{IIW} \leq 0.43$<br>Boron content shall be considered in $CE_{Pcm}$ formula even if it is less than 0.0005%. |
| b | Deleted |
| c | Deleted |
| d | Nb + V + Ti < 0.15 % |
| e | Deleted |
| f | Deleted |
| g | Deleted |
| h | Deleted. |
| i | Deleted |
| j | Deleted |
| k | Deleted |
| l | Deleted |
| (New) m | Minimum for Si is not applicable for Al killed steel. |
| (New) n | Al/N shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel). |
| (New) o | Applicable for Al killed steel only. |
| (New) p | Cu+Ni shall not exceed 0.4%. |

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

If alloying elements other than those specified in Table 5 of this specification are

added to the steel, the limits of the additional components shall be agreed with the Purchaser.

**9.3 Tensile properties**

9.3.2 The finished pipe (after 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 inexcess 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 in no case shall be less than 20%.

**9.8 CVN impact test for PSL 2pipe**

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 ($K_vT$) 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 of PSL 2 pipe**

| Pipe Grade | Full-size CVN absorbed energy ($K_vT$) [a, b] [J] | |
|---|---|---|
| | *Average* | *Minimum* |
| B | 40 | 32 |
| X42 | 40 | 32 |
| X46 & X52 | 40 | 32 |
| X56 & X60 | 40 | 32 |
| X65 | 41 | 33 |
| X70 | 55 | 44 |

a) The required $K_vL$ (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.

9.8.2.2 For pipes of all grades, sizes and specified wall thicknesses, the minimum average (set of three test pieces) shear fracture area shall be at least 85 % with one minimum value of 75%, based at a test temperature of 0 °C (32 °F) or at a lower test temperature as specified in the Purchase Order.

9.8.2.4 (New) Testing of Charpy V-notch impact properties shall be performed on full–sized test specimens. However, if preparation of full size test specimen is not possible, then standard sub-sized test pieces shall be prepared as per ASTM A370 and for comparison of the measured energy (based on sub-sized specimen) with the values specified in Table 8, the measured energy shall be converted to the impact energy (KV) in Joules as per clause 9.8.1.1 of API Spec 5L.

**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 of this specification.

**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 of this specification.

**9.10.5 Geometric deviations**

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

a) 3.2 mm for cold-formed dents with sharp-bottom gouges and not encroaching upon the specified minimum wall thickness.
b) 6.4 mm for other dents.
c) 1 mm at the pipe ends, i.e. within a length of 100 mm at each of the pipe ends.

Dents that exceed the above specified limits shall be considered as defect and shall be treated in accordance with C.3 of this specification. 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**

For any hard spot, detected by visual inspection, larger than 50 mm (2.0 in) in any direction, hardness test shall be performed using portable hardness test equipment. Hardness values at these spots greater than 248$HV_{10}$ shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of this specification.

9.10.7 **Other surface imperfection**

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

a) Imperfections that have a depth ≤ 0.05 *t* 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 of this specification.

b) Imperfections that have a depth > 0.05 *t* 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 of API Spec 5L and as modified in this specification or shall be treated in accordance with Clause C.3 of this specification.

c) Imperfections that encroach on the minimum permissible wall thickness shall be classified as defects and treated in accordance with Clause C.3 of this specification.

d) (new) Sections of the pipes containing cracks, sweats and leaks shall be treated in accordance with clause C.3 b) or C.3 c).

**9.11 Dimensions, mass and tolerances**

**9.11.3 Tolerances for diameter, wall thickness, length and straightness**

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

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

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

| Specified outside diameter *(D)* mm (in) | Diameter tolerance | | Out – of – roundness tolerance e(new) | |
|---|---|---|---|---|
| | Pipe except the end [a] | Pipe end [a,b,c] | Pipe except the end [a] | Pipe end [a,b,c] |
| *D*≤ 168.3 (6 5/8) | ± 0.0075 *D* | - 0.4 mm to + 1.6 mm | 0.020 *D* | 0.015 *D* upto a maximum of 2.0 mm |
| 168.3 (6 5/8)<D≤ 273.1 (10 3/4) | ± 0.0075 *D* | ± 0.005 *D* | 0.020 *D* | 2.0 mm |
| *D*> 273.1 (10 3/4)) | ± 0.0075 *D* upto a maximum of ± 3.0 mm | ± 1.6 mm | 0.020 *D* | 3.0 mm |

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

b) For SMLS pipe, the tolerances apply for t ≤ 25.0 mm (0.984 in),and the tolerances for thicker pipe shall be as agreed.

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

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

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

**Table 11 – Tolerances for wall thickness**

| Wall thickness (mm) | Tolerances (mm) |
|---|---|
| $t < 4.0$ | + 1.10<br>– 0.00 |
| $4.0 \leq t < 10.0$ | + 0.225 $t$<br>– 0.00 |
| $10.0 \leq t < 25.0$ | + 0.20 $t$<br>– 0.00 |
| $t \geq 25.0$ | + 5.00<br>– 0.00 |

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.

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 ≤ 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) Unless specified otherwise, the pipe ends shall be beveled as per API Spec 5L. 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 **Bevel Protectors**
(New)

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 2pipes**

10.1.3.1 Manufacturer shall issue inspection certificate 3.2 in accordance with EN 10204 for each dispatched pipe.

**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 [a] | One analysis per heat of steel |
| 2. | Product analysis [b] | Two pipes per lot (maximum 100 pipes) per heat |
| 3. | Tensile testing of the pipe body [c] | Two pipes per test unit of not more than 100 pipes per heat |
| 4.. | CVN impact testing of the pipe body with specified wall thickness as given in Table 22 of API spec 5L | One set of three specimen per test unit of not more than 100 pipes per heat |
| 5. | Vickers Hardness testing of pipe body | Each specimen taken from one finished pipe from each lot (Maximum 50 pipes) per heat (see 10.2.4.8) |
| 6. | Hydrostatic testing | Each pipe |
| 7. | Weighing of pipe | Each pipe shall be measured and recorded |
| 8. | Wall thickness measurement [e] | Each pipe |
| 9. | Pipe diameter and out-of- roundness [e] | Each pipe |
| 10. | Length | Each length of pipe shall be measured and recorded |
| 11. | Straightness [e] | Each pipe |
| 12. | Visual inspection [d] | Each pipe |
| 13. | Other dimensional testing | Random testing, with the details left to the discretion of the manufacturer |

| | | |
|---|---|---|
| 14. | Non-destructive inspection | In accordance with Annex E of API Spec 5L and as modified herein |

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 Samples used for product analysis shall be taken from finished pipes only. 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 Tensile test specimens shall be taken from finished pipes only. Heating or artificial ageing of tests specimens is not permitted.

d Visual examination shall be carried out in a sufficiently illuminated area; minimum 1000 Lux. If required additional light shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

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

### 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 E 1806. 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 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.

**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 | 1L[b], 1T[c] |
| | CVN | 3T[d] |
| | Hardness | 1 T |

a. See figure 5 (a) of API Spec 5L for an explanation of the symbols used to designate orientation and location.

b. Longitudinal tensile tests shall be carried out on a strip specimen with full wall thickness prepared according to ASTM A370.

c. The transverse tensile tests shall be carried on flattened rectangular specimen prepared according to ASTM A370 for D ≥ 219.1mm only.

d. Test pieces shall be prepared in accordance with ASTM A370 without any prior flattening of the test material. Test specimen shall be taken from the body of the finished pipe only. Full size test specimen shall be used whenever possible.

10.2.3.2 **Test pieces for the tensile test**

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

Transverse tensile test for pipe body with specified outside diameter, $D \geq$ 219.1 mm (8.625 inch) shall be carried out on flattened rectangular test pieces.

Longitudinal tensile tests shall be carried out on a rectangular test piece with full wall thickness prepared in accordance with 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. 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.

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

10.2.4 **Test methods**

10.2.4.3 **CVN impact test**

The Charpy test shall be carried out in accordance with ASTM A3 70.

10.2.4.8 **Hardness Test**

Vickers hardness tests shall be carried out on the parent metal in accordance with ISO 6507-1. The resulting Vickers hardness value at any point shall not exceed 248 $HV_{10}$.

Hardness test locations shall be as shown in Figure 10.2.4.8

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**

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

10.2.8 **Dimensional testing**

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

10.2.8.7 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**

Reprocessing of line pipes to meet mechanical property test results is not allowed. This clause of API Spec 5L stands cancelled.

**10.2.12** (New) **Retesting**

In the event any analysis/test fails to conform to the specified requirements, manufacturer shall either reject the lot/test unit involved or test two additional lengths from same test unit. If both of the new tests conform to the specified requirements, then all the lengths in that test unit shall be accepted, with the exception of original selected length. If one or both of the retest samples fail to conform to the specified requirements, the purchaser or purchaser's representative reserves the right to either test remaining lengths in that test unit or reject the whole lot/test unit.

**10.2.12.1 Recheck analyses**

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

### 11.2 Pipe markings

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

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

11.2.3 The pipe number shall be placed by cold rolling or low stress dot marking on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of no 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 color 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 color 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 (New) PRODUCTION REPORT**

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.

- Detail of Billet/ Bloom (Heat-wise)
- Pipe Number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade
- Consignment details.

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.
- All other reports and results required as per this specification.
- Copy of final inspection report with MTC.
- Description and disposition of repairs.

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 (New) Online Pipe Tracking Data**

Additionally, the manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipes during production. Also, it is required to have traceability of each day production.

In order to establish traceability of pipes, the system should have minimum of following information:

- Heat/ Billet/ Bloom number
- Traceability of pipe at each station
- Final status of pipe
- Reason for each rejection

16 (New) **Pipe Loading**

The manufacturer/coater/supplier shall submit calculations and sketch for loading / unloading & stacking of Bare/Coated pipes at all points, e.g. warehouse/ pipe-yard (ex-works), loading and transportation on trailers, etc. as per API RP 5LT (latest edition).

In addition to the above, foreign manufacturers/coaters/suppliers shall submit calculations and sketches for loading/unloading, stacking & transportation by ship/ barge as per API RP 5LW (latest edition).

17 (New) **INSPECTION OF FIELD TESTS & WARRANTY**

Purchaser shall be reimbursed by Manufacturer for any pipe furnished on this order that fails under field hydrostatic test if such failure is caused by a material/ manufacturing defect in the pipe. The reimbursement cost shall include pipe, labor 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.

## 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. However, waiver of MPQT for any item shall be specifically as per instruction in Material Requisition (MR).

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

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

### B.5 MANUFACTURINGPROCEDURE QUALIFICATION TESTS (MPQT)

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

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

The various tests to be conducted on each pipe shall be as follows. The test method

and acceptance values shall be as per this specification unless specified differently in this Annex.

a. **Visual Examination**

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

b. **Ultrasonic Examination**

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 note b & c of Table 20 shall be conducted on:

- Two (2) transverse test pieces from base material
- Two (2) longitudinal test pieces from base material

ii. **Fracture toughness testing**

Four (4) sets of three transverse specimen shall be extracted from base metal. Test pieces shall be tested at - 40°C, - 10°C, 0°C and + 20° C for shear area and absorbed energy to produce full transition curve. The minimum average (set of three test pieces) shear fracture area at the test temperature specified in clause 9.8.2 of this specification shall be complied with. For other temperatures, the value 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.

**d. Burst Test (New)**

Burst Test shall be done on each grade of pipe for each size on lowest thickness at the time of first day production test. Burst pressure & location of failure shall be recorded. Technical audit shall be carried out by OWNER / OWNER'S representative during manufacturing.

Burst pressure of the subjected pipe shall not be less than the calculated burst pressure based on the minimum actual Ultimate Tensile Strength of the subjected pipe.

## 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 TREATMENTOF DRESSABLE SURFACE DEFECTS

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

### C.3 TREATMENT OF NON-DRESSABLE SURFACE DEFECT

Pipes that contain non-dressable surface defects shall be given one or more of the following dispositions.

a) Deleted

b) The sections of the pipe containing the surface defects shall be cut off, within the limits on length.

c) The entire pipe length shall be rejected.

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

**E. 1 QUALIFICATION OF PERSONNEL**

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

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

**Inspector Qualification**

Acceptable qualification for NDT inspectors shall be as specified below:

*(i) For UT*

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

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

*(ii) For all other NDT methods*

| | | |
|---|---|---|
| Evaluation of indications | : | Level II & Level III inspector |
| Shift Supervisor | : | Level II inspector |

**E.3 METHODS OF INSPECTION**

E.3.1 **General**

E.3.1.1 All seamless pipes shall be non-destructively inspected for full length (100%) in accordance with applicable method given in Table E.2 of API Spec 5L using automatic ultrasonic equipment in accordance with clause E.5 of API Spec 5L and as modified in this specification.

E.3.3 **Pipe End Inspection-SMLS pipe**

E3.3.1 Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment, or, such non–inspected pipe end shall be cut–off. Records in accordance with E.5.4 of API Spec 5L shall be maintained.

E3.3.2 Ultrasonic inspection in accordance with ISO 10893–8 shall be used to verify that the 50 mm (2.0 in) wide zone at each pipe end is free of such laminar defects. Pipe ends not covered by automatic ultrasonic equipment shall be either cut–off or inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment.

E3.3.3 (New) Any lamination or inclusion either extending into the face or bevel of the pipe or present within 50 mm of pipe ends is classified as defects and treated in accordance with clause E.10 (e) or (f) of API Spec 5L.

E3.3.4 (New) Bevel face of each pipe end shall be magnetic particle inspected for the detection of laminar imperfections in accordance with ISO 10893–5.

**E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1 **Equipment**

E.5.1.3(New) 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 electromagneticinspection reference standards**

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

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

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

E.5.2.3 **Reference standards**

E.5.2.3.1 (New) **Reference standards for PSL2 SMLS pipe:**

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

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

**Table E.7 — Reference indicators**

| Item | Reference indicators | | |
|---|---|---|---|
| | Number of notches and orientation[a] | | Notch Type [b] |
| | OD | ID | |
| PSL2 SMLS pipe | 1L | 1L | N5 |

a) The symbol indicates the orientation of the notch i.e. L = Longitudinal.

b) Dimensions of Notch type N5 shall be 0.05 t × 50 mm x 1 mm (Depth x maximum Length x maximum width), where, 't' is the specified wall thickness. The depth tolerance is ± 15% of the specified notch depth or ± 0.05 mm. whichever is greater.

E.5.2.3.2 (New) **Reference standards for pipe body UT:**

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

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

b) depth, *d* : 0.25 *t* < d < 0.5 *t*, where is the specified wall thickness

Reference standard for the ultrasonic inspection of pipe ends shall have 6.4 mm ( $^1/_4$ inch) diameter FBH of a depth 0.5 t, where 't' is the specified wall thickness.

E.5.3 **Instrument standardization**

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

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

If during the above calibration verification, it is found that the equipment has not functioned satisfactorily in the opinion of the Purchaser's Representative, all the pipes

or coils already inspected after the previous verification shall be inspected again at Manufacturer's cost.

E. 5.5 **Acceptance limits**

E.5.5.4 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 $mm^2$ in area.

E.5.6 **Disposition of defects found by ultrasonic and electromagnetic inspection**

Disposition of any imperfection in pipe that produces an indication greater than the acceptable limits as specified in 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.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..

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

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

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

**E.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.

## Annex Q (New)

## Purchaser Inspection

**Q.1 INSPECTION NOTICE**

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

**Q.2 PLANT ACCESS**

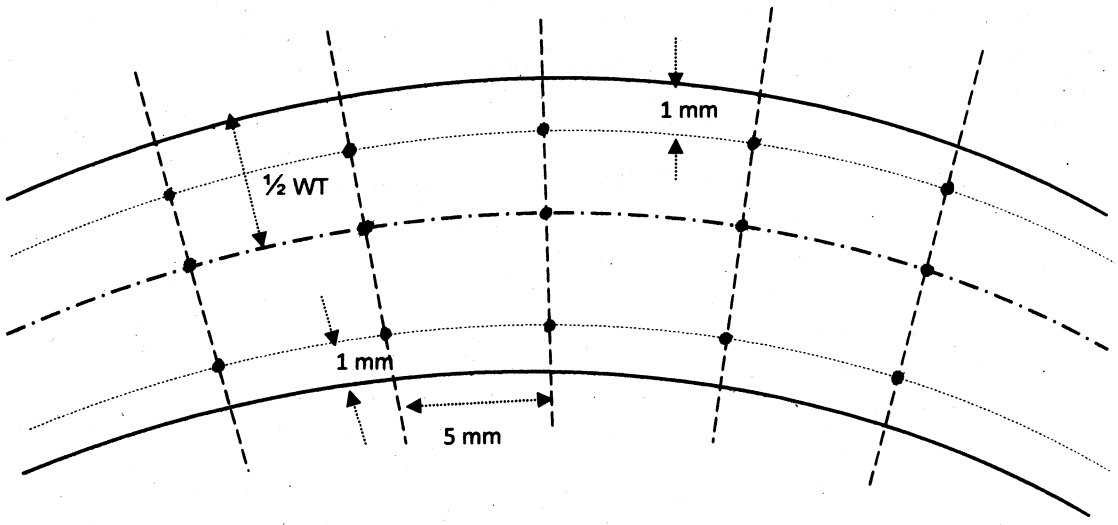
The inspector representing the purchaser shall have unrestricted access, at all times while work of the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable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

**Q.3 COMPLIANCE**

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

**Q.4 REJECTION**

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




Notes:

1. Number of hardness measurement required on each specimen shall be min. 12 at the dotted lines intersection locations

**FIGURE:**
**10.2.4.8**

**LOCATIONS FOR HARDNESS MEASUREMENT**

# STANDARD SPECIFICATION
# FOR
# SUBMERGED ARC LONGITUDINAL WELDED (SAWL) LINE PIPE (ONSHORE)

## SPECIFICATION NO.: MEC/TS/05/21/012B

## (OIL & GAS SBU)
## MECON LIMITED
## DELHI 110 092

| PREPARED BY: | CHECKED BY: | APPROVED BY: | ISSUE DATE: |
|---|---|---|---|
| SACHIN KUMAR (D.E.) | SACHIN SINGHAL (S.D.E.) | K. P. SINGH (A.G.M) | 13.04.2016 |

# AMENDMENT STATUS

| Sl. No. | Clause/ Paragraph/ Annex./ Exhibit/ Drg. Amended | Page No. | Ed. No. | Rev. No. | Date | Prepared by | | Checked by | | Approved by | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1. | Overall Revision | All | 3 | 1 | 13.04.16 | Sachin Kumar (D.E.) | | Sachin Singhal (S.D.E.) | | K. P. Singh (A.G.M.) | | In line with API Spec. 5L, 45th Ed., 2012 |
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**Abbreviations:**

| | |
|---|---|
| API | American Petroleum Institute |
| ASTM | American Society for Testing and |
| BM | Base Metal |
| CE | Carbon Equivalent |
| CVN | Charpy V-Notch |
| FBH | Flat Bottomed Holes |
| HAZ | Heat Affected Zone |
| ID | Inside Diameter |
| $K_vL$ | Charpy value in pipe longitudinal |
| $K_vT$ | Charpy value in pipe transversal |
| MPQT | Manufacturing Procedure Qualification |
| MPS | Manufacturing Procedure Specification |
| MPT | Magnetic Particle Testing |
| NDT | Non Destructive Testing |
| OD *ID* | Outside Diameter, Specified |
| SAWL | Submerged Arc Longitudinal Welded |
| SMAW | Shielded Metal Arc Welding |
| $S_r$ | Sizing ratio of the pipe |
| t | Wall Thickness, Specified |
| UT | Ultrasonic testing |

## CONTENTS

**1** SCOPE

This specification establishes the minimum requirements for the manufacture of submerged arc longitudinal welded steel line pipe 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 "PSL2".

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**
(New)

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

**1.2** **Grades**
(New)

This specification is applicable to line pipes of grade BM through X-80M.

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

ASTM A370 : Standard Test Methods and Definitions for Mechanical Testing of Steel Products

BS

BS 5996 : Specification for the Acceptance Level for Internal Imperfection in Steel Plate, Strip and Wide Flats Based on Ultrasonic Testing.

## 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 Level2 (PSL 2) as given in Table 1 of this specification and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (M) that identifies the delivery condition as per Table 3 of this specification.

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

| PSL | Delivery Condition | Pipe grade/ steel grade[a,b] |
|---|---|---|
| PSL 2 | Thermomechanical rolled | BM, X42M, X46M, X52M, X56M, X60M, X65M, X70M & X80M |

a Deleted
b The suffix (M) for PSL 2 grades belongs to steel grade

### 6.2 Delivery condition

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

## 8 MANUFACTURING

### 8.1 Process of Manufacture

Pipe furnished to this specification shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 of API 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 |
|---|---|---|---|---|
| SAWL | Thermomechanical rolled coil or plate | Cold forming | — | M |

**8.3 Starting Material**

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

8.3.3 The steel used for manufacture of pipe shall be fully killed and fine grained with ASTM grain size number 7 or finer as per ASTM E 112 for grades BM through X70M and grain size number 10 or finer for grade X80M.

**8.4 Tack welds**

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

**8.6 Weld seams in SAW pipe**

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

**8.9 Cold sizing and cold expansion**

8.9.2 All pipes shall be mechanically cold expanded for full length. The sizing ratio for the pipe, $s_r$, measured on the circumference, shall not be less than 0.008 or more than 0.015. The expansion shall be measured and recorded for one out of every 50 pipes.

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

$$S_r = |D_a - D_b| / D_a$$

where,

$D_a$ is the actual outside diameter after sizing

$D_b$ is the actual outside diameter before sizing

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

**8.11 Jointers**

8.11.1 Jointers on pipes are not permitted.

## 9 ACCEPTANCE CRITERIA

### 9.2 Chemical composition

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

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

**Table 5 - Chemical composition for pipe**

| Element | Mass fraction, based upon heat and product analyses (%) | | |
|---|---|---|---|
| | For Grades BM to X70M | | For Grade X80M |
| C [b] | 0.16 | max. (For Grade BM to X56M) | 0.12 max. |
| | 0.12 [f] | max.(For Grade X60M to X70M) | |
| Si | 0.15 [m (New)] | min. | 0.45 max. |
| | 0.45 | max. | |
| Mn[b] | 1.20 | Max. (For Grade BM) | 1.85 max. |
| | 1.30 | max. (For Grade 42M & X46M) | |
| | 1.40 | max. (For Grade X52M & X56M) | |
| | 1.60 | max. (For Grade X60M to X70M) | |
| P | 0.020 | max. | 0.020 max. |
| S | 0.010 | max. | 0.006 max. |
| V[d] | 0.05 | max. (For Grade BM to X56M) | Note 'd' |
| | 0.08 | max. (For Grade X60M to X70M) | |
| Nb[d] | 0.05 | max. (For Grade BM to X46M) | Note 'd' |
| | 0.10 | max. (For Grade X52M to X70M) | |
| Ti[d] | 0.04 | max. | Note 'd' |
| Al [n (New)] | 0.02 [0(New)] | min. | Note 'n (New)' |
| | 0.07 | max. | |
| Cr | 0.20 | max. | 0.40 max. |
| Mo | 0.28 | max. | 0.30 max. |
| Cu [p (New)] | 0.35 | max. | 0.50 max. |

| Element | Mass fraction, based upon heat and product analyses (%) | | |
|---|---|---|---|
| Ni [p (New)] | 0.20 | max. | 0.50 max. |
| N [n (New)] | 0.012 | max. | 0.008 max. |
| B | 0.0005 | max. | 0.0005 max. |
| Ca | 0.006 | max. | ---- |

**Notes to Table 5**

| | |
|---|---|
| a | Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the $CE_{Pcm}$ limits apply if C < 0.12% and $CE_{IIW}$ limits apply if C > 0.12%. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:<br>$CE_{Pcm} \leq 0.23$<br>$CE_{IIW} \leq 0.43$<br>Boron content shall be considered in $CE_{Pcm}$ formula even if it is less than 0.0005%. |
| b | Deleted |
| c | Deleted |
| d | Nb + V + Ti < 0.15 % |
| e | Deleted |
| f | Deleted |
| g | Deleted |
| h | Deleted. |
| i | Deleted |
| j | Deleted |
| k | Deleted |
| l | Deleted |
| (New) m | Minimum for Si is not applicable for Al killed steel. |
| (New) n | Al/N shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel). |
| (New) o | Applicable for Al killed steel only. |
| (New) p | Cu+Ni shall not exceed 0.4% (applicable for Grade BM to X-70M).<br>Cu+Ni shall not exceed 0.75% (applicable for Grade X-80M). |

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

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

Purchaser.

**9.3** **Tensile properties**

**9.4**

9.3.2 The finished pipe (after cold expansion or sizing operation) 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 X46M | 131 (19,000) |
| X52M to X60M | 125 (18,000) |
| X65M to X70M | 120 (17,400) |
| X80M | 120 (17,400) |

The ratio of body yield strength and body tensile strength of each test pipe on which yield strength and tensile strength are determined, shall not exceed 0.90 when tested using flattened test specimen. The ratio between yield strength and tensile strength for weld metal of finished expanded pipe shall not exceed 0.90, when tested using cylindrical all weld specimen.
The tensile strength of the weld shall be equal to or higher than the specified minimum tensile strength of the base metal.

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

**9.8** **CVN impact test for PSL 2 pipe**

9.8.1 **General**

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

9.8.2 **Pipe body tests**

9.8.2.1 The minimum average (set of three test pieces) absorbed energy value ($K_vT$) 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**

| Specified Outside Diameter D mm(in) ↓ / Pipe Grades → | Full-size CVN absorbed energy, minimum average (Joules) | | | | | | |
|---|---|---|---|---|---|---|---|
| | BM | X42M | X46M & X52M | X56M & X60M | X65M | X70M | X80M |
| ≤508 (20") | 40 | 40 | 40 | 40 | 41 | 55 | 80 |
| 559 (22") & 610 (24") | 40 | 40 | 40 | 40 | 45 | 60 | 84 |
| 660 (26") & 711 (28") | 40 | 40 | 40 | 43 | 49 | 65 | 93 |
| 762 (30") & 813 (32") | 40 | 40 | 40 | 46 | 52 | 68 | 102 |
| 864 (34") & 914 (36") | 40 | 40 | 40 | 49 | 55 | 73 | 110 |
| 965 (38") & 1016 (40") | 40 | 40 | 42 | 52 | 58 | 77 | 118 |
| 1067 (42") & 1118 (44") | 40 | 40 | 44 | 54 | 61 | 81 | 125 |
| 1168 (46") & 1219 (48") | 40 | 40 | 46 | 56 | 64 | 84 | 133 |

9.8.2.2 For pipe with D < 508 mm, the minimum average (set of three test pieces) shear fracture area shall be at least 85 % with no individual value less than 75%, based at a test temperature of 0 °C (32 °F) or at a lower test temperature as specified in the Purchase Order.

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

9.8.3 **Pipe weld and HAZ tests**

The minimum average (set of three test pieces) absorbed energy value ($K_VT$) for each pipe weld and HAZ test shall be as specified in Table 8 of this specification, based upon full-size test pieces at a test temperature of 0°C (32°F) or at a lower test temperature as specified in the Purchase Order.

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

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

**9.10 Surface conditions, imperfections and defects**

**9.10.1 General**

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

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

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

a) 3.2 mm for cold-formed dents with sharp-bottom gouges and not encroaching upon the specified minimum wall thickness.

b) 6.4 mm for other dents.

c) 1 mm at the pipe ends, i.e. within a length of 100 mm at each of the pipe ends.

d) Any dent on weld and heat affected zone (HAZ).

Dents that exceed the above specified limits shall be considered as defect and shall be treated in accordance with C.3 b) or C.3 c) of API 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, detected by visual inspection, larger than 50 mm (2.0 in) in any direction, hardness test shall be performed using portable hardness test equipment. Hardness values at these spots greater than $248HV_{10}$ for grades BM through X70M and greater than $285HV_{10}$ for X80M shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of API Spec 5L.

**9.10.7.1 Other surface imperfection**

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

a) Imperfections that have a depth < 0.05t and do not encroach on the minimum permissible wall thickness shall be classified as acceptable imperfections and shall be treated in accordance with Clause C. 1 of this specification.

b) Imperfections that have a depth > 0.05t and do not encroach on the minimum permissible 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 b) or C.3 c) of API Spec 5L.

c) Imperfections that encroach on the minimum permissible 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.

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 (in) | Diameter tolerances[d] | | Out-of-roundness tolerance [e(new)] | |
|---|---|---|---|---|
| | Pipe except the end[a] | Pipe end[a,c] | Pipe except the end[a] | Pipe end[a,c] |
| *D* < 508(20) | ±3.0 mm | ± 1.6 mm | 0.020 *D* | 0.005 *D* |
| 508(20) ≤ *D* ≤ 610(24) | + 3 mm,<br>- 0.0025 *D* | ± 1.6 mm | 0.020 *D* | 0.005 *D* |
| 610(24 ) < *D* ≤ 914(36) | + 3 mm,<br>- 0.0025 *D* | ± 1.6 mm | 0.015 *D* | 0.005 *D* |
| *D* > 914(36) | ±3.0 mm | ± 1.6 mm | 0.015 *D* but a maximum of 15 mm | 5 mm |

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

b Deleted

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

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

e (New) Out-of-roundness tolerances apply to maximum and minimum diameters as measured with bar (New) 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.

The tolerances on specified wall thickness shall be (+) 15% and (-) 0%. Table 11 of API Spec 5L stands deleted.

The +ve tolerance for wall thickness doesn't apply to the weld area. Clause 9.13.2 of API Spec 5L shall be referred 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.

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 0.1% of pipe length, 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 ≤ 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**

9.12.5.7 (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 bevel protectors as per Manufacturer's standard. Bevel protectors shall be of a design such that they can be re-used by coating applicator for providing on externally anti-corrosion coated pipes subsequent to coating of line pipe.

**9.13 Tolerances for the weld seam**

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

Forming and welding operations shall be conducted to minimize coil edge offset and distortion and peaking at longitudinal seam. The manufacturer shall provide appropriate tooling with 'Vee' blocks and calibrated dial indicators needed to measure the distortion and misalignment at the seam. All pipes shall be checked for offset of

skelp edges. Offset shall be measured and recorded at least 3 times per operating shift and measurements shall be taken each end.

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

9.13.2 **Height of the flash or weld bead/reinforcement**

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

d) The outside weld bead shall not extend above the adjacent pipe surface by more than 3.2 mm (1/8 in.) for all specified wall thicknesses. Table 16 of API Spec 5L stands modified accordingly.

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

9.13.3 **Misalignment of the weld beads of SAW pipes**

Misalignment of weld beads [see Figure 4 d) of API Spec 5L] exceeding 3.0 mm measured on radiographic film shall be treated in accordance with clause C.3 b) or C.3 c) of API Spec 5L. Checking of the weld seam misalignment shall also be carried out on metallographic examination specimen as per clause 10.2.5 of this specification.

**10. INSPECTION**

10.1 **Types of inspection and inspection documents**

10.1.3 **Inspection documents for PSL 2 pipes**

10.1.3.1 Manufacturer shall issue inspection certificate 3.2 in accordance with EN 10204 for each dispatched pipe 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 [a] | One analysis per heat of steel |
| 2. | Product analysis [b] | Two pipes per lot (maximum 100 pipes) per heat |
| 3. | Tensile testing of the pipe body | Once per test unit of not more than 100 pipes |
| 4. | Tensile testing of the longitudinal seam weld of pipe[c] | Once per test unit of not more than 100 pipes |
| 5. | Tensile testing of all weld test specimen | Once; during manufacturing procedure qualification tests (MPQT) and whenever batch of electrode or wire & flux combination is changed (see Annex B) |
| 6. | CVN impact testing of the pipe body of pipe | One set of three transverse specimen per test unit of not more than 50 pipes per heat |
| 7. | CVN impact testing of the longitudinal seam weld and HAZ of pipe | One set of three transverse specimen per test unit of not more than 50 pipes per heat |
| 8. | DWT testing of the pipe body of pipe with $D$ > 508 mm (20.000 in) | Once set of 2 specimen per test unit of not more than 50 pipes per heat |
| 9. | Guided-bend testing of the longitudinal seam weld of pipe | Once set of 2 specimen (one face and one root )per test unit of not more than 50 lengths of pipe |
| 10. | Hardness testing of hard spots | Any hard spot exceeding 50 mm (2.0 in) in any direction |
| 11. | Cold expansion sizing ratio | Once per test unit of not more than 50 pipes (measurement shall be recorded) |
| 12. | Macrographic & metallographic testing (including Vicker's hardness test) of the longitudinal seam weld of pipe as defined in clause 10.2.5 of this specification | At least one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs max.) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered and at the beginning of the production of each combination of specified outside diameter and specified wall thickness |

| | | |
|---|---|---|
| 13. | Hydrostatic testing | Each pipe |
| 14. | Wall thickness measurement[d] | Each pipe |
| 15. | Visual inspection | Each pipe |
| 16. | Weighing of pipe | Each pipe shall be measured and recorded |
| 17. | Pipe diameter and out-of-roundness [d] | Each pipe |
| 18. | Length | Each length of pipe shall be measured and recorded |
| 19. | Straightness[d] | Each pipe |
| 20. | Non-destructive inspection | In accordance with Annex E of API Spec 5L and as modified herein |
| 21. | Geometric deviations [d] | Each pipe |
| 22. | Radial offset of strip edges [d] | Each pipe [e] |
| 23. | Height of the flash or weld bead/ reinforcement[d] | Each pipe [f] |
| 24. | Misalignment of the weld beads of SAW[d] | Each pipe (including specimen for macrographic examination) |
| 25. | Other dimensional testing | Random testing, with the details left to the discretion of the manufacturer |

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 Pipe produced by each welding machine shall be tested.
d Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum).
e Measurements shall be taken at two locations (at a distance of one to two diameters from each end) on each pipe joint.
f Measurement shall be performed by welding gauge and/or by using template having cut out for weld bead.
g "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 EI806. 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 b) of API Spec 5L and Figure 10.2.5.3.1 & 10.2.5.3.2 of this specification, whichever is applicable, and as given in Table 20 of this specification.

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

| Sample Location | Type of test | Number, orientation and location of test pieces per sample[a] | |
|---|---|---|---|
| | | Specified outside diameter, D in m (in) | |
| | | < 508 (20.000) | ≥ 508 (20.000) |
| Pipe body | Tensile | 1T180 | 1T180 |
| | CVN | 3T90 | 3T90 |
| | DWT | — | 2T90 |
| Seam Weld | Tensile | 1W[b] | 1W[b] |
| | CVN | 3W and 3HAZ | 3W and 3HAZ |
| | Guided - bend | 2W[c] | 2W[c] |

a See Figure 5 b) of API Spec 5L for an explanation of the symbols used to designate orientation and location of samples and test pieces, b Test specimen shall be tested for ultimate tensile strength only.
b Test specimen shall be tested for ultimate tensile strength only.
c One face and one root guided bend weld test shall be conducted on the samples prepared from the finished pipe.

**10.2.3.2 Test pieces for the tensile test**

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

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

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

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

**10.2.3.3 Test pieces for the CVN impact test**

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

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

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

**10.2.3.4 Test pieces for the DWT test**

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

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

**10.2.3.8 Test pieces for Macrographic and metallographic tests**
(New)

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

**10.2.4 Test methods**

**10.2.4.3 CVN impact test**

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

**10.2.4.4 Drop-weight tear test**

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

**10.2.4.6 Guided-bend test**

The guided-bend test shall be carried out in accordance with ASTM A370.The mandrel dimension, $A_{gb}$, shall not exceed 4.0 times the thickness of the specimen.

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

10.2.5 **Macrographic and metallographic tests**

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

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3.2 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 $HV_{10}$ for grades BM through X70M and not exceed 285 $HV_{10}$ for grade X80M. 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** lx. If required additional lights shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

10.2.8 **Dimensional testing**

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

**10.2.10 Non-destructive inspection**

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

**10.2.11 Reprocessing**

This clause of API Spec 5L stands cancelled.

**10.2.12 Retesting**

In the event any analysis/test fails to conform to the specified requirements, manufacturer shall either reject the lot/test unit involved or test two additional lengths from same test unit. If both of the new tests conform to the specified requirements, then all the lengths in that test unit shall be accepted, with the exception of original selected length. If one or both of the retest samples fail to conform to the specified requirements, the purchaser or purchaser's representative reserves the right to either test remaining lengths in that test unit or reject the whole lot/test unit.

**10.2.12.1 Recheck analyses**

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

### 11.2 Pipe markings

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

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

11.2.3 The pipe number shall be placed by cold rolling or low stress dot marking 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/plate 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.

- Detail of Coils (Heat-wise)
- Pipe Number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade
- Consignment details.

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.
- Records of qualification of welders and procedures for repair welding.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- All other reports and results required as per this specification.
- Copy of final inspection report with MTC.
- Description and disposition of repairs.

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 (New) Online Pipe Tracking Data**

Additionally, the manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipes during production. Also, it is required to have traceability of each day production.

In order to establish traceability of pipes, the system should have minimum of following information:

- Heat/Coil number
- Traceability of pipe at each station
- Final status of pipe
- Reason for each rejection

**16 (New) Pipe Loading**

The manufacturer/coater/supplier shall submit calculations and sketch for loading / unloading & stacking of Bare/Coated pipes at all points, e.g. warehouse/ pipe-yard (ex-works), loading and transportation on trailers, etc. as per API RP 5LT (latest edition).

In addition to the above, foreign manufacturers/coaters/suppliers shall submit calculations and sketches for loading/unloading, stacking & transportation by ship/ barge as per API RP 5LW (latest edition).

**17 (New) INSPECTION OF FIELD TESTS & WARRANTY**

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

## Annex B

## Manufacturing Procedure Qualification for PSL 2 Pipe

### B.1 INTRODUCTION

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

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

These manufacturing procedure qualification tests (MPQT) shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser Representative. The MPQT 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. However, waiver of MPQT for any item shall be specifically as per instruction in the Material Requisition (MR).

### B.3 CHARACTERISTICS OF THEMANUFACTURINGPROCEDURE SPECIFICATION

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

### B.5 MANUFACTURINGPROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

**a. Visual Examination**

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

**b. Ultrasonic Examination**

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

**c. Radiographic Examination**

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

**d. Mechanical Properties**

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

The following tests shall be conducted:

i. Guided bend test

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

ii. Tensile test

Tensile tests shall be conducted on:

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

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

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

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

iii. Metallographic tests

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

iv. CVN impact testing

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

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

The minimum average (set of three test pieces) absorbed energy value ($K_vT$) at the test temperature specified in clause 9.8 and Table 8 of this specification shall be complied with for test pieces extracted from base metal, weld and HAZ.

v. Fracture toughness testing

*For pipe with specified outside diameter, D ≤ 508.0 mm (20.0 inch):*
Four (4) sets of CVN base metal test pieces shall be tested at - 40°C, - 10°C, 0°C and + 20° C for shear area and absorbed energy to produce full transition curve. The minimum average (set of three test pieces) shear fracture area at the test temperature specified in clause 9.8 of this specification shall be complied with. For other temperatures, the value shall be for information only.

*For pipe with specified outside diameter, D> 508.0 mm (20.0 inch):*
Five (5) sets of DWTT test pieces shall be extracted from base metal in a transverse direction at points selected by Purchaser. Each set shall consist of two test pieces taken from same test coupon. The sets of base metal test pieces shall be tested at - 40°C, - 20°C, - 10°C, 0°C and + 20°C for shear area to produce full transition curve. The value at the test temperature specified in clause 9.9 of this specification shall be complied with. For other temperatures, the value shall be for information only

**e. Burst Test (New)**

Burst Test shall be done on each grade of pipe for each size on lowest thickness at the time of first day production test. Burst pressure & location of failure shall be recorded. Technical audit shall be carried out by OWNER / OWNER'S representative during manufacturing.

Burst pressure of the subjected pipe shall not be less than the calculated burst pressure based on the minimum actual Ultimate Tensile Strength of the subjected pipe.

## Annex C

## Treatment of surface imperfections and defects

### C.1 TREATMENT OF SURFACE IMPERFECTIONS

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

### C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

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

### C.4 REPAIR OF DEFECTS BY WELDING

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

a. No repair of weld seam is permissible after cold expansion,
b. No repair of weld seam is permissible at pipe ends up to a length of 300 mm.
c. Through thickness repair of weld seam is not permitted.
d. Maximum length of any repair shall be 300 mm.
e. Minimum length between weld repairs shall be >100 mm.
f. No repair of a repaired weld is permitted.
g. Repair welding shall be executed only after specific approval by Purchaser Representative for each repair.
h. The repair weld shall be performed with minimum of two passes.

C.4.3 The cumulative length of weld seam repairs on one pipe shall be ≤ 5 % of the pipe length.

C.4.6 After weld repair, the total repaired area shall be Radiographically and Ultrasonically inspected in accordance with clause E.4 & E.5 of API Spec 5L and as modified herein.

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

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

## Annex-D

## Repair Welding Procedure

**D.2 REPAIR WELDING PROCEDURE QUALIFICATION**

D.2.3 **Mechanical Testing**

D.2.3.2 **Transverse Tensile Test**

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

D.2.3.3 **Transverse Guided bend test**

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

D.2.3.4 **Charpy (CVN) impact test**

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

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

D.2.3.5 (New) **Hardness Testing**

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

## Annex E

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

**E.1 QUALIFICATION OF PERSONNEL**

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

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

Inspector Qualification

Acceptable qualification for NDT inspectors shall be as specified below:

*(i) For UT*

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

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

*(ii) For all other NDT methods*

| | | |
|---|---|---|
| Evaluation of indications | : | Level II & Level III inspector |
| Shift Supervisor | : | Level II inspector |

**E.3 METHODS OF INSPECTION**

E.3.1 **General**

E.3.1.1 The weld seams of the pipe shall be inspected by ultrasonic methods (Refer Table E.1 of API Spec 5L) for full length (100%) for the entire thickness, using automatic

ultrasonic equipment in accordance with clause E.5 of API Spec 5L and as modified in this specification.

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

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

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

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

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

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

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

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

E.4.2 Radiological Inspection Equipment

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

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

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

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

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

E.4.5 **Acceptance limits for imperfections found by radiographic inspection**

Slag-inclusion-type and/or gas-pocket-type imperfections in the weld at pipe ends are not acceptable and shall be removed by cutting off the section of pipe containing these imperfections. The remaining imperfection -free section of the pipe will be acceptable provided its length is within the specified minimum length and the weld at the new pipe end contains no imperfections.

E.4.6 **Defects found by radiographic inspection**

Defects in the weld such as cracks, lack of complete penetration and lack of complete fusion in the pipe material shall be removed by cutting off the section of pipe containing these defects. The remaining defect-free section of the pipe will be acceptable provided its length is within the specified minimum.

E.5 **ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1 **Equipment**

E.5.1.2 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 and probe decoupling. All ultrasonic testing equipment shall be provided with recording device. In addition, an automatic weld tracking system shall be provided for correct positioning of the probes with respect to weld centre

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

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

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

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

E.5.2.3 **Reference standards for Ultrasonic testing**

E.5.2.3.1 **Reference standards for pipe weld seam UT**

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

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

**Table E.7 — Reference indicators**

| Item | Reference indicators [a] | | | |
|---|---|---|---|---|
| | Number of notches and orientation | | Notch Type [b] | Diameter of radially drilled hole mm(in) |
| | OD | ID | | |
| Weld seam Edge | 2L | 2L | N5 | d |
| Weld Seam Center | 1L, IT | 1L, IT | N5 | 1.6 (0.063)[c] |

a. The symbol indicates the orientation of the notch i.e. L = Longitudinal and T = Transverse. Reference indicators shall be located as per Figure E. 1 of this specification.
b. Dimensions of Notch type N5 shall be 0.05t x 50 mm x 1 mm (Depth x maximum Length x maximum width), where, 't' is the specified wall thickness. The depth tolerance is ± 15% of the specified notch depth or ± 0.05 mm, whichever is greater.
c. Through thickness hole shall be drilled in the centre of the weld seam.
d. Not required.

E5.2.3.2 **Reference standards for plate UT**

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

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

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

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

E.5.3 **Instrument standardization**

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

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

- Every time the running of the system gives rise to doubts on its efficiency.

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

E.5.5 **Acceptance limits**

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

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

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

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

E.5.6 **Disposition of defects found by ultrasonic and electromagnetic inspection**

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

**E.7 RESIDUAL MAGNETISM**

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

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

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

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

**E.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY OF SAWL PIPES**

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

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

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

**E.9 LAMINAR IMPERFECTIONS ALONG THE STRIP/ PLATE EDGES OR PIPE WELD SEAM OF SAWL PIPES**

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

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

per clause E.5.6 of this specification.

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

**Table E.9 - Acceptance criteria for laminar imperfection in plates (New)**

| Location | Maximum individual imperfection | | Minimum imperfection Size considered | | | Maximum population density[a] |
|---|---|---|---|---|---|---|
| | Area $mm^2$ | Length[b] mm | Area $mm^2$ | Length[b] mm | Width[b] mm | |
| Plate excluding edges | 1000 | 100 [d] | 300 | 35 | 8 | 10 [per 1.0 m x 1.0 m] |
| Longitudinal edges of plate | 500 | 40 | — | 20 | — | 4 [per 1.0 m length] |

a Number of imperfections of size smaller than the maximum imperfection size and greater than the minimum imperfection size,
b Length is the dimension at right angles to the scan track,
c Width is the dimension parallel to the scan track.
d Any planar imperfection which is not parallel to the plate surface is not acceptable,
e For an imperfection to be larger than the minimum imperfection size, the minimum area, minimum length and minimum width given for the plate, all have to be exceeded.

## E. 10 DISPOSITION OF PIPES CONTAINING DEFECTS

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, MP1 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 E.10 of API Spec 5L.

**Annex Q (New)**

**Purchaser Inspection**

**Q.1 INSPECTION NOTICE**

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

**Q.2 PLANT ACCESS**

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

**Q.3 COMPLIANCE**

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

**Q.4 REJECTION**

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

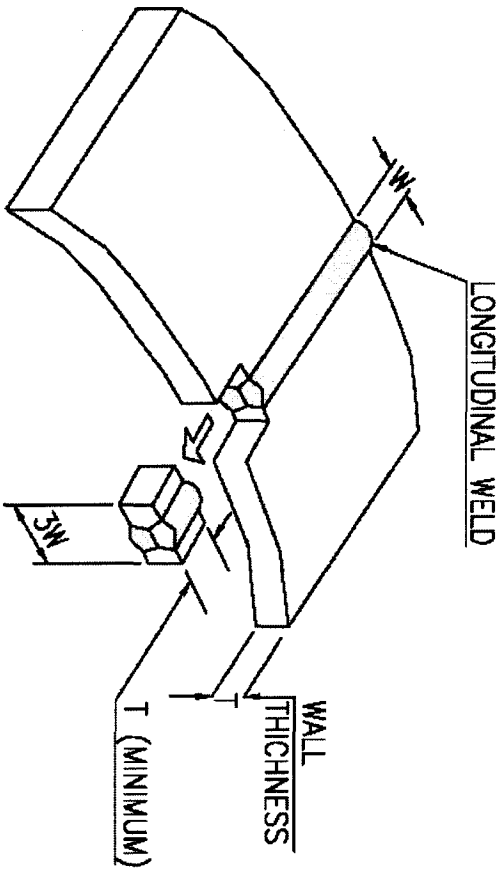
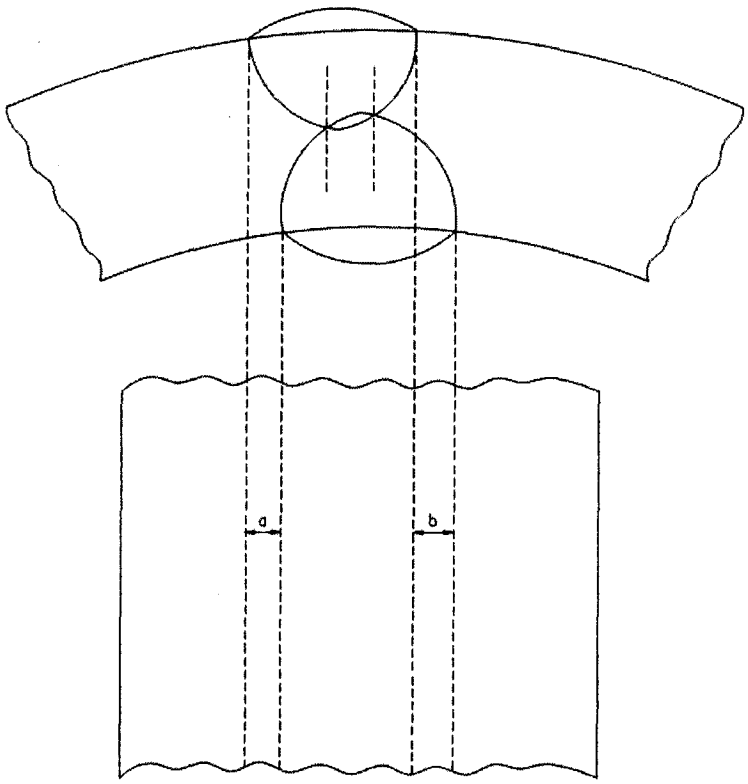
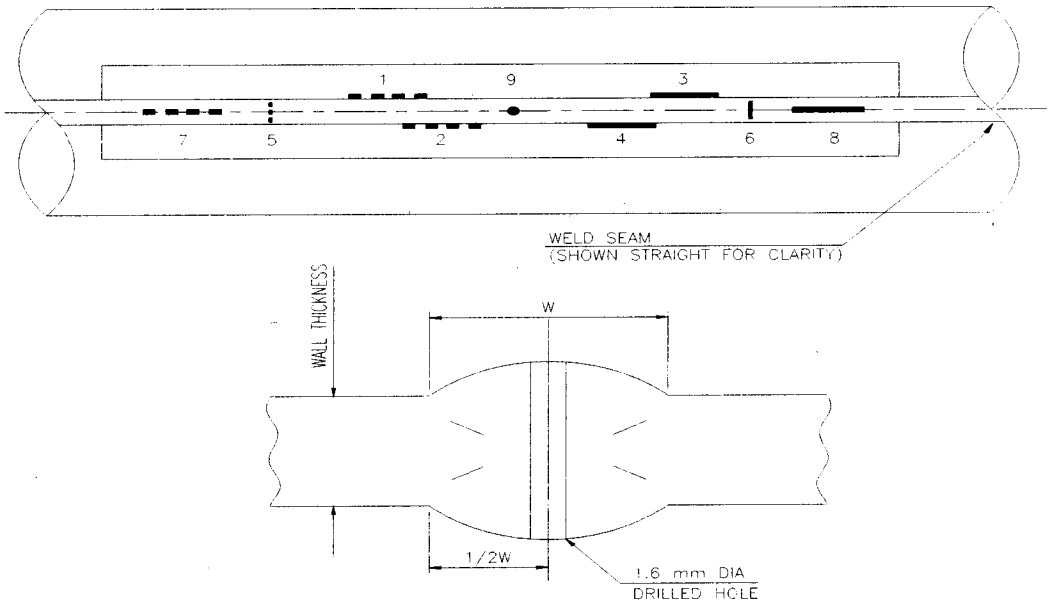



FIGURE 10.2.5.3.1

METALLOGRAPHIC SPECIMEN EXTRACTION PLAN




X-RAY FILM
PROCEDURE FOR MEASUREMENT OF OUT OF LINE WELD HEAD
FIGURE 10.2.5.3.2




1,2 - LONGITUDINAL INSIDE NOTCH AT WELD SEAM EDGE
3,4 - LONGITUDINAL OUTSIDE NOTCH AT WELD SEAM EDGE
5 - TRANSVERSE INSIDE NOTCH ACROSS WELD
6 - TRANSVERSE OUTSIDE NOTCH ACROSS WELD
7 - LONGITUDINAL INSIDE NOTCH AT WELD SEAM CENTER
8 - LONGITUDINAL OUTSIDE NOTCH AT WELD SEAM CENTER
9 - 1.6 mm DIA THROUGH THICKNESS HOLE

FIGURE E.1

**REFERENCE STANDARD FOR U.T. OF WELD SEAM**

# STANDARD SPECIFICATION
# FOR
# HIGH FREQUENCY WELDED (HFW)
# LINE PIPE
# (ONSHORE)

**SPECIFICATION NO.: MEC/TS/05/21/012**

## (OIL & GAS SBU)
## MECON LIMITED
**DELHI 110 092**

| PREPARED BY: | CHECKED BY: | APPROVED BY: | ISSUE DATE: |
|---|---|---|---|
| SACHIN KUMAR (D.E.) | SACHIN SINGHAL (S.D.E.) | K. P. SINGH (A.G.M) | 13.04.2016 |

# AMENDMENT STATUS

| Sl. No. | Clause/ Paragraph/ Annex./ Exhibit/ Drg. Amended | Page No. | Ed. No. | Rev. No. | Date | Prepared by | | Checked by | | Approved by | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Name & Desig. | Sig. | Name & Desig. | Sig. | Name | Sig. | |
| 1. | Overall Revision | All | 3 | 1 | 13.04.16 | Sachin Kumar (D.E.) | | Sachin Singhal (S.D.E.) | | K. P. Singh (A.G.M.) | | In line with API Spec. 5L, 45th Ed., 2012 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Abbreviations:

| | |
|---|---|
| API | American Petroleum Institute |
| ASTM | American Society for Testing and |
| CE | Carbon Equivalent |
| CVN | Charpy V-Notch |
| FBH | Flat Bottomed Holes |
| HAZ | Heat Affected Zone |
| HFW | High Frequency Welded |
| ID | Inside Diameter |
| $K_v$ *T* | Charpy value in pipe longitudinal |
| $K_v$L | Charpy value in pipe transversal direction |
| MPQT | Manufacturing Procedure Qualification |
| MPS | Manufacturing Procedure |
| MPT | Magnetic Particle Testing |
| NDT | Non Destructive Testing |
| OD*ID* | Outside Diameter, Specified |
| *t* | Wall Thickness, Specified |
| UT | Ultrasonic testing |

## CONTENTS

## 1 SCOPE

This specification establishes the minimum requirements for the manufacture of high frequency welded steel line pipe 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 (New) Pipe Size

This Specification shall be applied to line pipe of size 4½" OD thru 24" OD (both sizes included).

### 1.2 (New) Grades

This specification is applicable to line pipes of grade BM through X-80M.

## 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 E112-12: Standard Test Methods for Determining Average Grain size
ASTM A370 : Standard Test Methods and Definitions for Mechanical Testing of Steel Products

BS

BS 5996 : Specification for the Acceptance Level for Internal perfection in Steel Plate, Strip and Wide Flats Based on Ultrasonic testing.

## 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 (PSL 2) as given in Table 1 of this specification and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (M) that identifies the delivery condition as per Table 3 of this specification.

Table 1 of API 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[a b] |
|---|---|---|
| PSL 2 | Thermo mechanical rolled | BM, X42M, X46M, X52M, X56M, X60M, X65M, X70M & X80M |
| a Deleted<br>b The suffix (M) for PSL 2 grades belongs to steel grade | | |

### 6.2 Delivery condition

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

## 8 MANUFACTURING

### 8.1 Process of Manufacture

Pipe furnished to this specification shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 of API 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 |
|---|---|---|---|---|
| HFW | Thermo mechanical-rolled coil | Cold forming | Heat treating[a] of weld area only | M |
| a See clause 8.8 of this specification for applicable heat treatment | | | | |

High frequency electric welding shall be performed with a minimum welding current frequency of 200 kHz. The welding system shall have an integrated control in which following data as a minimum shall be monitored:

- Welding Temperature
- Welding speed
- Current and Voltage

Abutting edges of the coil shall be milled or machined immediately before welding. The width of the coil shall be continuously monitored.

**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 for grades BM through X70M and grain size number 10 or finer for grade X80M.

**8.8 Treatment of weld seams in EW pipes**

8.8.2 **PSL 2 HFW pipe**

The weld seam and the entire Heat Affected Zone (HAZ) shall be heat treated so as to stimulate a normalizing heat treatment in order to control the grain structure so that no untempered martensite remains in the weld seam and the HAZ, and the mechanical properties of heat treated zone approximate that of the parent metal.
Heat treatment temperature of the weld seam and the entire HAZ shall be continuously measured and recorded.

**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.

**Table 5 - Chemical composition for pipe**

| Element | Mass fraction, based upon heat and product analyses (%) | | |
|---|---|---|---|
| | For Grades BM to X70M | | For Grade X80M |
| C [b] | 0.16 | max. (For Grade BM to X56M) | 0.12 max. |
| | 0.12 [f] | max.(For Grade X60M to X70M) | |
| Si | 0.15 [m (New)] | min. | 0.45 max. |
| | 0.45 | max. | |
| Mn[b] | 1.20 | Max. (For Grade BM) | 1.85 max. |
| | 1.30 | max. (For Grade 42M & X46M) | |
| | 1.40 | max. (For Grade X52M & X56M) | |
| | 1.60 | max. (For Grade X60M to X70M) | |
| P | 0.020 | max. | 0.020 max. |
| S | 0.010 | max. | 0.006 max. |
| V[d] | 0.05 | max. (For Grade BM to X56M) | Note 'd' |
| | 0.08 | max. (For Grade X60M to X70M) | |
| Nb[d] | 0.05 | max. (For Grade BM to X46M) | Note 'd' |
| | 0.10 | max. (For Grade X52M to X70M) | |
| Ti[d] | 0.04 | max. | Note 'd' |
| Al [n (New)] | 0.02 [0(New)] | min. | Note 'n (New)' |
| | 0.07 | max. | |
| Cr | 0.20 | max. | 0.40 max. |
| Mo | 0.28 | max. | 0.30 max. |
| Cu [p (New)] | 0.35 | max. | 0.50 max. |
| Ni [p (New)] | 0.20 | max. | 0.50 max. |
| N [n (New)] | 0.012 | max. | 0.008 max. |
| B | 0.0005 | max. | 0.0005 max. |
| Ca | 0.006 | max. | ---- |

**Notes to Table 5:**

| | |
|---|---|
| a | Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the $CE_{Pcm}$ limits apply if C ≤ 0.12% and $CE_{IIW}$ limits apply if C > 0.12%. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits:<br><br>$CE_{Pcm} \leq 0.23$<br>$CE_{IIW} \leq 0.43$<br>Boron content shall be considered in $CE_{Pcm}$ formula even if it is less than 0.0005%. |
| b | Deleted |
| c | Deleted |
| d | Nb + V + Ti < 0.15 % |
| e | Deleted |
| f | Deleted |
| g | Deleted |
| h | Deleted. |
| i | Deleted |
| j | Deleted |
| k | Deleted |
| l | Deleted |
| (New) m | Minimum for Si is not applicable for Al killed steel. |
| (New) n | Al/N shall be minimum 2 (not applicable to titanium-killed steel or titanium-treated steel). |
| (New) o | Applicable for Al killed steel only. |
| (New) p | Cu+Ni shall not exceed 0.4% (applicable for Grade BM to X-70M).<br>Cu+Ni shall not exceed 0.75% (applicable for Grade X-80M). |

9.2.3 For heat analysis and product analysis, all the elements listed in Table 5 of this specification shall be analyzed and reported, even if those are not purposely added but are present as residuals only.
If alloying elements other than those specified in Table 5 of this specification are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

**9.3 Tensile properties**

9.3.2 The finished pipe (after 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 inexcess of SMYS. MPa (psi) |
|---|---|
| Up to and including X46M | 131 (19,000) |
| X52M to X60M | 125 (18,000) |
| X65M to X70M | 120 (17,400) |
| X80M | 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 tensile strength of the weld (after heat treatment of the weld seam) shall be equal to or higher than the specified minimum tensile strength of the base metal.

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

**9.6 Flattening test**

Acceptance criteria for flattening tests shall be as follows:

a) For HFW pipe of grade ≥ X60M and $t \geq 12.7$ mm, there shall be no opening of the weld before the distance between the plates is less than 66% of the original outside diameter. For all other combinations of pipe grade and specified wall thickness, there shall be no cracks or breaks in either weld or parent metal before the distance between the plates is less than 50% of the original outside diameter. Dye penetrant testing shall be used to positively confirm the presence of crack, break or opening.

b) For HFW pipe with a $D/t > 10$, there shall be no cracks or breaks other than in the weld before the distance between the plates is less than 33% of the original outside diameter.

c) For all pipes, there shall be no evidence of lamination or burnt metal during the entire test before opposite walls of the pipe meet.

Note: The weld extends to a distance of 13 mm on each side of the weld line. The original outside diameter is the specified outside diameter.

**9.8 CVN impact test for PSL 2pipe**

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 ($K_vT$) 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 ($K_vT$) [a, b] [J] | |
|---|---|---|
| | *Average* | *Minimum* |
| BM | 40 | 32 |
| X42M | 40 | 32 |
| X46M & X52M | 40 | 32 |
| X56M & X60M | 40 | 32 |
| X65M | 41 | 33 |
| X70M | 55 | 44 |
| X80M | 80 | 64 |

a) The required $K_vL$ (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.

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 °F) or at a lower test temperature as specified in the Purchase Order.

9.8.3 **Pipe weld and HAZ tests**
9.8.4

The average (set of three test pieces) absorbed energy value ($K_vT$) for each pipe weld and HAZ test shall be as specified in Table 8 of this specification, based upon full-size test pieces at a test temperature of 0°C (32°F) or at a lower test temperature as specified in the Purchase Order.

**9.10 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 of this specification.

**9.10.3 Arc burns**

9.10.3.2 Arc burns shall be treatedinaccordance with clause C.3 of this specification. As a reference method for confirming the existence of an arc bum, the area shall be buffed with wire brush or sanding disc and etched with 10% solution of ammonium persulfate or a 5% solution of nital.

However, arc burns can be considered for acceptance, in case the same is re-crystallized by seam heat treatment. In such case, the Manufacturer shall demonstrate the recrystallization to Purchaser by taking a sample as per clause 10.2.3.8 (New) of this specification.

**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 of this specification.

**9.10.5 Geometric deviations**

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

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

Dents that exceed the above specified limits shall be considered as defect and shall be treated in accordance with C.3 of this specification. 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, detected by visual inspection, larger than 50 mm (2.0 in) in any direction, hardness test shall be performed using portable hardness test equipment. Hardness values at these spots greater than $248HV_{10}$ for grades BM through X70M and greater than $285HV_{10}$ for X80M shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of this specification.

9.10.7 **Other surface imperfection**

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

a) Imperfections that have a depth ≤ 0.05 *t* 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 of this specification.

b) Imperfections that have a depth > 0.05 *t* 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 of API Spec 5L and as modified in this specification or shall be treated in accordance with Clause C.3 of this specification.

c) Imperfections that encroach on the minimum permissible wall thickness shall be classified as defects and treated in accordance with Clause C.3 of this specification.

**9.11 Dimensions, mass and tolerances**

**9.11.3 Tolerances for diameter, wall thickness, length and straightness**

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

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

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

| Specified outside diameter *(D)* mm (in) | Diameter tolerance | | Out – of – roundness tolerance e(new) | |
|---|---|---|---|---|
| | Pipe except the end [a] | Pipe end [a,c] | Pipe except the end [a] | Pipe end [a,c] |
| *D*≤ 168.3 ($6^{5}/_{8}$) | ± 0.0075 *D* | - 0.4 mm to + 1.6 mm | 0.020 *D* | 0.015 *D* upto a maximum of 2.0 mm |
| 168.3 ($6^{5}/_{8}$)<D≤ 273.1 ($10^{3}/_{4}$) | ± 0.0075 *D* | ± 0.005 *D* | 0.020 *D* | 2.0 mm |
| *D*> 273.1 ($10^{3}/_{4}$)) | ± 0.0075 *D* upto a maximum of ± 3.0 mm | ± 1.6 mm | 0.020 *D* | 3.0 mm |

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

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

The tolerances on specified wall thickness shall be (+) 15% and (-) 0%. Table 11 of API Spec 5L stands deleted.

The +ve tolerance for wall thickness doesn't apply to the weld area. Clause 9.13.2 of API Spec 5L shall be referred 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.

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 ≤ 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.

**9.16** (New) **Reverse Bend Test**

All pipes shall meet the minimum acceptance criteria for Reverse Bend Test as follow:

A specimen which fractures completely prior to the engagement of mandrel and specimen as specified in clause 10.2.4.9 (New) of this specification, or which reveals cracks or ruptures in the weld or heat affected zone longer than 4 mm shall be rejected. Cracks less than 6 mm long at the edges of the specimen shall not be cause for rejection. Dye penetrant testing shall be used to positively confirm cracks or openings.

**10 INSPECTION**

**10.1 Types of inspection andinspection documents**

**10.1.3 Inspection documents for PSL 2pipes**

10.1.3.1 Manufacturer shall issue inspection certificate 3.2 in accordance with EN 10204 for each dispatched pipe.

**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 [a] | One analysis per heat of steel |
| 2. | Product analysis [b] | Two pipes per lot (maximum 100 pipes) per heat |
| 3. | Tensile testing of the pipe body | Two pipes per test unit of not more than 100 pipes per heat |
| 4. | Tensile testing of the longitudinal weld seam of pipe [c] | Two pipes per test unit of not more than 100 pipes per heat |
| 5. | CVN impact testing of the pipe body | One set of three transverse specimen per test unit of not more than 50 pipes per heat |
| 6. | CVN impact testing of the weld and HAZ of pipe [c] | One set of three transverse specimen per test unit of not more than 50 pipes per heat |
| 7. | Flattening test of pipe | As shown in Figure 6 a) of API Spec 5L |
| 8. | Reverse Bend Test (New) | Same as Figure 6 a) of API Spec 5L |
| 9. | Hardness testing | Any hard spot exceeding 50 mm (2.0 in) in any direction |
| 10. | Hydrostatic testing | Each pipe |
| 11. | Weighing of pipe | Each pipe shall be measured and recorded |
| 12. | Wall thickness measurement [d] | Each pipe |
| 13. | Pipe diameter and out-of- roundness [d] | Each pipe |
| 14. | Length | Each length of pipe shall be measured and recorded |
| 15. | Straightness [d] | Each pipe |
| 16. | Tolerances for the weld seam [d]<br>a) Radial offset of coil edges<br>b) Height of flash and<br>c) Depth of groove after trimming of inside flash | Each pipe |

| | | |
|---|---|---|
| 17. | Visual inspection | Each pipe |
| 18. | Metallographic testing (including Vicker's hardness test) of the longitudinal seam weld of pipe as defined in clause 10.2.5 of this specification | At least one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs max.) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered and at the beginning of the production of each combination of specified outside diameter and specified wall thickness. |
| 19. | Other dimensional testing | Random testing, with the details left to the discretion of the manufacturer |
| 20. | Non-destructive inspection | In accordance with Annex E of API Spec 5L and as modified herein |

**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) Pipe produced by each welding machine shall be tested at least once per week,
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 E 1806. 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 b) and Figure 6 a) of API Spec 5L and Figure 10.2.4.9.1 & 10.2.5.3.2 of this specification, whichever is applicable, and as given in Table 20 of this specification.

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

**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] | |
|---|---|---|---|
| | | Specified outside diameter, *D* mm (in) | |
| | | <219.1 mm (8.625 in) | ≥219.1 mm (8.625 in) |
| Pipe body | Tensile | 1L90, IT[b d] | 1T180 [c] |
| | CVN | 3T90 | 3T90 |
| Seam Weld | Tensile | d | IW[d] |
| | CVN | 3W and 3HAZ | 3W and 3HAZ |
| | Hardness | 1W (As shown in figure 10.2.5.3 of this specification) | |
| Pipe body and weld | Flattening | As shown in figure 6 a) of API Spec 5L | |
| | Reverse Bend | As shown in figure 10.2.4.9.1 of this specification | |

a) See figure 5 (b) of API Spec 5L for an explanation of the symbols used to designate orientation and location.
b) Deleted
c) The transverse tensile test shall be carried on flattened rectangular strip specimen prepared according to ASTM A370.
d) Test specimen shall be tested for transverse yield strength.

10.2.3.2 **Test pieces for the tensile test**

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

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

Longitudinal tensile tests shall be carried out on a rectangular test piece with full wall thickness prepared in accordance with ASTM A370.

For tensile test piece, both inside and outside flash of weld in excess of pipe wall thickness shall be removed from the test piece either by grinding or machining.

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. 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 4½" (114.3mm) OD line pipe, if preparation of standard sub-sized test piece as per ASTM A370 is not possible, CVN impact testing with transverse test specimen may not be carried out.

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

10.2.3.7 **Test pieces for flattening test**

The test pieces shall be prepared in accordance with ISO 8492. The length of each test piece shall be ≥ 60 mm.

Minor surface imperfections may be removed by grinding.

10.2.3.8 **(New)** **Test pieces for Macrographic and metallographic tests**

Test piece for metallographic testing shall be taken transverse to the longitudinal weld seam as indicated in Figure 10.2.5.3 of this specification. The test piece shall be suitably ground, polished and etched to reveal the macro-structure.

10.2.3.9 **(New)** **Test pieces for Reverse bend test**

Ring specimen of width between 100 mm to 115 mm shall be taken from the pipe. Reverse bend test shall be carried out as per clause 10.2.4.9 (New) of this specification.

10.2.4 **Test methods**

10.2.4.3 **CVN impact test**

The Charpy test shall be carried out in accordance with ASTM A3 70.

10.2.4.7 **Flattening test**

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

The flattening test shall be carried out in accordance with ISO 8492.

10.2.4.9 **(New)** **Reverse bend test**

The mandrel shall be plunged into the test piece prepared in accordance with clause 10.2.3.9 (New) of this specification, with the weld in contact with the mandrel, to such a depth that the angle of engagement between mandrel and specimen reaches 60° as shown in figure 10.2.4.9.1 of this specification. If the combination of diameter &

wall thickness of pipe and radius of mandrel is such that the angle of engagement cannot reach 60°, then the mandrel shall be plunged into the specimen until opposite walls of the specimen meet.

**Selection of Mandrel**

The reverse bend test shall be carried out with a mandrel, whose radius (R), or width (A) shall be calculated for any combination of diameter, wall thickness and grade with the following formula:

$$A = 2R = \frac{1.4(D-t)t}{e(D-2t)-1.4t} - t$$

Where,

D - Specified outside diameter of pipe, mm
t - Specified wall thickness of pipe, mm
1.4 - Peaking factor
e - Strain

Minimum value of 'e' shall be as per Table 23 of API Spec 5L reproduced as below:

| Grade of Steel | Minimum 'e' value |
|---|---|
| BM | 0.1375 |
| X42M | 0.1375 |
| X46M | 0.1325 |
| X52M | 0.1250 |
| X56M | 0.1175 |
| X60M | 0.1125 |
| X65M | 0.1100 |
| X70M | 0.1025 |
| X80M | 0.0900 |

10.2.5 **Macrographic and metallographic tests**

10.2.5.3 The test piece shall be visually examined using a minimum 40X magnification to provide evidence that heat treatment of weld zone is adequate and there is no untempered martensite or detrimental oxides from the welding process present along the weld seam. The metallographic examination shall be documented on micrographs (at 10X to 20X magnification). In case imperfections or defects are observed, it will become a cause for re-evaluation of welding parameters and heat treatment as deemed necessary by Purchaser's Representative.

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248$HV_{10}$ for grades BM through X70M and not exceed 285 $HV_{10}$ for grade X80M. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80$HV_{10}$. 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**

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

10.2.8 **Dimensional testing**

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

10.2.8.7 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 (New) Retesting**

In the event any analysis/test fails to conform to the specified requirements, manufacturer shall either reject the lot/test unit involved or test two additional lengths from same test unit. If both of the new tests conform to the specified requirements, then all the lengths in that test unit shall be accepted, with the exception of original selected length. If one or both of the retest samples fail to conform to the specified requirements, the purchaser or purchaser's representative reserves the right to either test remaining lengths in that test unit or reject the whole lot/test unit.

**10.2.12.1 Recheck analyses**

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 analyzed to meet the requirements of Table 5 of this specification.

**10.2.12.9 Reverse bend retests**

Reverse bend retest provisions shall be same as specified for retests in clause 10.2.12 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 (New) Marking shall also include API Monogram, Purchase Order number, item number, pipe number and heat number.

**11.2 Pipe markings**

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

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

11.2.3 The pipe number shall be placed by cold rolling or low stress dot marking on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of no 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.

- Detail of Coils (Heat-wise)
- Pipe Number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade
- Consignment details.

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.
- Records of qualification of welders and procedures for repair welding.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- All other reports and results required as per this specification.
- Copy of final inspection report with MTC.
- Description and disposition of repairs.

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 (New)** **Online Pipe Tracking Data**

Additionally, the manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipes during production. Also, it is required to have traceability of each day production.

In order to establish traceability of pipes, the system should have minimum of following information:

- Heat/Coil number
- Traceability of pipe at each station
- Final status of pipe
- Reason for each rejection

**16** **Pipe Loading**
(New)

The manufacturer/coater/supplier shall submit calculations and sketch for loading / unloading & stacking of Bare/Coated pipes at all points, e.g. warehouse/ pipe-yard (ex-works), loading and transportation on trailers, etc. as per API RP 5LT (latest edition).

In addition to the above, foreign manufacturers/coaters/suppliers shall submit calculations and sketches for loading/unloading, stacking & transportation by ship/ barge as per API RP 5LW (latest edition).

**17** **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.

## 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. However, waiver of MPQT for any item shall be specifically as per instruction in Material Requisition (MR).

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

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

### B.5 MANUFACTURINGPROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

a. **Visual Examination**

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

b. **Ultrasonic Examination**

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

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. **Flattening test**

Two (2) flattening test pieces shall be extracted; one test piece shall be tested with weld at 0° and other at 90°.

ii. **Tensile test**

Tensile tests shall be conducted on:

*For pipe with specified outside diameter, D < 219.1 mm (8.625 inch) :*
- Two (2) longitudinal test pieces from base metal
- Two (2) annular test pieces from the pipe end

*For pipe with specified outside diameter, D ≥ 219.1 mm (8.625 inch):*

- Two (2) transverse test pieces from base metal
- Two (2) transverse test pieces from the longitudinal weld seam

iii. **Metallographic tests**

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

iv. **CVN impact testing**

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

- Four sets of three (3) transverse test pieces each from base metal
- One set of three (3) transverse test pieces with weld in middle
- One set of three (3) transverse test pieces with HAZ in middle

The minimum average (set of three test pieces) absorbed energy value ($K_vT$) at the test temperature specified in clause 9.8 and Table 8 of this specification shall be complied with for test pieces extracted from base metal, weld and HAZ.

v. **Fracture toughness testing**

Four (4) sets of CVN base metal test pieces shall be tested at - 40°C, - 10°C, 0°C and + 20° C for shear area and absorbed energy to produce full transition curve. The minimum average (set of three test pieces) shear fracture area at the test temperature specified in clause 9.8 of this specification shall be complied with. For other temperatures, the value shall be for information only.

**d. Burst Test (New)**

Burst Test shall be done on each grade of pipe for each size on lowest thickness at the time of first day production test. Burst pressure & location of failure shall be recorded. Technical audit shall be carried out by OWNER / OWNER'S representative during manufacturing.

Burst pressure of the subjected pipe shall not be less than the calculated burst pressure based on the minimum actual Ultimate Tensile Strength of the subjected pipe.

## Annex C

## Treatment of surface imperfections and defects

### C.I 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.

### C.3 TREATMENT OF NON-DRESSABLE SURFACE DEFECT

Pipes that contain non-dressable surface defects shall be given one or more of the following dispositions.

a) Deleted

b) The sections of the pipe containing the surface defects shall be cut off, within the limits on length.

c) The entire pipe length shall be rejected.

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

### E. 1 QUALIFICATION OF PERSONNEL

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

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

**Inspector Qualification**
Acceptable qualification for NDT inspectors shall be as specified below:

*(i) For UT*

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

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

*(ii) For all other NDT methods*

| | | |
|---|---|---|
| Evaluation of indications | : | Level II & Level III inspector |
| Shift Supervisor | : | Level II inspector |

### E.3 METHODS OF INSPECTION

E.3.1 **General**

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

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

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

E.3.2.1 Pipe ends 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.3.2.3 Ultrasonic inspection in accordance with the method described in ISO 10893-8 shall be used to verify that the 50 mm (2.0 in) wide zone at each pipe end is free of any laminar imperfections in the circumferential direction.

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

**E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1 **Equipment**

E.5.1.2 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. In addition, an automatic weld tracking system shall be provided for correct positioning of the probes with respect to weld centre.

**E.5.2 Ultrasonic and electromagneticinspection reference standards**

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

E.5.2.2 Reference standards shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in normal production.
The reference standard (calibration pipe) shall also be of the same material, type and have the same surface finish and heat treatment as the pipe being inspected.

E.5.2.3 **Reference standards**

E.5.2.3.1 (New) **Reference standards for pipe weld UT:**

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

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

**Table E.7 — Reference indicators**

| Item | Reference indicators | | |
|---|---|---|---|
| | Number of notches and orientation[a] | | Notch Type [b] |
| | OD | ID | |
| Weld Seam | 1L | 1L | N10 |

a) The symbol indicates the orientation of the notch i.e. L = Longitudinal. Reference indicators shall be located as per Figure E.I of this specification.

b) Dimensions of Notch type N10 shall be 0.1 t × 50 mm x 1 mm (Depth x maximum Length x maximum width), where, 't' is the specified wall thickness. The depth tolerance is ± 15% of the specified notch depth or ± 0.05 mm. whichever is greater.

E.5.2.3.2 (New) **Reference standards for coil/ pipe body UT:**

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

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

b) depth, *d* : 0.25 *t* < d < 0.5 *t*, where is the specified wall thickness

Reference standard for the ultrasonic inspection of coil edges (area adjoining weld seam)/ pipe ends shall have 6.4 mm ( $^1/_4$ inch) diameter FBH of a depth 0.5 t, where 't' is the specified wall thickness.

E.5.3 **Instrument standardization**

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

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

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

E. 5.5 **Acceptance limits**

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

a) Locations showing indications above the acceptance limits during automatic

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

E.5.6 **Disposition of defects found by ultrasonic and electromagnetic inspection**

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

## E.7 RESIDUAL MAGNETISM

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

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

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

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

## E.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY OF EW PIPES

E.8.1 The coil, except the longitudinal coil edges (in case of inspection before pipe forming) or pipe body, except the pipe weld seam (in case of inspection after seam welding) shall be ultrasonically tested for laminations using an oscillating or straight running pattern of probes in accordance with ISO 10893-9 or ISO 10893-8 (as applicable) amended as follows:

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

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

## E.9 LAMINAR IMPERFECTIONS ALONG THE STRIP/ PLATE EDGES OR PIPE WELD SEAM OF EW PIPES

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

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

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

**Table E.9 - Acceptance criteria for laminar imperfection in coil/ pipe body (New)**

| Location | Maximum individual imperfection | | Minimum imperfection size considered | | | Maximum population density |
|---|---|---|---|---|---|---|
| | Area | Length | Area | Length | Width | |
| Coil (except the longitudinal edges) or pipe body (except the pipe weld seam) | 1000 | 100 [d] | 300 | 35 | 8 | 10 [per 1.0 m x 1.0 m] |
| Longitudinal edges of the coil or each side of pipe weld seam | 500 | 40 | — | 20 | — | 4 [per 1.0 m length] |

a) Number of imperfections of size smaller than the maximum imperfection size and greater than the minimum imperfection size,
b) Length is the dimension at right angles to the scan track,
c) Width is the dimension parallel to the scan track.
d) Any planar imperfection which is not parallel to the coil surface is not acceptable,
e) For an imperfection to be larger than the minimum imperfection size, the minimum area, minimum length and minimum width given for the coil/ pipe body, all have to be exceeded.

## 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 ROTARY ULTRASONIC INSPECTION OF PIPE (ALTERNATIVE METHOD)

As an alternative, full pipe may be ultrasonically inspected after welding of longitudinal seam by rotary ultrasonic testing method (pipe in rotating condition) in accordance with ISO 10893-8 amended as follows:

- The coverage area during ultrasonic inspection shall be 100 % of the pipe body including weld seam, sides of the weld seam and pipe ends.

The reference standard for the weld seam as per clause E.5.2.3.1 and Table E.7 of this specification shall be used for the rotary ultrasonic testing.

If the manufacturer opts for rotary ultrasonic testing of full pipe in accordance with this clause, then, the requirement for ultrasonic inspection as per clause E.3.1.1, E.3.2.3, E.8 and E.9 of API Spec 5L and as modified herein shall not be applicable.

## Annex Q (New)

## Purchaser Inspection

**Q.1 INSPECTION NOTICE**

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

**Q.2 PLANT ACCESS**

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

**Q.3 COMPLIANCE**

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

**Q.4 REJECTION**

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

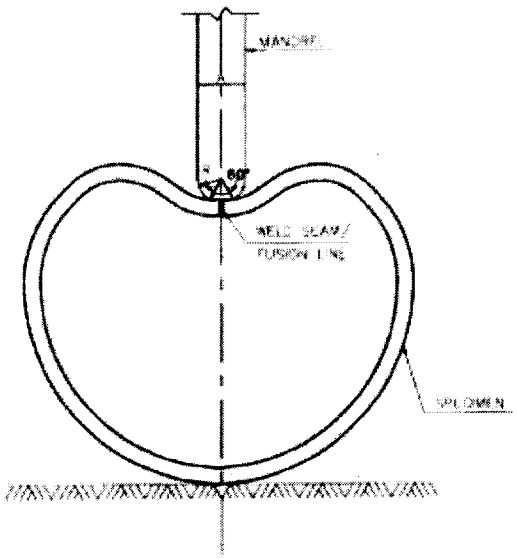



**FIGURE: 10.2.4.9.1**

**REVERSE BEND TEST**

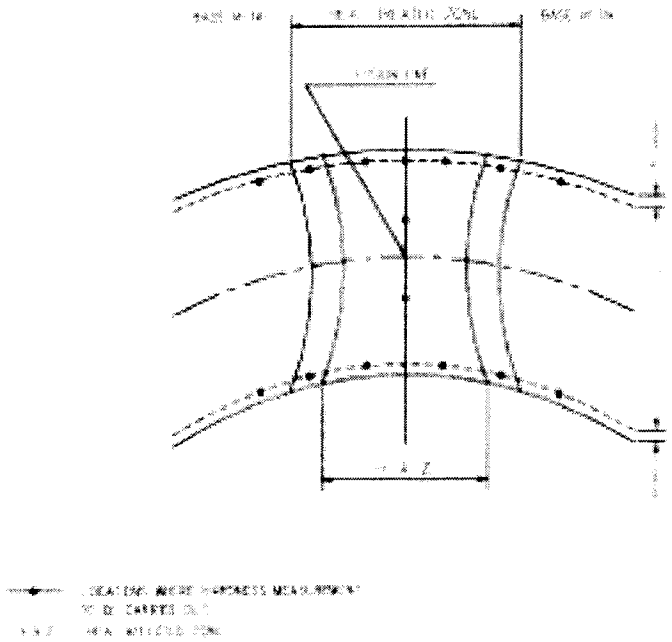
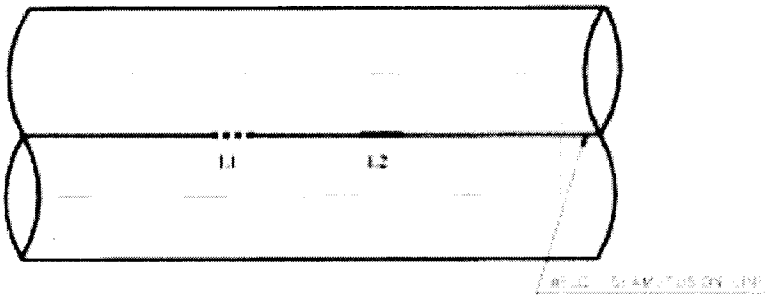


**FIGURE: 10.1.5.3**

**METALLOGRAPHIC SPECIMEN AND LOCATIONS FOR HARDNESS MEASUREMENT**




L1 : Longitudinal inside notch (N10) at weld line
L2 : Longitudinal outside notch (N10) at weld line

**FIGURE: E.1**

**REFERENCE STANDARD FOR UT OF LONGITUDINAL WELD SEAM**