ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)

BAGHJAN – MADHUBAN PIPELINE PROJECT (ASSAM)

BID DOCUMENT FOR PROCUREMENT OF

COATED & BARE LINE PIPE

UNDER OPEN INTERNATIONAL COMPETITIVE BIDDING

TENDER No.: CPG9236P19

VOLUME – II OF II

PREPARED AND ISSUED BY

MECON
मेकॉन
ISO 9001 Company

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

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OIL & GAS SBU, DELHI

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MATERIAL REQUISITION

MATERIAL REQUISITION

(MR No. : MEC/23U1/05/21/M/001/S012)

PROJECT: BAGHJAN – MADHUBAN PIPELINE PROJECT

CLIENT: OIL INDIA LIMITED

TENDER NO.: CPG9236P19

Item: Supply of Coated & Bare Line Pipes, Transportation & Maintenance

MR Item No.	Description: Line Pipes as per API 5L, PSL-2 (45th edition) and Technical Specifications Nos. MEC/TS/05/21/012B & MEC/TS/05/21/012C and 3LPE Coating as per Technical Specification No. MEC/S/05/21/014 and Amendment to TS							Qty. (m)	Manufacturing Process (LSAW / HSAW)	Designated "Place of Delivery of Coated Pipe"
	Specified OD Inch (mm)	Specified W.T. (mm)	Ends	Std./ Code	Material Grade	Finish	Min. 3LPE External Coating Thickness (mm)			
A1	30" (762)	12.7	PE	API 5L	X-70	Coated	2.5	38,531	Bidder to indicate	* Duliajan (Assam)
A2	30" (762)	15.9	PE	API 5L	X-70	Coated	2.5	393	LSAW	
A3	30" (762)	15.9	PE	API 5L	X-70	Bare	-	750	LSAW	

* Proposed location of storage yards is Duliajan, Assam or any other location within radius of 50 KM.

Brief of scope are as follows:

a) **For Item nos. A1 & A2**: Manufacture and Supply of Coated Pipe (3LPE External coating), transportation, handling, unloading & stacking of all coated pipes to designated Warehouse / Storage Yard, including development & maintenance of the Warehouse / Storage Yard (Land for Warehouse / Storage Yard shall be arranged by owner, i.e. Oil India Ltd.).

b) **For Item nos. A3:** Manufacture and Supply of Bare Pipe, transportation, handling, unloading & stacking of Bare Line Pipes up to designated Storage Yard / Warehouse , including development & maintenance of the Warehouse / Storage Yard (Land for Warehouse / Storage Yard shall be arranged by owner, i.e. Oil India Ltd.).

Important Note:

i. Item Nos. A1 & A2 shall have External Coating.

ii. Item no. A3 shall be supplied in bare conditions only, without any External coating.

iii. Item No. A3 shall be supplied from least possible number of heats.

iv. Pipe coating implies External 3 Layer Polyethylene (3LPE) Coating.

v. Item no. A1 shall be manufactured by LSAW / HSAW process.

vi. Item nos. A2 & A3 shall be manufactured by LSAW process only.

vii. Proposed location of storage yards is Duliajan, Assam or any other location within radius of 50 KM.

viii. Deviation to specifications expressed in the offer make the bid liable for rejection.

ix. Colour bands of 50 mm width to be placed at both the ends, inside of Bare Pipes at a distance of 150 mm from the pipe ends and outside of 3LPE Coated Pipes at a distance of 450 mm from the pipe ends.

x. White Band marking inside for all the items.

xi. Yellow Band Marking outside on each Pipe for Item A1 and violet band marking outside on each pipe for item A2.

xii. Raw Material Inspection will be witnessed by Vendor appointed TPIA as per EN 10204, 3.2certification.

xiii. Inspection by vendor appointed TPI shall be as per EN 10204, 3.2certification. Inspection of Steel Plate/Coil required for manufacturing of Line Pipe shall also be 3.2 certified as per EN 10204.

A. SCOPE OF WORK

1.0 Brief scope of works:

a) Scope of Supply of Bare/ Coated pipes as per above Mentioned Material Requisition.

b) Development of Dump Sites as detailed in the Material requisition.

c) Handling, loading and transportation of bare and coated pipes to designated Dump Sites including provision of required number of trailers/trucks for transportation including marine/rail transportation if required (Arrangement of land for Dump Site/ Warehouse/ Storage Yard shall be done by owner, i.e. Oil India Ltd.).

d) Unloading, Handling & Stacking of bare and coated line pipes at Dump sites.

e) Maintenance of Dump Sites.

f) Handing over of bare/ coated Line pipes to the Pipeline Laying/ installation agency progressively.

g) The Dump Sites shall be maintained for the entire duration as specified in the 'Bid Document'.

Other requirements in respect of supply shall be as follows:-

i. Pipes shall be ordered only to Specified grade as in MR/SOR. Intermediate grades shall not be acceptable. Higher grade pipe shall not be considered as a substitute for a pipe ordered without OIL/ MECON prior approval.

ii. The manufacturer shall be required to establish and maintain quality assurance system in accordance with ISO:9001 or equivalent. OIL/ MECON reserve the right to audit manufacturer's quality system.

1.1 Works associated with External coating of Line Pipes

i) Supply of all coating materials as per specification no. MEC/S/05/21/014 for carrying out 3-layer polyethylene external coating. The bidder's proposed coating raw material supplier(s) shall be manufacturer of the materials meant for the three layer side extruded polyethylene coating of pipes. They must have manufactured and supplied the offered grades of materials within the last five years reckoned from the bid due date. These manufacturer(s) shall be evaluated at the bid stage and the bidder shall submit necessary letter of authorization and confirmation (as applicable) from such proposed manufacturer(s). Bidder offer shall be unconditional irrespective of the finally qualified raw material manufacturer(s).

Cleaning and surface preparation of pipes, application of 3 layer side extruded polyethylene coating on bare line pipes as applicable, carrying out inspection and testing, repairing of coating defects, re-testing, any cutting of pipes for the purpose of PQT or regular production testing, carrying out re-beveling and all associated works after cutting etc. and carrying out all coating works as per specification. Application shall also include coating of pipes of non-standard lengths obtained.

ii) The minimum thickness of finished 3LPE coating shall be 2.5 mm for 30" OD Pipe.

iii) A detailed procedure/ write up covering each step, starting from selection of raw material, preparation for coating, detailed coating steps, including First Day Production test, in-house inspection, rejection and repair procedure shall be Furnished.

iv) The coater shall also submit past reference of identical coating jobs with names of consultant, client, job reference and year of completion for at least one Completed job in past five years along with acceptance certificate.

v) Bidder shall submit copy of certificate approved by Third Party Inspection Agency/Client in past showing the use of proposed raw material from a single manufacturer/brand or different manufacturers/ brand.

vi) Prior to start of production, Bidder shall, at his own cost and risk, carry out a trial "First Day Production Coating" to prove that his plants (machinery and manpower), materials and coating procedure shall result in a quality of end product conforming to the functional requirements and properties as stated in the relevant technical specifications, standards and material manufacturer's recommendations. At least 25 (twenty five) test pipes shall be coated in accordance with the approved procedure and relevant standards.
Company representative shall select test pipes at random out of the above mentioned 25 pipes.

1.2 **Works associated with Ware House/Storage yards**

Bidder will be responsible for maintaining warehouse facilities including preservation, traceability, security and insurance at place as defined in the State of Assam for Coated / Bare pipes. The size of warehouse shall be adequate for storage of maximum quantities.

Note: Arrangement of land for Dump Site/ Warehouse/ Storage Yard shall be done by owner, i.e. Oil India Ltd.

The exact quantity to be stacked at dump site shall be intimated to the contractor after award of work. Contractor shall be responsible for performing all works as per scope of work at the client provided dump site locations and quantity of pipes to be stacked at no extra time / cost to the company. In case of split of order between multiple bidders, each successful bidder shall maintain his dump site (s) at the same dumpsite provided by the client (M/s Oil India Ltd.).

i) Bidder(s) shall develop the Ware House area required for stacking/storing of specified quantity of coated / bare pipes. Bidder shall be responsible for maintaining suitable warehouse facilities including preservation, traceability, security and insurance at mentioned warehouses/Dumpsite locations. Bidder shall carry out in this regard all civil works within the Ware House required for temporary storage of pipes in all types of soils such as site grading, clearing, cutting, leveling, filling-up, providing temporary internal roads duly compacted for movement of cranes/trailers within the Ware House, providing temporary fencing and gates/barrier, cabins etc. as per the relevant drawings and other requirements indicated in the Contract document. Bidder shall be responsible for making approach road as required to the Ware House from the nearest main road.

In case any tree cutting is involved, the disposal of uprooted trees shall be as per prevailing environment protection law. All internal access roads shall be dressed and consolidated by means of power driven rollers to obtain maximum compaction. Bidder shall also provide adequate drainage within the Ware House. All leveling, dressing and consolidation works shall be carried out as per the instructions of Company Representative. Bidder shall obtain tree cutting permission from concerned authority wherever applicable.

i) A typical layout of storage yards sketch no. MEC/05/28/GEN/014/01 is enclosed for reference purpose. Bidder shall develop a detailed development plan of Ware House including approach road and obtain MECON/OIL'S approval prior to commencement of Ware House development works.

ii) The Ware House shall be provided with barbed wire fencing (Drawing no.MEC/05/28/GEN/014/02)

iii) The bare/coated pipes within the Ware House may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. Supply of sand and other materials shall be in Bidder's scope. This cover may consist of dry, germ free straw with a plastic film, otherwise foam rubber shall be used. The support shall be spaced in such a manner as to avoid permanent bending of the pipes. Bare pipe stacks shall consist of limited number of layers so that overstressing & deformation of the pipe is avoided. In case of coated pipes, stacks shall consist of limited number of layers so that the pressure exercised by the pipe's own weight does not cause deformation of the line pipe/ damages to coating. Each section shall be separated by means of spacers suitably spaced for this purpose. Calculation for stacking arrangement for bare/coated pipes and number of layers of pipes at storage yards shall be submitted by the coating contractor and approved by MECON/OIL.

iv) Bidder shall also be responsible for providing illumination at the Ware House. The illumination shall be 10 to 15 lux minimum and shall be provided with 11 meters flood light poles. The required power for the lighting shall be arranged by the Bidder.

v) Bidder shall be responsible for maintenance and management of Storage yards/ Ware House for the time specified elsewhere in the tender document or as advised by MECON/OIL including providing security guard etc.

vi) Handing over of pipes to laying contractor progressively, based on the construction requirement. Inspection of all bare & coated line pipes in presence of company representative while handing over of pipes to laying contractor at Storage yards/ Ware House. Repair of damaged pipes, beveled end defects and damaged coating (including supply of coating materials for repair) noticed at the time of handing over of bare/ coated pipes to laying contractor. All handling, lifting tools etc. required for inspection of coated/ bare line pipes at Ware House shall be carried out by the bidder. Bidder shall load the coated & bare pipes on to the truck/ trailer (arranged by Installation Agency) at the Storage yards/ Ware House during handing over.

vii) Handing over of all surplus coated & bare pipes to laying contractor at the Storage yards/ Ware House at the end of work.

1.3 Materials to be supplied by Bidder

Bidder shall procure and supply in sequence and at appropriate time, all corrosion coating materials, repair materials, all accessories, consumables and utilities required for completion of works. The rates quoted for the execution of the work shall be inclusive of supply of these materials. All materials supplied shall be strictly in accordance with the requirements of relevant applicable Company specifications enclosed.

Materials to be supplied shall include, but not limited to, the following:

a) All materials and equipment required for repair, re-beveling and / or cutting out defects of bare pipes.

b) All consumables, equipment required for surface cleaning / preparation etc.

c) Coating materials and other materials, equipment, consumables as required for coating.

d) All materials and equipment required for conducting all types of inspection and tests including non-destructive testing of pipes after rebevelling/ grinding.

e) All materials and equipment required for repairing of defects of coated pipes and thereafter re-testing.

f) All equipment, tools, tackles, trucks/ trailers, devices required for loading, transportation, hauling, handling, unloading, stacking, and storage of bare/ coated pipes.

g) Any other items not mentioned above but required for timely completion of work in all respect.

1.4 Other Requirements

i) The coating plant, equipment, machinery and other facilities shall be in good operating condition to meet the job requirement of quality and production. Worn out or improvised plant are not acceptable. The coating plant(s) for the work shall be of size and capacity that shall be suitable for the scale of work, production rate, time schedule specified elsewhere in the tender document.

ii) Bidder shall, at his own responsibility and cost, provide and prepare all necessary area for the storage of pipes and all other materials for coating yard, stock piling, and other temporary installation. Bidder shall provide servitude agreements as required with the relevant authorities and on work completion to clean, restore and pay settlements and claim for damages.

iii) It is mandatory for the Bidder to provide all testing instruments/ equipment required for qualification, pre production and regular production testing with adequate inventory to carry out tests required within the coating yard. No outside testing is acceptable for this purpose.

iv) Bidder shall, at his own responsibility and cost, provide water and power supply and other utilities, obtain permit regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing authorities.

v) All handling, loading, unloading, stacking/storing shall be done in such a manner as to minimize mechanical damages & corrosion and as per the procedure approved by the Company.

a. All handling shall be done with slings or padded hooks.

b. Trailers shall be cleaned of debris or any other substance that might damage the pipe.
c. Suitable timber and other dunnage shall be used to protect the pipes against the damage during transit.
d. Loading shall be done in accordance with API RP 5L1 and procedure approved by the Company.
e. Finished pipe to be stored for a significant period of time in the coating yard in a manner to prevent corrosion and damages to the coating.

vi) A NACE Level-II coating specialist shall be made available during entire duration of coating works.

vii) Coating wastage generated due to standard cut backs on external coating shall be the property of the Bidder.

viii) Any other works not listed specifically herein but required to be carried out by the Bidder in order to complete the job in all respects, shall also form a part of Bidder's scope.

B. REMARKS / COMMENTS

1. **GENERAL NOTED**

VENDOR'S COMPLIANCE

Vendor must include the following statement in his bid:
We certify that our bid is fully complying with your enquiry dated …… And referenced ……
Compliance with this material requisition in any instance shall not relieve the Vendor of his responsibility to meet the specified performance.

2. **COMPLIANCE WITH SPECIFICATION**

The vendor shall be completely responsible for the receiving/ taking over, design, materials, fabrication, testing, inspection, preparation for shipment, transport, storage at client designated Dump Yard/ Warehouse and delivery to designated pipeline laying contractor of the above items strictly in accordance with the Material Requisition and all attachments thereto.

3. **INSPECTION**

Vendor shall appoint anyone of the following TPIA for inspection purpose. Vendor has to propose minimum 4 nos. of below listed agencies to be approved by OIL/ MECON.

1) Det Norske Veritas (DNV)
2) BVQI
3) Technische Ulierwachungs Verein (TUV)
4) Lloyds
5) RITES
6) I.R.S.
7) Tuboscope Vetco

Apart from inspection by TPIA, inspection shall also be performed by OIL and or its authorized representative / MECON and or its authorized inspection agency (AIA), as set out and specified in the codes and particular documents forming this MR.

4. **CERTIFICATION**

The vendor shall be completely responsible for the design, materials, fabrication, coating, testing, inspection, preparation for shipment, loading of the above item strictly in accordance with the Material Requisition and all attachments thereto. All items shall be provided with EN 10204, 3.2 Certification.
The steel plate/coil required for pipe manufacturing shall also be certified as per EN 10204, 3.2 Certification.

5. Procurement of Steel Plates/ Coils

5.1 List of acceptable Steel Plate/Coil Manufacturer

The following steel manufacturers are acceptable for the supply of Steel Plates/Coil to be used in the manufacture of quoted line pipes. The Pipe manufacturer shall furnish specific confirmation for compliance to specifications from any of two (2) proposed steel plate/coil manufacturer(s).

For Plate (Upto X-70)

1. Mannesmann Salzgitter Roehrenwerke, Germany
2. Dillinger, Germany
3. JSW Steel, USA
4. Ilva, Itay
5. Azovstahl, Ukraine
6. Arcelor Mittal,France/Germany
7. Voest Alpine, Austria
8. Sumitomo Metal, Japan
9. Nippon Steel, Japan
10. Usimians, Brazil
11. Posco, South Korea
12. Welspun PCMD, India
13. Baoshan Iron & Steel Co. Ltd, Shangai, China
14. Essar Steel, India
15. Jindal Steel & Power Ltd (up to 20.6 mm)
16. Rourkela Steel Plant (SAIL) (up to 23.8 mm)

For Coil (Upto X-70)

1. Thyssen Krupp, Germany
2. AHMSA (Altos Hornos De Mexico), Mexico
3. Baoshan Iron & Steel Co. Ltd, Shangai, China
4. Wuhan Iron & Steel, China
5. US Steel Kosice, Slovak Republic
6. Essar Steel, India
7. Erdemir, Turkey
8. Posco, South Korea

9. TISCO (Group) Co.Ltd, China
10. Maanshan Iron & Steel Co. Ltd., China
11. Jinan Iron & Steel Co.Ltd., China
12. Benxi Iron & Steel, China
13. Jiangsu Shagang (Group), China
14. Shou-gang Qian Iron & Steel Co. Ltd., China
15. Hyundai Steel, South Korea
16. Hadeed Saudi Iron & Steel Co., Saudi Arabia
17. Hunan Valin Lianyuan Steel Co.Ltd. China (Arecelor Mittal Group)
18. Arcelor Mittal,France/Germany
19. Anyang Iron & Steel Group Co.Ltd. China
20. Angang Steel Co.Ltd., China
21. HBIS Hebei Iron & Steel Group Co.Ltd, China
22. Megasteel, Malaysia (upto X-70, WT-10.3mm)
23. JSW steel limited, Dolvi, India (earlier Ispat (up to X-70, WT-11.7mm)
24. SAIL, Bokaro,India (upto X-70, WT-11.1mm)
25. Llyod Steel, India (upto X-70, WT-11.7mm)
26. JSW Steel Limited, Vijayanagar, Bellary, India

6. VENDOR'S DOCUMENTS

The drawings/documents shall be reviewed, checked, approved and duly signed/stamped by successful manufacturer/supplier before submission. Revision number shall be changed during submission of the revised documents and all revisions shall be highlighted by clouds. Whenever the successful Bidder/supplier require any sub-supplier drawings to be reviewed by MECON, the same shall be submitted by the supplier after duly reviewed, approved and stamped by the successful Bidder/supplier. Direct submission of the sub-supplier's drawings without Manufacturer/supplier's approval shall not be entertained.

Review/Approval of the successful Manufacturer/supplier drawings/documents by MECON would be only to review the compatibility with basic designs and concepts and in no way absolve the successful Manufacturer/supplier of his responsibility/contractual obligation to comply with PR requirements, applicable codes, specifications and statutory rules/regulations. Any error/deficiency noticed during any stage of manufacturing/execution/installation shall be promptly corrected by the successful Manufacturer/supplier without any extra cost or time, whether or not comments on the same were received from MECON during the drawing review stage.

The successful Manufacturer/supplier shall submit a prerecorded Training CDs/DVDs and it shall comprise the basic theories and fundamentals, related standards, design parameters, manufacturing & inspection methods, and other relevant details. The

CDs/DVDs shall have to be self-contained, user-friendly using animation/videos and other multimedia techniques.

Vendor shall supply the documentation as listed under point C of this Material Requisition.

All documents shall be supplied in English language.

Vendor shall strictly follow the document numbering procedure in their document as illustrated below:

Project No.	Item	Document Index No.	Serial No.	Revision No.

Where,

Project No. is 23U1

Item is LPBR/COAT depending on bare or coated

Document Index No. will be of three characters as indicated under point D of this MR;

Serial No. shall be 4 digit no. ranging from 0001 to 9999

Revision No. is Revision of the document starting with Ro, R1 ……;

Example: For QA/QC program, the document no. will be

0000	**LPBR/LPCOAT**	**QAP**	**0001**	**R0**

C. DOCUMENTS & DATA REQUIREMENTS

The table hereunder specifies the quantities and the nature of the documents to be submitted by the CONTRACTOR to OIL/MECON. The documents required at the inquiry stage and to be included in the bid are listed under column A.

The documents required after award of the AGREEMENT and subject to the written approval of the OIL/MECON are listed under column B.

The final and certified documents are listed under column C.

Any document, even when preliminary, shall be binding and therefore duly identified and signed by the CONTRACTOR. It shall bear the Project reference, the material Requisition number and the identification number.

THE DOCUMENTS ARE FULLY PART OF THE SUPPLY WHICH SHALL BE COMPLETE ONLY IF AND WHEN THE DOCUMENTS COMPLYING FULLY WITH THE MATERIAL REQUISITION REQUIREMENTS ARE RECEIVED BY THE ENGINEER.

Item	Documents and Data	Document Index No.	A	B		C	
			No. of copies	No. of copies	Required date	No. of copies	Required date
1	Drawing/data submittal list/schedule	DLS	1	3	2 weeks +weekly	3	2 weeks after approval
2	Fabrication//Rolling, test and delivery schedule (per item)	FTD	1	3	2 weeks +weekly	3	1 within weeks
3	Progress report	PRT		3	Daily +weekly		Daily +weekly
4	Catalogues / References	CRS	1				
5	Code compliance certificate	CCC		3	2 weeks	3	1 week after approval
6	The welding method and welding procedure specification and records WPS/PQR for EW or Manufacturing Process for Seamless	WPS/MPS	1	3	Within 2 weeks		1 week after approval + with final techn. file
7	QA/QC program	QAP	1	3	2 weeks	3	
8	Inspection and test procedure	ITP	1	3	2 weeks	3	
9	NDE reports	NDR		3	When available	3	1 week after approval + with final techn. file

Item	Documents and Data	Document Index No.	A	B		C	
			No. of copies	No. of copies	Required date	No. of copies	Required date
10	Hydro-test report	HTR		3	When available	3	2 weeks after approval + with final techn. file
11	List of subcontractors with their scope	LSS		3	2 weeks		With final techn. file
12	Copy of purchase orders to subcontractors	CPS		3	2 weeks		With final techn. file
13	Copy of purchase order	CPO					With final techn. file
14	Packing/shipping list w/weights and dimensions	PSD		3	2 weeks	3	2 weeks before shipping
15	Final technical file	FTF				6	With shipping

NOTES

1) Durations in column B (Required date) are weeks after LOA or as indicated in Table Durations in column C (Required date) are weeks after document approval or as indicated in Table.

   Due date of each document may be proposed.

2) Latest submittal time for:

- ❖ Test procedure : 2 weeks before test
- ❖ Test report : 2 week after test

3) Final technical file shall be supplied in hard copy as indicated, and in electronic format (.pdf Acrobat files) on six (6) CD-ROMs.

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
						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
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: $CE_{Pcm} \leq 0.23$ $CE_{IIW} \leq 0.43$ 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). 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, - 0.0025 *D*	± 1.6 mm	0.020 *D*	0.005 *D*
610(24) < *D* ≤ 914(36)	+ 3 mm, - 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 E1806. Samples used for product analysis shall be taken from finished pipes only.

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

10.2.3.1 General

In addition to API Spec 5L requirements, samples and test pieces for various types of tests shall be taken from Figure 5 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.

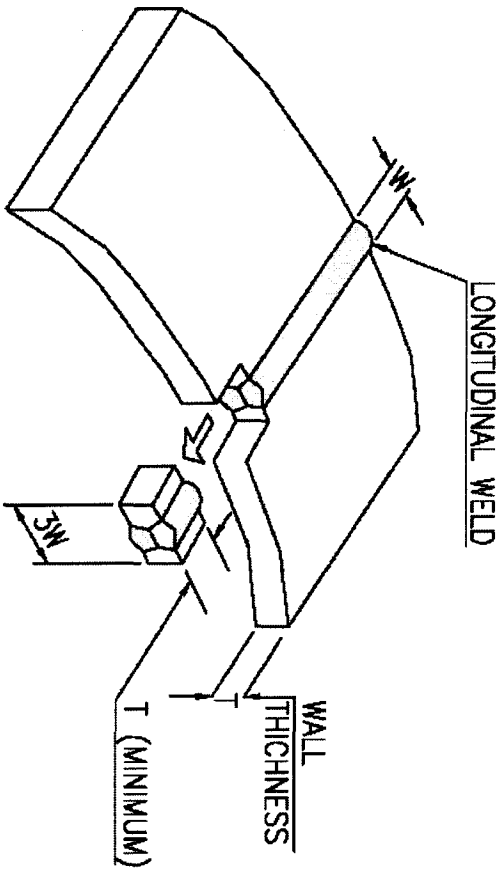
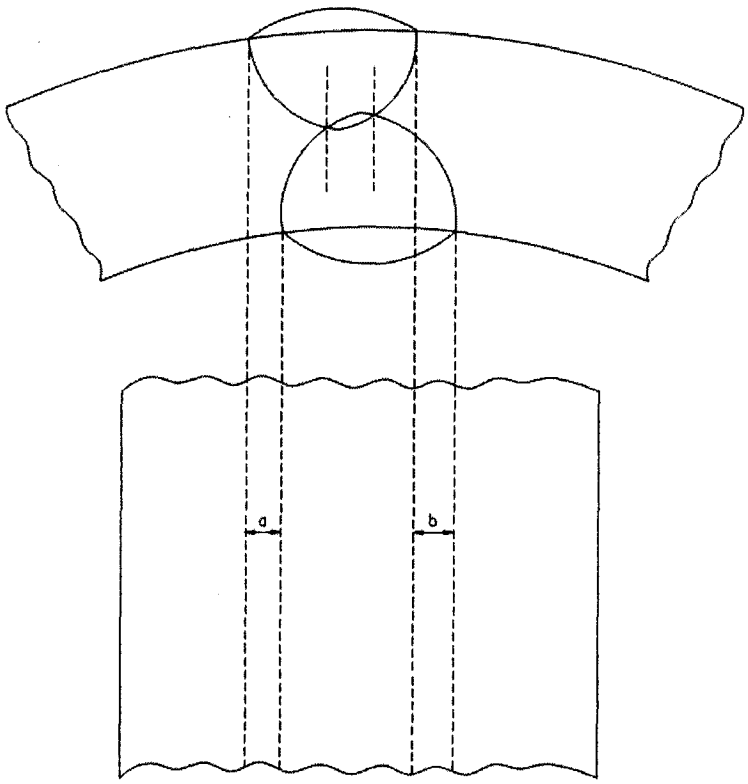
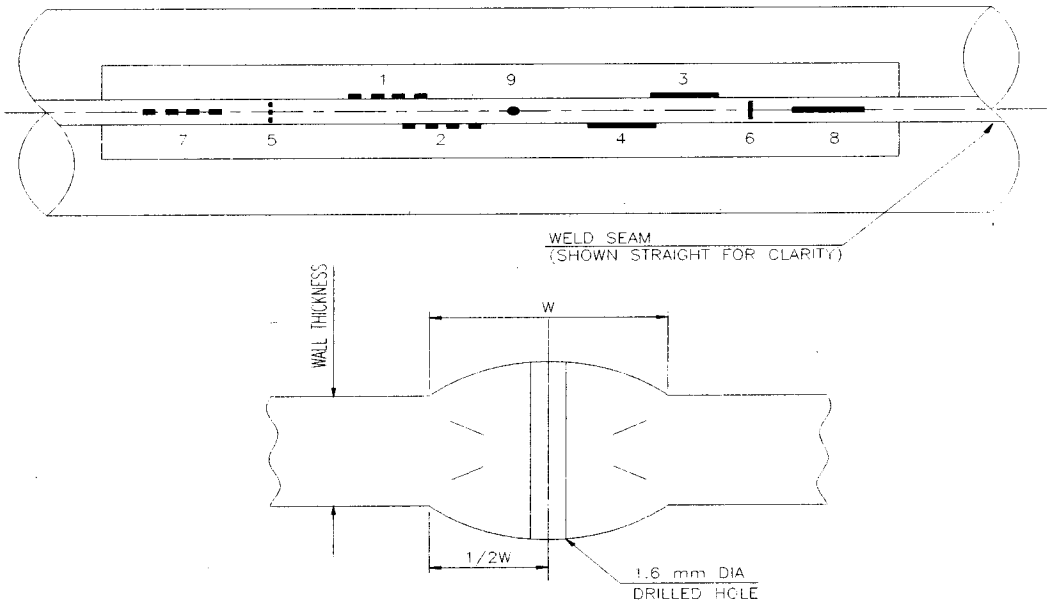


FIGURE 10.2.5.3.1

METALLOGRAPHIC SPECIMEN EXTRACTION PLAN



X-RAY FILM
PROCEDURE FOR MEASUREMENT OF OUT OF LINE WELD BEAD
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 SUBMERGED ARC HELICAL WELDED (SAWH) LINE PIPE (ONSHORE)

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

(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
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
SAWH	Submerged Arc Helical 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 helical 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 (New) Pipe Size

This Specification shall be applied to line pipe of size 18" OD thru 48" 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 E 112-12: 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 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.

PSL	Delivery Condition	Pipe grade/ steel grade[a,b]
PSL 2	Thermomechanically 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

6.3

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

6.3.3

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
SAWH	Thermomechanically rolled coil	Cold forming	—	**M**

8.3 Starting Material

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

8.3.3 The steel used for manufacture of pipe shall be fully killed and fine grained 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).

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

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

8.9 Cold sizing and cold expansion

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

8.10 **Coil end welds**

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

8.11 **Jointers**

8.11.1 Jointers on pipes are not permitted.

9 ACCEPTANCE CRITERIA

9.2 Chemical composition

9.2.2 For pipes supplied as per this specification, the chemical composition of each heat of steel on product analysis shall be as given in Table 5 of this specification.
Table 5 of API 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: $CE_{Pcm} \leq 0.23$ $CE_{IIW} \leq 0.43$ 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). 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 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) ↓	Full-size CVN absorbed energy, minimum average (Joules)						
Pipe Grades →	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 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, - 0.0025 *D*	± 1.6 mm	0.020 *D*	0.005 *D*
610(24)<*D* ≤ 914(36)	+ 3 mm, - 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 – 2t). Diameter measurements shall be taken at both ends of the pipe with a circumferential tape,

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

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

(New) 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 Coil Edges**

Forming and welding operations shall be conducted to minimize coil edge offset and distortion and peaking at helical or spiral 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 at 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.

9.16 **Residual stress test**
(New)

All the pipes shall meet the testing and minimum acceptance criteria for Residual stress test. The residual stress test shall be carried out on the pipe after hydrostatic test. The computed residual stress shall not exceed 10% of the specified minimum yield strength (SMYS) of the pipe when calculated as per clause 10.2.4.9 (New) of this specification

10. **INSPECTION**

10.1 **Types of inspection and inspection documents**

10.1.3 **Inspection documents for PSL 2 pipes**

10.1.3.1 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	Once per test unit of not more than 100 pipes
4.	Tensile testing of the helical seam weld of pipe[c]	Once per test unit of not more than 100 pipes
5.	Tensile testing of all weld test specimen	Once; during manufacturing procedure qualification tests (MPQT) and whenever batch of electrode or wire & flux combination is changed (see Annex B)
6.	CVN impact testing of the pipe body 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 helical 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.	Hardness testing of hard spots	Any hard spot exceeding 50 mm (2.0 in) in any direction
10.	Guided-bend testing of the helical 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
11.	Hydrostatic testing	Each pipe
12.	Wall thickness measurement[d]	Each pipe

13.	Macrographic & metallographic testing (including Vicker's hardness test) of the helical seam weld of pipe as defined in clause 10.2.5 of this specification	At least one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs max.) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered and at the beginning of the production of each combination of specified outside diameter and specified wall thickness
14.	Pipe diameter and out-of-roundness [d]	Each pipe
15.	Visual inspection	Each pipe
16.	Weighing of pipe	Each pipe shall be measured and recorded
17.	Other dimensional testing	Random testing
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.	Residual stress test	At least one per test unit and one test at the beginning of each shift (12 hrs maximum) and whenever the production line settings are changed, the first pipe shall be tested for residual stress.

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 El806. 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

Table 20 – Number, Orientation, and Location of test pieces per sample for Mechanical test of pipe

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	1T	1T
	CVN	3T	3T
	DWT	—	2T
Seam Weld	Tensile	1W[b]	1W[b]
	CVN	3W and 3HAZ	3W and 3HAZ
	Guided - bend	2W[c]	2W[c]

a See Figure 5 c) 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.
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 c) of API Spec 5L.

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

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

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

10.2.3.3 Test pieces for the CVN impact test

In addition to the API 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 (New) Test pieces for Macrographic and metallographic tests

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

10.2.3.9 (New) Test piece for Residual Stress test

Residual Stress test shall be carried out as per clause 10.2.4.9 (New) of this specification. The test piece shall be 150 mm wide ring cut from one end of the pipe. The test piece shall be cut by flame cutting torch or by sawing.

10.2.4 Test methods

10.2.4.3 CVN impact test

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

10.2.4.4 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.

10.2.4.9 (New) **Residual stress test**

The test ring prepared as per clause 10.2.3.9 (New) of this specification shall be served by flame cutting or sawing parallel to the axis of pipe. The serving shall be performed 180^0 from the spiral weld. The test ring shall be allowed to cool down to the ambient temperature prior to serving.
The increase in circumference, if any, after serving shall be measured using fiducial marks of known separation on the specimen prior to serving. The residual stress then shall be calculated using following formula:

$$S = \{(E * t * C) / (12.556 * R^2)\} - \{(F * R^2) / t\}$$

Where;

S - Residual Stress, kPa (psi)
C - Increase in circumference, mm (in)
t - Specified wall thickness, mm (in)
E - Young's Modulus of Elasticity, 2×10^8 kPa, (29×10^6 psi)
R - Pipe Radius, mm (0.5 * specified outside diameter), mm (in)
F - 0.1154 in SI units, (0.425 in conventional units)

10.2.5 **Macrographic and metallographic tests**

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

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3.2 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not

exceed 248 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 analyzed to meet the requirements of Table 5 of this specification.

10.2.12.9 (New) **Residual stress retests**

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

11 MARKING

11.1 General

11.1.1 Pipe manufactured in accordance with this specification shall be marked by the manufacturer as per the requirements of API 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

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

11.2.3 The pipe number shall be placed by cold rolling or low stress dot marking 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 **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 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 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 helical 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 spiral weld.

- Two (2) cylindrical all-weld test pieces from helical weld.

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

The results of the test shall meet the minimum requirements of the 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.

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

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 pipe shall be performed after hydrostatic testing.

E.3.2 Pipe End Inspection -Welded Pipe

E.3.2.1 Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment, or, such non-inspected pipe end shall be cut-off. Records in accordance with 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 **(New)** Bevel face at each pipe end shall be magnetic particle inspected for the detection of laminar imperfections in accordance with ISO 10893-5.

E.4 RADIOGRAPHIC INSPECTION OF WELD SEAMS

E.4.2 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 length.

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, 1T	1L, 1T	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 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 '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) <u>For pipe weld seam inspection:</u>
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) <u>For coil/pipe body inspection:</u>
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 SAWH PIPES

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

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

  Table 3 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 SAWH PIPES

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

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

as per clause E.5.6 of this specification.

Table 2 of ISO 10893-9 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[a]
	Area Mm^2	Length[b] mm	Area Mm^2	Length[b] mm	Width[b] mm	
Coil or the pipe body	1000	100 [d]	300	35	8	10 [per 1.0 m x 1.0 m]
Coil edges 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 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 coil/ppipe 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, 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.

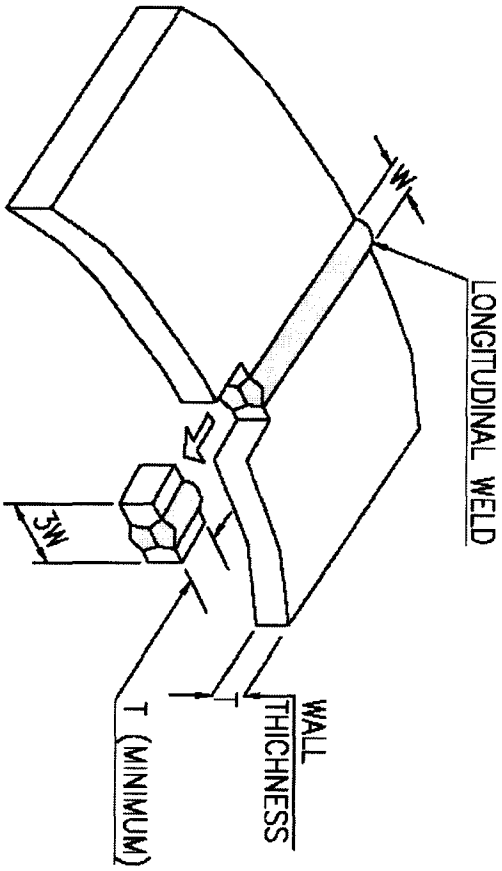
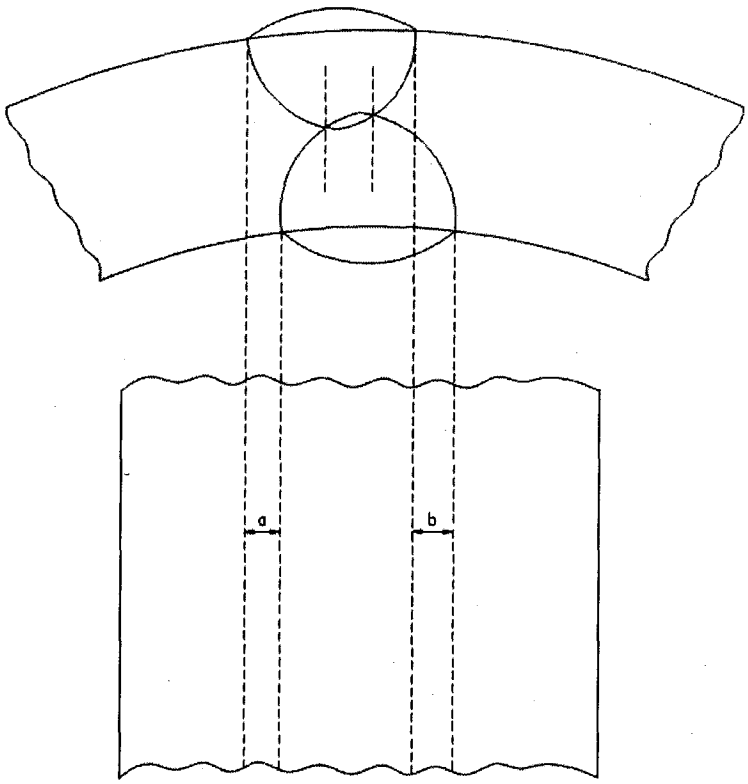


FIGURE 10.2.5.8.1

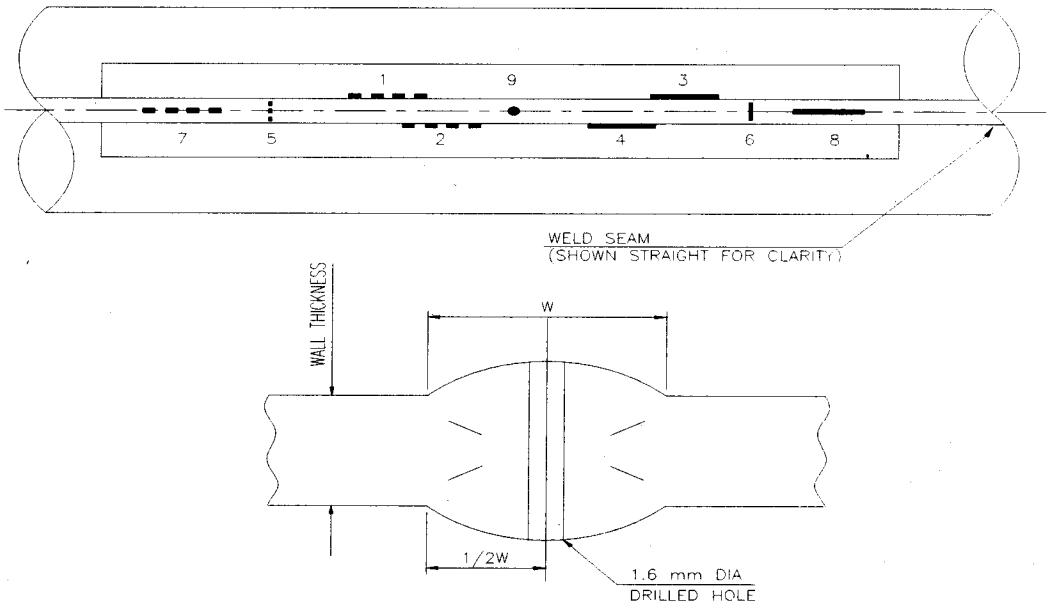
METALLOGRAPHIC SPECIMEN EXTRACTION PLAN



X-RAY FILM

PROCEDURE FOR MEASUREMENT OF OUT OF LINE WELD BEAD

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

Rev. : 0
Edition : 1

SPECIFICATION

FOR

3-LAYER POLYETHYLENE COATING OF LINEPIPES

SPECIFICATION NO.: MEC/S/05/21/014

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	3-LAYER POLYETHYLENE COATING OF LINEPIPES	DOCUMENT NO. MEC/S/05/21/014	Page 1 of 1 REVISION : 0 EDITION : 1

CONTENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(A.K. Nimbekar)	(Vinod Kumar)	(A.K. Johri)	Feb. 2008

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 **SCOPE**

This specification covers the minimum requirements for supply/ arrangement of all materials, plant, equipment, plant sites, consumables, utilities and application including all labour, supervision, inspection and tests etc. for application of external anti-corrosion coating of pipes by using 3 Layer Side Extruded Polyethylene Coating conforming to DIN-30670, 1991, `Polyethylene Coating of Steel Pipes and Fittings' and the requirements of this specification.

2.0 **REFERENCE DOCUMENTS**

Reference has also been made to the latest edition of the following standards, codes and specifications. The edition enforce at the time of floating the enquiry shall be termed as latest edition.

a.	ASTM D-149	:	Standard Test Methods of Dielectric Breakdown voltage and Dielectric strength of solid electrical insulating materials at commercial frequencies.
b.	ASTM D-257	:	Standard Test Methods for D-C Resistance or conductance of insulating materials.
c.	ASTM D-543	:	Standard Method of Test for Ressistance of Plastics to Chemical Reagents.
d.	ASTM D-570	:	Standard Method of Test for Water Absorption of Plastics.
e.	ASTM D-638	:	Standard Test Method for Tensile Properties of Plastics.
f.	ASTM D-792	:	Standard Test Method of Specific Gravity and Density of Plastics by Displacement.
g.	ASTM D-1238	:	Test Method for Low Rate of Thermoplastics by Extrusion.
h.	ASTM D-1525	:	Test Method for Vicat Softening Temperature of Plastics
i.	ASTM D-1603	:	Test Method for Carbon Black in Olefin Plastics
j.	ASTM D-1693	:	Test Method for Environmental Stress Cracking of Ethylene Plastics
k.	ASTM D-2240	:	Test Method for Rubber Property – Durometer Hardness

l.	ASTM D-3895	:	Test Method for Oxidative – Induction Time of Polyolefins by Differential Scanning Calorimetry
m.	ASTM G-42	:	Tentative Methods for Cathodic disbonding of Pipeline Coatings Subjected to Elevated or Cyclic Temperatures.
n.	API RP 5L1	:	Recommended Practice for Railroad Transportation of Linepipe.
o.	API RP 5LW	:	Transportation of Line Pipe on barges and marine vessels
p.	DIN EN 10204	:	Metallic Products – Types of Inspection Documents
q.	DIN 53735	:	Testing of Plastics : Determination of Melt Index of Thermoplastics.
r.	ISO 8502-3	:	Preparation of Steel Stubstrates before Application of Paints and Related Products – Part-3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
s.	ISO 9002	:	Quality Systems : Specification of Production and Installation
t.	ISO 11124	:	Preparation of Steel Substrates Before Application of Paints and Related Products
u.	SIS 055900	:	Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness.
v.	APL 5L	:	Specification for Line Pipe
w.	ASME B 31.8	:	Gas Transmission and Distribution Piping Systems
x.	ASME B 31.4	:	Liquid Transportation systems for Hydrocarbons, Liquid petroleum Gas Anhydrous ammonia, and Alcohols
y.	CSA Z245.20-98	:	External Fusion Bond Epoxy Coating for Steel Pipe

The CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the coating plant to all persons concerned with carrying out the works specified in this specification.

3.0 PLANT SCALE AND INSTALLATION

3.1 CONTRACTOR shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), both new or existing shall be installed into a yard whose geometry and dimensions are such as to allow the execution of a continuous work schedule. For this purpose the CONTRACTOR shall ensure non stop work execution owing to prohibitive adverse weather conditions and install requisite equipment and plant in roofed and adequately weather protected areas.

3.2 Plant equipment, machinery and other facilities shall be in first class operating condition to atleast meet the job requirements of quality and production. Worn out and improvised plants are not acceptable.

3.3 The CONTRACTOR shall, at his own responsibility and cost, provide and prepare all necessary area for the storage of bare and coated pipe and all other materials, for coating yard, stock-piling and other temporary installation. For each area, CONTRACTOR shall provide necessary agreements as required with the land Owner(s) / relevant Authorities, and, on work completion, to clean, restore and pay servitude and claims for damages, as applicable.

3.4 CONTRACTOR shall at its own responsibility and cost, provide for water and power supply and other utilities and consumables and obtain authorisation regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing authorities.

3.5 CONTRACTOR shall at its own expense provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and during regular production. Outside testing for qualification and regular production is not acceptable to COMPANY.

3.6 The CONTRACTOR shall be fully responsible for adherence to all statutory regulations applicable for handling and disposal of the hazardous chemicals during the coating works.

3.7 The CONTRACTOR shall be responsible for obtaining all statutory approvals/ clearances from relevant Authorities including Pollution Control Board, as applicable for the coating plant(s).

4.0 **MATERIALS**

4.1 The three layer coating system shall comprise of a powder epoxy primer, polymeric adhesive and a polyethylene top coat. Coating materials shall be suitable for the service conditions and the pipe sizes involved. The coating materials i.e. epoxy powder, adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified and approval COMPANY in accordance with provision Annexure-I of this specification. CONTRACTOR shall obtain prior approval from COMPANY for the coating system and coating of all materials.

4.2 The coating materials Manufacturer shall carry out tests for all properties specified in para 5.3.1 and 5.3.2 for each batch of epoxy, adhesive and polyethylene compound. In addition, the Manufacturer shall also furnish Infra-red Scan for each batch of epoxy powder. The coating materials manufacturer shall issue test certificates as per DIN EN 10204, 3.1B for each batch of materials supplied to CONTRACTOR and the same shall be submitted to COMPANY for approval prior to their use.

4.3 In addition to Manufacturer's certificate, the CONTRACTOR shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of COMPANY Representative and test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's certificates.

a) **Epoxy Powder**

i. Gel Time
ii. Cure Time
iii. Moisture Content
iv. Thermal Characteristics (Tg1, Tg2, ΔH)

b) **Adhesive**

i. Specific Gravity
ii. Melt Flow Rate
iii. Vicat Softening Point

c) **Polyethylene**

i. Melt Flow Rate
ii. Specific Gravity
iii. Vicat Softening Point
iv. Moisture Content
v. Oxidative Induction Time

In case of failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required as per para 5.3.1 and 5.3.2 including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

4.4 All materials to be used shall be supplied in sealed, damage free containers and shall be suitably marked and identifiable with the following minimum information:

a. Name of the manufacturer
b. Type of material
c. Batch Number
d. Place and Date of Manufacture
e. Shelf Life/ Expiry Date (if applicable)
f. Quantity

All materials noted to be without above identification shall be deemed suspect and shall be rejected by COMPANY. Such materials shall not be used for coating and shall be removed from site and replaced by CONTRACTOR at its expense.

4.6 CONTRACTOR shall ensure that all coating materials properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.

4.7 CONTRACTOR shall be required to use all materials on a date received rotation basis, i.e. first in-first used basis.

5.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING

5.1 The coating must be able to withstand a maximum in service operating temperature of +65°C and shall conform to `S' Type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of atleast +80°C, without impairing its serviceability and properties specified.

5.2 The top coat polyethylene used shall be black readymade compound, fully stabilized against influence of ultraviolet radiation (.e. sunlight), oxygen in air and heat (due to environmental temperature as specified above). No appreciable changes shall occur during exposure to such environments up to at least a period of 6000 hours. The CONTRACTOR shall submit certificate from Manufacturer in this regard.

5.3 Properties

Properties of coating system and coating material shall comply the requirements indicated in subsequent paragraph. In case the coating/ material properties are tested as per test methods/ standards other than specified herein below, the same may be accepted provided the test procedures and test conditions are same or more stringent than the specified.

5.3.1 Properties of Epoxy Powder and Adhesive

CONTRACTOR shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirements and properties of coating system as specified in para 5.1 and 5.3.3 of this specification respectively. Epoxy powder properties shall be as per CSA Z245.20.98. The colour of epoxy powder shall be either green or dark red or

any other colour approved by COMPANY except grey colour. Copolymer grafted adhesive shall have the following properties.

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	1.0	ASTM D1238
b.	Vicat Softening Point	°C	100 min.	ASTM D1525
c.	Specific Gravity	-	0.926 min.	ASTM D792

5.3.2 **Properties of Polyethylene Compound**

Sl. No.	Properties	Units	Requirement	Test Method
a.	Tensile Strength @+25°C	N/mm^2	17 min.	ASTM D 638
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10 minute	0.25 min.	ASTM D 1238 or DIN 53735
c.	Specific Gravity @+25°C	-	0.926 min. (MDPE) 0.941 min. (HDPE)	ASTM D 792
d.	Hardness @+25°C	Shore D	50 min.	ASTM D 2240
e.	Water Absorption, 24 hours, @+25°C	%	0.05 max	ASTM D 570
f.	Volume Resistivity @+25°C	Ohm-cm	10^{15} min	ASTM D 257
g.	Dielectric withstand,1000 Volt/sec rise @+25°C	Volts/ mm	30,000 min	ASTM D 149
h.	Vicat Softening Point	°C	110 min.	ASTM D 1525
i.	Elongation	%	600 min.	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 220°C, Aluminium pan, no screen	Min	10	ASTM D3895
j.	Environmental Stress Crack Resistance (ESCR) (for F_{50}) - Medium Density, Condition “C” - High Density, Condition “B”	Hours	 300 300	ASTM D1693
l.	Carbon Black Content	%	2 min.	ASTM D1603

5.3.3 **Properties of Coating System**

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) - @ 20±5°C - @ 60±5°C	Kg/cm	 8.0 min 5.0 min.	DIN 30670
b.	Impact Strength (min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 kV)	Joules per mm of coating thickness	7 min	DIN 30670
c.	Indentation Hardness - @ 23±2°C - @ 70±2°C	mm	 0.2 max 0.3 max	DIN 30670
d.	Elongation at Failure	%	300 min.	DIN 30670
e.	Coating Resistivity (*)	Ohm-m^2	10^8 min.	DIN 30670
f.	Heat Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
g.	Light Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
h.	Cathodic Disbondment - @+65°C after 30 days - @+65°C after 48 hrs	mm radius of disbondment (**)	 15 max. 7 max.	ASTM G42
i.	Degree of Cure of Epoxy - Percentage Cure, ΔH - ΔTg	 % °C	 95 +3/ -2	CSA Z245.20-98(*)

(*) Test carried out in an independent laboratory of national/ international recognition on PE top coat is also acceptable.

(**) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G42.

(***) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.

6.0 MEASUREMENT AND LOGGING

CONTRACTOR shall maintain records in computer using MS ACCESS database Software containing all the relevant data of individual pipe and pipe coating including pipe number, heat number, diameter, length, wall thickness, defects, coating number, batches of materials, sampling, testing, damages, repairs, rejects and any other information that COMPANY considers to be relevant and required for all incoming bare pipes and COMPANY approved outgoing coated pipes as applicable. CONTRACTOR's documentation shall be designed to ensure full tractability of pipe and coating materials through al stages of coating and testing. CONTRACTOR shall submit this information in the form of a report at the agreed intervals. The above data shall be provided in MS ACCESS format in Compact Disc (CD), CONTRACTOR shall provide one Computer Terminal to COMPANY Representative for monitoring / tracking of the above. The CONTRACTOR shall also submit the material balance details to COMPANY for information at the end of each shift.

7.0 COATING PROCEDURE AND QUALIFICATION

7.1 Upon the award of the CONTRACT, the CONTRACTOR shall submit within two(2) weeks, for COMPANY approval, a detailed report in the form of bound manual outlining, but not limited to the following:

a. Details of plant(s), locations, layout, capacity and production rate(s).
b. Details of the equipment available to carry out the coating works including surface preparation, epoxy powder application and its recycling system, adhesive & polyethylene extrusion, moisture control facilities available for coating materials.
c. Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.
d. Details of chemicals pre-treatment facilities including process control and inspection equipment for phosphoric acid wash, de-ionised-ionised water wash and chromate wash.
e. Facilities in the yard for unloading, handling, transport, production, storage, stockpiling, loading of bare and coated pipes and warehouses for storage of other coating materials.
f Plant Organisation Chart and availability of manpower including coating specialist.
g Details of utilities/facilities such as water, power, fuel, access roads and communication etc.

After approval has been given by COMPANY, no change in plant set-up shall be made. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY.

7.2 At least two(2) weeks prior to the commencement of production coating, a detailed procedure of CONTRACTOR's methods, material proposed, etc., shall be formulated by CONTRACTOR and submitted for COMPANY's approval in the form of a bound manual. The procedure shall include, but not limited to the following information and proposals:

a. Pipe inspection at the time of bare pipe receipt.
b. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile, methods of measurements and consumables.
c. Complete details of chemical pre-treatment viz phosphoric acid wash, de-ionised water wash, and chromate wash including product data sheets, health and safety sheets and manufacturer's recommended application procedure.
d. Pipe heating, temperatures and control prior to epoxy application.
e. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendation from manufacturer(s).
f. Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.
g. Quenching and cooling, including time and temperature.
h. Quality assurance system, Inspection and test plan and reporting formats, including instrument and equipment types, makes and uses etc.
i. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repairs thereof including coating stripping technique.
j. Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.
k. Complete details and inventory of laboratory and equipment for procedure qualification and regular production.
l. Pipe handling and stock piling procedures.
m. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause 6.0 of this specification.
n. Complete details of test certificates for raw materials including test methods and standards used.
o. Test certificates from PE compound manufacturer for tests for thermal aging coating resistivity and aging under exposure to light. These test certificates shall not be older than three years.
p. Health, safety and environment plans.
q. Storage details of coating materials and chemicals.
r. Continuous temperature monitoring at various stages of coating.

Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedure from COMPANY. No change in the procedure shall be made after approval has been given by the COMPANY. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY.

7.3 Prior to start of production, the CONTRACTOR shall, at his expense, carry out a coating PQT for each pipe diameter on max. wall thickness, for each type of pipe, for each coating material combination, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in clause 5.3, relevant standards, specifications and material manufacturer's recommendations. CONTRACTOR shall give seven (7) working days notice to witness all procedures and tests.

A batch representing a normal production run, typically 15 pipes, shall be coated in accordance with the approval coating procedure and the coating operations witnessed by COMPANY Representative. Out of these pipes, at least one pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers.

Atleast 5 (five) test pipes shall be selected by Company Representative for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. All tests shall be witnessed by COMPANY's representative. Out of 5(five) test pipes 1(one) pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers. Remaining 4(four) test pipes shall be coated with all three layers.

During PQT, the CONTRACTOR shall qualify various procedures forming a part of coating operations as detailed subsequently.

7.4 Qualification of Procedures

7.4.1 Epoxy Powder Application & Recycling

During pre-qualification, air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed vs coating thickness, etc. shall be established. Dew point of air used to supply the fluidised bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT.

Also, the CONTRACTOR shall remove samples of reclaimed powder from the reclamation system. These of reclaimed powder shall be subject to a detailed visual examination, thermal analysis and moisture content tests. The properties of the reclaimed powder shall be within the range specified by the Manufacturer of epoxy powder. In case the properties of the reclaimed powder are out of the range specified by the Manufacturer, CONTRACTOR shall not the use the reclaimed powder during the regular production.

7.4.2 Pipe Pre-Heating

The CONTRACTOR shall establish the temperature variation due to in-coming pipe temperature, line speed variation, wall thickness variation, emissivity, interruptions, etc. and document the same during the PQT stage. During PQT, proper functioning of pipe temperature monitoring and recording system including alarm/ hooter shall be demonstrated to the COMPANY Representative.

7.4.3 Surface Preparation

The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. The ratio to shots to grits shall be established during procedure qualification testing, such that the resultant surface profile is not dished and rounded. The qualification shall be performed through a visual inspection, measurement of roughness and check of the presence of dust in the abrasive blast cleaned pipe surface.

7.4.4 Chemical Pre-Treatment

7.4.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash

The procedure to apply the chemical pre-treatment viz. phosphoric acid wash followed by de-ionised water wash shall be in accordance with the recommendation of the manufacturer and shall result in intended cleaning requirements of this specification. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the cleanliness/ temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed vs dwell time, rinsing procedure, testing & control, rectificatory measures, drying procedure etc. shall be clearly established during PQT. Also the quality of the deionised water shall be established during PQT.

7.4.4.2 Chromate Treatment

The procedure to apply the chromate treatment shall be in accordance with the recommendation of the manufacturer. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed, pipe heating after chromating and time limit within which the pipe to be heated, testing & control, rectificatory measures, shall be clearly established during PQT.

7.4.5 Coating Application

The COMPANY Representative will check the correctness of each coating application operation, values of the main parameters of each operation, pre-heating pipe surface temperature prior to epoxy powder application temperature, line speed, fusion bonded epoxy curing time, temperature and flow rate of co-polymer adhesive and polyethylene etc. and the same shall be recorded. These values shall be complied with during regular production.

7.5 Qualification of Applied Coating

7.5.1 Tests on pipe coated partly with epoxy and partly with epoxy & adhesive Layers

a. **Degree of Cure**

Epoxy film samples (min 4 Nos.) shall be scrapped from the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using Differential Scanning Calorimatry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply the specified requirements.

b. **Epoxy Layer Thickness**

Epoxy layer thickness shall be checked at every one meter spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

c. **Adhesive Layer Thickness**

Adhesive layer thickness shall be checked at every one meter spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

d. **Holiday Inspection**

Entire pipe shall be subject to holiday inspection and the test voltage shall be set to exceed 5 v/micron of epoxy thickness specified for the portion coated only with epoxy layer.

e. **Adhesion Test**

i) Adhesion Test (24 hrs or 48 hrs) shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table 4.

ii) Adhesion of FBE shall also be separately determined at ambient temperature at two locations by the "St Andrews Cross" method and the test shall comply with the specified requirements.

f. **2.5° Flexibility Test**

2.5° Flexibility test shall be carried out on the epoxy coated pipe at test temperature of 0°C. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table-4.

g. **Cross-section & Interface Porosity Test**

Cross section porosity and interface porosity tests shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table-4.

7.5.2 **Tests on pipes coated only with all three layers**

a. **Bond Strength**

Three test pipes shall be selected for bond strength tests. On each of the selected pipes, three bond strength test shall be performed for each specified temperature i.e. one at each end and one in the middle of the pipe and

specified requirements shall be complied with, i.e. bond strength as well as mode of separation. Length of peel shall be minimum 65mm. None of these samples shall fail.

b. **Impact Strength**

Three test pipes shall be selected for impact strength test and the test shall meet the requirement.

c. **Indentation Hardness**

Two samples for both the temperatures from all pipes shall be taken. If any one of these samples fail to satisfy the requirements, then the test shall be repeated on four more samples. In this case, none of the samples must fail.

d. **Elongation at Failure**

Six samples each from two coated pipes i.e. 12 samples in all shall be tested and the test shall comply the specified requirement. Only one sample per pipe may fail.

e. **Cathodic Disbondment Test**

Two CD test shall be carried out for the total lot of test pipes having all three layers. One test shall be carried out for 30 days duration and another test for 48 hours duration The tests shall comply the specified requirement. Whenever Procedure Qualification is necessitated for different pipe size with same coating material combination, 48 hours test only be conducted. 30 days CD test is not mandatory in this case.

f. **Holiday Inspection**

All the pipes shall be subject to holiday inspection. The test voltage shall be as specified in para 10.4(b)

g. **Coating Thickness Measurement**

All pipes shall be subject to coating thickness measurement. Acceptance criteria shall be as per para 10.3

h. **Air Entrapment**

One sample each from pipe body and on weld (if applicable) shall be taken from all four coated pipes and the specified requirements shall be complied with.

i. **Degree of Cure**

Epoxy film samples (minimum 4 no., equally spaced) shall be scrapped from one coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply with the specified requirements.

7.5.3 **Inspection of all test pipes**

All pipes shall be subject to the following inspections:

a. surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test immediately after De-ionised water wash.
b. pH of pipe surface before and after phosphoric acid wash.
c. visual inspection of chromate coating.
d. visual inspection of finished coating, cut back dimension, internal/ external cleanliness, end sealing and bevel inspection.

Acceptance criteria for all inspection and testing shall be as specified in this specification.

7.6 After completion of the qualification tests and inspection as per para 7.4 and 7.5 above, the CONTRACTOR shall prepare and issue to COMPANY for approval a detailed report of the above tests and inspection including test reports/ certificates of all materials and coatings tested. Only upon written approval from COMPANY, CONTRACTOR shall commence production coating.

7.7 On successful completion of PQT, coating of all five(5) test pipes shall be removed and completely recycled as per the approved coating procedure specification, at CONTRACTOR's expense. Remaining pipes will be accepted by COMPANY provided they meet the requirements of this specification and need not be stripped and re-cycled.

7.8 The CONTRACTOR shall re-establish the requirements of qualification and in a manner as stated before or to the extent considered necessary by COMPANY, in the event of, but not limited to, the following :

- Every time there is a change in the previously qualified procedure.
- Every time there is a change in the manufacturer and change in formulation of any of the raw materials and change in location of raw material manufacture.
- Every time the coating yard is shifted from one location to the other or every time the critical coating equipments (induction heater, epoxy spray system, extruder, etc) are shifted.
- Any change in line speed during coating application.

- Any time when in COMPANY's opinion the properties are deemed to be suspect during regular production tests.

7.9 COMPANY reserves the right to conduct any or all the test required for qualification through an independent laboratory or agency at the cost of CONTRACTOR when in COMPANY's opinion, the results are deemed suspect. COMPANY's decision shall be final.

8.0 PIPE SURFACE PREPARATION

8.1 Unless specified otherwise, the pipes shall be supplied free from mill applied oils but may be subject to contamination occurring during transit.

8.2 Prior to cleaning operation, CONTRACTOR shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The CONTRACTOR shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers of ensure traceability of pipe after coating.

8.3 Any oil, grease, salt or other contaminants detrimental to the formation of a good coating bond or coating quality shall be removed prior to coating application. Contaminants may be removed by the use of non-oily solvents. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvents cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.

8.4 All pipes shall be preheated to a temperature 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blasting cleaning units to achieve the specified surface cleanliness and profile. After first abrasive blast cleaning, chemical pre-treatment with phosphoric acid solution as per para 8.6 shall be carried out prior to second abrasive blast cleaning. However at the option of CONTRACTOR, chemical pre-treatment with phosphoric acid solution as per para 8.6 may be carried out after the second abrasive blaster.

The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. The equipment used for abrasive blast cleaning shall meet the specified requirements and shall be free from oil, water soluble salts and other forms of contamination to ensure that the cleaning process is not impaired. Traps, separators and filters shall be checked for condensed water and oil at the start of each shift and emptied and cleaned regularly. During abrasive blast cleaning the metallic abrasive shall be continuously sieved to remove "fines" and "contaminates" and the quality checked at every four hours. Abrasive used for blast cleaning shall comply ISO- 11124.

8.5 Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively the CONTRACTOR may link pipes suitably together to prevent the entry of any short/grit into the pipe.

8.6 Chemical Pre-treatment with Phosphoric Acid Solution

8.6.1 All pipes shall provided chemical pre-treatment with phosphoric acid solution. 10% solution of phosphoric acid, Oakite 31 / 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminations.

The CONTRACTOR shall provide data sheets and supporting documentation for the phosphoric acid to be used. The documentation shall verify that the phosphoric acid is suitable for the treatment of line prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.

8.6.2 The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 75 °C. Phosphoric acid treatment shall be followed immediately by washing with de-ionised water. Deionised water used shall conform to the following requirements :

Sl. No.	Properties	Unit	Requirement
a.	Turbidity	NTU	1 max.
b.	Conductivity	μmho/cm	5 max.
c.	Hardness	-	Nil
d.	Total Alkalinity as $CaCO_3$	mg/l	2 to 3
e.	Chloride as Cl	mg/l	1 max.
f.	Sulphate as $SO_4^=$	mg/l	1 max.
g.	PH	-	6.5 to 7.5

Tests to determine the above properties shall be carried out in accordance with "Standard Methods for the Examination of Water and Wastewater" published jointly by American Public Health Association, American Water Works Association and Water Pollution Control Federation.

Quality of the deionised water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of deionised water wrt the above requirements shall cause for stoppage of the operations.

8.6.3 The pH of the pipe surface shall be determined both before and after the de-ionised water rinse initially on each pipe and in case of consistent results, the frequency may be relaxed to once per hour at the discretion of COMPANY Representative. The measured pH shall be as follows :

Before de-ionised water wash: 1 to 2
After de-ionised water wash : 6 to 7

8.6.4 After the de-ionised water wash, the pipe shall be dried with dry air and preheated to a temperature of 65°C to 85°C.

8.6.5 The salt tests shall be carried out after de-ionised water rinse. One test shall be carried out at one end of each pipe. The acceptance criteria shall be 2$\mu g/cm^2$. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendation.

8.7 Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2½ of Swedish Standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns(Rz). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO:8502 – 3. Acceptance limit shall be either quality rating 2 or Class 2.

8.8 All pipes shall be visually examined for presence of any shot/ grit/ loose material left inside the pipe during blast cleaning. Suitable mechanical means (stiff brush) shall be employed to remove the same before the pipes are processed further. In addition, inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focused at the middle of the pipe at one end while inspection is carried out visually from other end. Any foreign material or shots/ grit present in the pipe shall be completely removed by mechanical/ brush, high pressure air jets, by tilting of pipe etc.

8.9 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The CONTRACTOR shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.

8.10 The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall be surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. After blast cleaning, all surfaces shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application. All surface defects such as slivers, scab, burns, laminations, welds spatters, gouges, scores, indentations, slugs or any other defects considered injurious to the coating integrity made visible during blast cleaning shall be reported to the COMPANY Representative and on permission from COMPANY Representative, such defects shall be removed by filing or grinding. After any grinding or mechanical repairs, the remaining wall thickness shall be checked and compared with specified thickness. Ay pipes having thickness less than 95% of specified thickness shall be kept aside and disposed off as per the instructions of COMPANY Representative. The method employed to remove surface defects shall not burnish or destroy then anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/ oil and

water traps. Where burnishing results in destruction of anchor pattern, the anchor patter shall be restored by suitable means. Pipes which have damages repaired by grinding and have ground areas more than 50mm in diameter shall be re-blasted.

Any dust or loose residues that have been accumulated during blasting and/ or during filing/ grinding operations shall be removed by vacuum cleaning.

If contamination of surface occurs, the quality of blast cleaning method and process shall be examined. If the surface roughness is outside the specified limit, the blast cleaning material shall be checked and replaced.

8.11 Upon Completion of the blasting operations, the quality control supervisor shall accept the pipe for further processing or return for re-blasting after removal of defects/ imperfections. In case imperfections are considered detrimental to the coating quality, the same shall be reported to COMPANY's Representative for final decision on rejection or re-blasting/ removal of defects. Re-blasting/ removal of defects or returning pipe to the yard shall be at the CONTRACTOR's cost.

COMPANY's Representative, in additions, reserves the right to initiate any of the above actions during periodic inspections for oil, dust, salt, imperfections, surface defects, lack of white metal finish etc.

8.12 In order to ensure that pipe with defects are not processed further, provisions shall be available to lift the pipes from inspection stand.

8.13 **Chemical Pre-treatment with Chromate Solution**

8.13.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically Pre-treated with a 10% strength chromate solution.

8.13.2 The CONTRACTOR shall provide data sheets and supporting documentation for the chemical to be used. The documentation shall verify that the chemical is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.

8.13.3 The chemical pre-treatment shall be applied fully in accordance with the chemical suppliers' instructions and in a manner that ensures 100% uniform coverage of the pipe surface without introducing surface contamination.

8.13.4 The CONTRACTOR shall check that the concentration for the chemical pre-treatment solution remains within the range recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at the make up of each fresh solution and once per hour, using a method approved by the chemical manufacturer. The CONTRACTOR shall also ensure that the chemical pre-treatment solution remains free from contamination at all times. Recycling of chemical pre-treatment solution is not permitted.

8.13.5 The CONTRACTOR shall ensure that the temperature of the substrate is maintained between 40°C and 80°C and the chromate solution temperature does not exceed 60° or as recommended by the manufacturer.

8.13.6 The chromate coating shall be smooth, even, free from runs, drips or excessive application and lightly adherent with no flaking of the coating. The chromate coated steel must be thoroughly dried immediately after application and shall be achieved by boiling off any residual solution on the surface.

8.14 The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half on hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below :

Relative Humidity %	Maximum elapsed time
> 80	2 hours
70 to 80	3 hours
< 70	4 hours

Any pipe not processed within the above time-humidity requirement shall be completely re-blasted. Any pipe showing flash rusting shall be re-blasted even if the above conditions have not been exceeded.

8.15 Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm^2 in area/ or having contamination of steel surface shall be rejected and sent for re-blasting.

9.0 COATING APPLICATION

The external surface of the cleaned pipe conforming to clause 8.0 of this specification shall be immediately coated with 3-layer extruded polyethylene coating in accordance with the procedures approved by COMPANY, relevant standards and this specification. In general, the procedure shall be as follows :

9.1 Pipe Heating

9.1.1 Immediately prior to heating of pipe, all dust and grit shall be removed from both inside and outside of the pipe by a combination of air blast, brushing and vacuum cleaning. Suitable arrangement shall be made to protect the bevel ends from getting damaged during the coating operation.

9.1.2 Induction heater or gas furnace shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of

induction heating, appropriate frequency shall be used to ensure `deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface. This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of bluing or other apparent oxide formation) is not acceptable.

9.1.3 External surface of the pipe shall be heated to about 190°C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.

9.1.4 Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each line pipe. The monitoring instrument shall be able to raise an alarm/ activate audio system (hooter) in the event of tripping of induction heater/ gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped and recoated.

9.1.5 Temperature measuring & monitoring equipment shall be calibrated twice every shift and/ or as per COMPANY representative's instruction.

9.1.6 Contractor shall ensure that pipe surface emissivity variations are minimised during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.

9.2 **Pipe Coating**

9.2 .1 Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe.

i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150 mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.
ii. Grafted co-polymer adhesive applied by extrusion, minimum thickness 0.200 mm.
iii. Polyethylene coating by extrusion.

The coated pipe shall be subsequently quenched and cooled in water for a period which shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

9.2.2 Minimum total thickness of finished coating shall be as under :

Pipe Size (Specified Outside Diameter)	Minimum Coating Thickness (mm) (*)	
	Normal Type (n)	Reinforced Type (v)
Up to 10¾" (273.1 mm)	2.0	2.7
Over 10¾" (273.1 mm) to below 20" (508.0 mm)	2.2	2.9
From 20" (508.0mm) to below 32" (813.0 mm)	2.5	3.2
From 32" (813.0 mm) and above	3.0	3.7

(*) In case HDPE material is used as top coat, 10% reduction in minimum coating thickness specified is permissible.

Required coating thickness shall be Normal Type (n), unless otherwise specified.

9.2.3 Coating materials shall be inspected in accordance with the manufacturer's recommendation prior to coating application and it shall be ensured that the materials are moisture free. In case the relative humidity exceeds 80%, the adhesive and polyethylene material shall be dried using hot air as per the directions of COMPANY representative.

9.2.4 Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subjected to:

a) satisfactory qualification of the reclaimed system during PQT stage

b) the proportion of the reclaimed powder in the working mix does not exceed 20% at any one time.

c) the quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at para 5.3.1.

9.2.5 Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and for this purpose filters, dehumidifier/ heater as required alongwith control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-) 40°C and this shall be monitored during the regular production.

9.2.6 Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm/ activate audio system (hooter) in the event

of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.

9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed. The application of the adhesive layer shall not be permitted after epoxy is fully cured. The CONTRACTOR shall establish, to the satisfaction of the COMPANY representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The CONTRACTOR shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.

9.2.8 Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/ temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.

9.2.9 CONTRACTOR shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on to the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, CONTRACTOR shall supplement by other method to avoid air entrapment. The methods used shall be witnessed and approved by COMPANY.

9.2.10 Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.

9.2.11 Coating and/ or adhesive shall terminate 150mm (+)20/(-)0 mm from pipe ends. The adhesive shall seal the end of applied coating. CONTRACTOR shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.

9.2.12 Failure to comply with any of the above applicable requirement and of the approved procedure shall be cause for the rejection of the coating and such coating shall be removed in a manner approved by COMPANY at CONTRACTOR's expense.

10.0 INSPECTION AND TESTING

10.1 **General**

CONTRACTOR shall establish and maintain such quality assurance system as are necessary to ensure that goods or services supplied comply in all respects with the requirements of this specification. The minimum inspection and testing to be performed shall be as indicated subsequently herein.

10.2 **Visual Inspection**

Immediately following the coated, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating shall be of natural colour and gloss, smooth and uniform and shall be blemish free with no dust or other particulate inclusion. The coating shall not slow and defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts swelling, disbonded zones, air inclusions, tears, voids or any other irregularities. Special attentions shall be paid to the areas adjacent to the longitudinal weld (if applicable), adjacent to the cut back at each of pipe and within the body of the pipe.

In addition inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focussed at the middle of the pipe at line end while inspection is carried out visually form other end.

10.3 Coating Thickness

a. The coating thickness shall be determined by taking atleast 10 measurement at locations uniformly distributed over the length and periphery of each pipe. In case of weld pipes, five of the above readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All the readings must meet the minimum requirements. However, localised coating thickness of less than the permissible minimum thickness can be tolerated on the condition that it does not attain a total extent of more than $5cm^2$ per meter length of coated pipe, and the actual coating thickness does not drop more than 10% below the permissible minimum coating thickness at these locations. The frequency of thickness measurement as stated above shall be initially on every pipe, which shall be further reduced depending upon consistency of results, at the sole discretion of COMPANY's representative. Resultsof all measurement shall be recorded.

b. Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipe shall be at CONTRACTOR's expense.

c. Coated pipes not meeting the above requirements shall be rejected. The CONTRACTOR shall remove the entire coating and the pipe shall be recycled to the cleaning and coating operations as per the approved procedure and shall be to CONTRACTOR's expenses.

10.4 Holiday Detection

a. Each coated pipe length shall be checked over 100% of coated surface by means of a "holiday detector" of a type approved by COMPANY for detecting holidays in the finished coating.

b. The holiday detector shall be a low pulse DC full circle electronic detector with audible alarm and precise voltage control with DIN VDE 0433 Part 2. The set voltage for inspection shall be 25 kV. Travel speed shall not exceed 300 mm/s.

c. CONTRACTOR shall calibrate the holiday detector at least once every 4 hours of production. CONTRACTOR shall have necessary instruments or devices for calibrating the holiday detector.

d. Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm^2 in size are detected in its length attributable to coating process.

e. Holidays which are lesser in number and size than those mentioned in (d) above, shall be repaired in accordance with a approved procedure and shall be to CONTRACTOR's expense.

10.5 Bond Strength Test

a. CONTRACTOR shall conduct bond strength test for composite coating as per clause 5.3.3 (a) of this specification. A minimum of 65mm length shall be peeled. First 20mm and last 20mm shall not be counted for assessment of bond strength.

b. The frequency of test for cut back portions shall be one pipe in every fifteen(15) pipes coated and for middle of pipe shall be one pipe in every sixty(60) pipes coated or one pipe per shift whichever is higher. On each selected pipe, bond strength shall be performed for each specified temperature. Test shall be performed at each cut back portion and one in the middle of pipe. The system shall disbond/ separate cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive. Disbondment/ separation at epoxy to steel interface or epoxy/ adhesive interface or adhesive/ polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.

c. In case the above tests do not comply with the above requirement, CONTRACTOR shall test all the preceding and succeeding coated pipes. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during the shift shall be tested until the coating

is provided acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at CONTRACTOR's expense.

d. The frequency of bond strength test as per para 10.5(b) for cut back portion may be reduced depending upon the consistently of result to one pipe in every twenty five(25) instead of every fifteen pipes, at the sole discretion of the COMPANY Representative.

10.6 **Impact Strength**

a. Impact resistance test shall be conducted as per clause 5.3.3 (b) of this specification. Initially the frequency of test shall be 2(two) coated pipes per shift, which may be further reduced and/ or waived depending upon consistently acceptable results at the sole discretion of COMPANY's representative.

b. Minimum thirty(30) impacts located equidistant along the length of coated pipe shall be performed.

c. Immediately after testing, the test area shall be subjected to holiday detection at the same voltage as used prior to impact strength test. The pipe shall be rejected if any holiday is noted in the test area.

d. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.7 **Indentation Hardness**

a. Indentation hardness test shall be as per clause 5.3.3 (c) of this specification. The frequency of test shall be initially 2(two) coated pipes per shift which shall be further reduced to one test each on 2 coated pipes per week at random after 1 week of consistently acceptable results. Two samples for each temperature shall be taken from the cut back portion of coated pipe and one in middle of the pipe for this test.

b. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.8 **Air Entrapment Test**

a. Strips from bond strength tests or coated pipe may be used to help determine the porosity of the finished coating. Strip shall be also cut from longitudinal weld (if applicable) at cut back portion and examined for the presence of voids.

b. Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the

edge of the coating to a 45° angle and view with a microscope. Similar examination shall be done in the coating cut back area.

c. One sample each either on the bond strength strip or coated pipe and strip cut from the longitudinal weld (if applicable) shall be examined for air entrapment per shift. Strips shall be viewed from the side.

d. All examination shall be done using a 30X magnification hand-held microscope. The polyethylene and adhesive layers shall have no more than 10% of the observed area taken up with air entrapment (porosity or bubbles). Air entrapment shall not occupy more than 10% of the thickness in each case. Bubbles shall not link together to provide a moisture path to the epoxy layer.

e. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.9 **Degree of Cure**

a. Epoxy film samples shall be removed from cut back portion of the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply the specified requirements.

b. Frequency of this test shall be once per shift. Pipe shall be selected randomly by COMPANY Representative during the middle of a shift. Suitable provisions/ arrangements as per the instructions of COMPANY Representative shall be made by the CONTRACTOR for this purpose.

c. In case of test failure, production carried out during the entire shift shall be rejected, unless the CONTRACTOR proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

10.10 **Epoxy Layer Adhesive Test**

a. Adhesion of epoxy layer shall be determined at ambient temperature by the "St Andrews Cross" method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30°/ 150°. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/ lift the coating from the 30° angle with a sharp knife.

b. Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion of the pipe from which the Degree of Cure test has been carried out as per para 10.9 above.

c. In case of test failure, retesting and disposal of coated pipe shall be as per 10.9(c) above.

10.11 **Cathodic Disbondment Test**

a. 48 hours CD test shall be conducted as per clause 5.3.3. (h) of this specification.

b. The frequency of this test shall be once in every two weeks or one test representing each batch of epoxy powder used, whichever is more frequent.

c. In case the test fails to conform to the specified requirement, at the option of the CONTRACTOR, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test shall be repeated or the shall be repeated using two additional samples taken from the same end of the affected pipe.

When both retests conform to the specified requirement, the lot of pipes shall be accepted. When one or both the retests fail to conform to the specified requirement, all coated pipes after previous acceptable test and prior to next acceptable shall be rejected. All rejected pipes shall be stripped, re-cleaned and re-coated. COMPANY may consider a further retest program to determine whether any of the affected pipe meet the criteria for acceptance upon written request by the CONTRACTOR.

10.12 Damages occurring to pipe coating during above tests shall be repaired in accordance with approved coating repair procedure.

10.13 Repairs occurring on account of the production test are however excluded from above mentioned limitations at para 10.4 (d) above.

10.14 COMPANY, reserves the right to perform inspection and witness tests on all activities concerning the pipe coating operations starting from bare pipe to finished coated pipe ready for dispatch and also testing of raw materials. CONTRACTOR shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the COMPANY's Representative. Inspection and tests performed or witnessed by COMPANY's Representative shall in no way relieve the CONTRACTORs obligation to perform the required inspection and tests.

10.15 In case rate of defective or rejected pipes and/ or samples tests are 10% or more for a single shift (typically 8 hours), CONTRACTOR shall be required to stop production and carry out a full and detailed investigation and shall submit findings to COMPANY for approval. CONTRACTOR shall recommence the production only after getting the written permission from COMPANY.

Under no circumstances any action or omission of the COMPANY's representative shall relieve the CONTRACTOR of his responsibility for material and quality of coating

produced. No pipes shall be transported from the coating plants unless authorised by COMPANY in writing.

11.0 HANDLING, TRANSPORTATION AND STORAGE

11.1 The CONTRACTOR shall be fully responsible for the pipe and for the pipe identification marking from the time of "taking over" of bare pipe from COMPANY until such time that the coated line pipes are `handed over' and/ or installed in the permanent installation as the case may be according to the provisions of the Contract.

At the time of "taking over" of bare pipes CONTRACTOR shall inspect and record all the relevant details referred above including pipe defects in the presence of COMPANY. All pipes shall be checked for bevel damages, weld seam height, dents, gouges, corrosion and other damages. COMPANY Representative shall decide whether pipe defects/ damages are suitable for repair. Damage to the pipes which occur after the CONTRACTOR has taken delivery such as dents, flats, or damage to the weld ends shall be cut off or removed and pipes rebevelled and repaired again as necessary. The cost of this work, as well as that of the pipe lost in cutting and repair shall be to the CONTRACTOR's account. All such works shall be carried out after written approval of the COMPANY. Any reduction in length shall be indicated in the CONTRACTOR's pipe tracking system.

11.2 The CONTRACTOR shall unload, load, stockpile and transport the bare pipes within the coating plant(s) using suitable means and in a manner to avoid damage to pipes.

The CONTRACTOR shall stockpile the bare pipes at the storage area of the coating plant. The CONTRACTOR shall prepare and furnish to COMPANY a procedure/ calculation generally in compliance with API RP-5L1 for pipe stacking, which shall be approved by COMPANY prior to commencement.

11.3 The CONTRACTOR shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe and coating. The procedure shall be approved by COMPANY prior to commencement of work.

11.4 Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-abrasive/ non-metallic materials. In this case, pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings are prohibited. Fork lifts may be used provided that the arms of the fork lift are covered with suitable pads preferably rubber.

11.5 Bare/ coated pipes at all times shall be stacked completely clear from the ground so that the bottom row of pipes remain free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. Bare/ coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This

cover can, for example, consist of dry, germ free straw with a plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes.

Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. CONTRACTOR shall submit calculations for COMPANY approval in this regard. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes.

The ends of the pipes during handling and stacking shall always be protected with bevel protectors.

11.6 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there as pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 Nos. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitable padded at the contact points with the pipe.

11.7 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other advers weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at CONTRACTOR's expenses. These materials, shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion. When supplied in containers and envelopes, they shall bot be dropped or thrown, or removed by means of hooks, both during the handling operations till their complete use. During unloading transport and utilization, any contact with water earth, crushed stone and any other foreign material shall be carefully avoided.

CONTRACTOR shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials which are susceptible to change in properties and characteristics due to unsuitable storage. If necessary the CONTRACTOR shall provide for a proper conditioning.

11.8 In case of any marine transportation of bare/ coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. CONTRACTOR shall furnish all details pertaining to marine transportation including necessary drawings of cargo barges, storing/ stacking, sea fastening of pipes on the barges/ marine vessels to the COMPANY for approval prior to undertaking such transportation works. In addition CONTRACTOR shall also carry out requisite analyses considering the proposed transportation scheme and establish the same is safe and stable. On-deck overseas shipment shall not be allowed.

12.0 REPAIR OF COATING

CONTRACTOR shall submit to COMPANY, its methods and materials proposed to be used for executing a coating repair and shall receive approval from COMPANY prior to use. In open storage the repair coating materials must be able to withstand a temperature of atleast +80°C, without impairing its serviceability and properties. CONTRACTOR shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.

All pipe leaving coating plant, shall have sound external coating with no holiday porosity on 100% of the surface.

Defects, repairs and acceptability criteria shall be as follows :

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm^2 or linear damage (cut) of less than 3 cm shall be repaired by stick welding using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2.0mm and an area not exceeding 20 cm^2 shall be rebuild by heat shrink patch only and without exposing to bare metal.
- Defects or size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrinks repair patch by exposing the bare metal surface.
- Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500mm shall be repaired using heat shrinkable sleeves of HTLP80 or equivalent.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, CONTRACTOR shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 170 mm of linear length of pipe then the coating shall be

repaired by the use of heat shrinkable sleeves thereby making up the coating cut back length of 150 mm.

Not withstanding the above, under no circumstances, if the defects exceeds 70mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

Irrespective of type of repair, the maximum nos of repair of coating shall be as follows :

- Holiday repair of size $\leq$ 100 cm^2 attributable to process of coating application shall be maximum of one per pipe.
- In addition to the above, defects to be repaired by heat shrink patch/ sleeve shall be maximum 2(two) per pipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as per this specification.

All repairs carried out to coating for whatever reason shall be to the account of CONTRACTOR.

Cosmetic damages occurring only in the Polyethylene layer only need not be repaired by exposing upto steel surface, as deemed fit by the COMPANY representative. In any case the CONTRACTOR shall establish his material, methods and procedure of repair that results in acceptable quality of product by testing and shall receive approval from COMPANY prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness. CONTRACTOR shall test repairs to coating as and when required by COMPANY.

13.0 MARKING

CONTRACTOR shall place marking on the outside surface of the coating at one end of the coated pipe, and marking shall indicate, but not limited to the following information:

a. Pipe number, Heat number
b. Diameter & Wall Thickness
c. Coated Pipe Number
d. Colour band
e. Any other information considered relevant by COMPANY.
f. Pipe Manufacturer Name
g. Inspection Mark/ Punch

CONTRACTOR shall obtain prior approval on making procedure to be adopted from the COMPANY.

14.0 QUALITY ASSURANCE

14.1 The CONTRACTOR shall have established within the organisation and, shall operate for the contract, a documented Quality System that ensures that the requirements of this specification are met in all aspects. The Quality System shall be based upon ISO 9001/2 or equivalent.

14.2 The CONTRACTOR shall have established a Quality Assurance Group within its organisation that shall be responsible for reviewing the Quality System and ensuring that it is implemented.

14.3 The CONTRACTOR shall submit the procedures that comprise the Quality System to the COMPANY for agreement.

14.4 The CONTRACTOR's Quality System shall pay particular attention to the control of Suppliers and sub-contractors and shall ensure that the requirements of this specification are satisfied by the Suppliers and Sub-contractors operating Quality system in their organisation.

14.5 The CONTRACTOR shall, prior to the commencement of work, prepare and issue a Quality plan for all of the activities required to satisfy the requirements of this specification. The plan shall include any sub-contracted work, for which the sub-contractors Quality plans shall be submitted. The plan shall be sufficiently detailed to indicate sequentially for each discipline the requisite quality control, inspection , testing and certification activities with reference to the relevant procedures and the acceptance standards.

14.6 The CONTRACTOR's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the CONTRACTOR will be monitored by the COMPANY Representatives who will witness and accept the inspection testing and associated work required by this specification.

ANNEXURE-I

LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

The following combinations of coating materials are considered acceptable. In the event of award of contract, CONTRACTOR shall furnish the combination(s) proposed and reconfirmation of compatibility & properties of the proposed combination (s) from the raw materials Manufacturers & system properties.

Epoxy Powder (Manufacturer)	Adhesive (Manufacturer)	PE Compound (Manufacturer)
CORRO-COAT EP-F 2001 (JOTUN)	FUSABOND 158D (DUPONT)	SCLAIR 35 BP HDPE (NOVACOR)
PE 50-8190/8191 (BASF) or CORRO-COAT EP-F 2001 (JOTUN)	LUCALEN G3510H (BASF)	LUPOLEN 3652 D SW 00413 (BASF)
PE 50-6109 (BASF) or CORRO-COAT EP-F 2001/2002HW (JOTUN) or SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	HE 3450 (BOREALIS)
CORRO-COAT EP-F 2001 (JOTUN)	LE – 149 V (S K CORPORATION)	ET 509 B (S K CORPORATION)
SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	PB 48A004 (GAIL)

Although the above combinations would be acceptable to COMPANY, the responsibility of suitability for application, performance, properties and compliance to the coating system requirements shall unconditionally lie with the CONTRACTOR.

AMENDMENTS TO TECHNICAL SPECIFICATION Nos. MEC/TS/05/21/12, MEC/TS/05/21/12A, MEC/TS/05/21/12B, MEC/TS/05/21/012C & MEC/TS/05/21/14

1. LINE PIPE: Amendment to TS No. MEC/TS/05/21/012

a) 10.2.3.1 Table-20 (Modified)

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	1T180 [c]
	CVN	3T90	3T90
Seam Weld	Tensile	-	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 tensile strength.

b) Annexure-B: Cl. No. B 5.2 (c) ii. Tensile Test (Modified)

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

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

2. LINE PIPE: Amendment to TS No. MEC/TS/05/21/012C (SAWH)

C.4 REPAIR OF DEFECTS BY WELDING (Modified)

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 hydrostatic testing.
b. No repair of weld seam is permissible at pipe ends up to a length of 300 mm.
c. Through thickness repair of weld seam is not permitted.
d. 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's representative for each repair.
h. The repair weld shall be performed with minimum of two passes.

3. Clause No. 9.8.2.2 of Technical Specification Nos. MEC/TS/05/21/12B and MEC/TS/05/21/12C

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

4. SEAMLESS Line Pipe Specification no. MEC/TS/05/21/12A

Cl. no. 7.3 (Modified):- Wall Thickness

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 wall thickness tolerances shall comply with the requirements of this specification. The tolerances on specified wall thickness shall be (+) 22.5% and (-) 0%. API Spec. 5LTable 9 stands cancelled

5. 3LPE COATING- Amendment to TS No. MEC/TS/05/21/14

List of acceptable Combinations of coating materials: Please refer (Annexure-I) (modified)

Addition: In case the contractor proposes coating material other than above mentioned combination of epoxy, adhesive and polyethylene,

coating procedure and qualification as per project specification need to be carried out by an i nternationally recognized agency by the coating material manufacturer.

All supporting documents submitted by the successful coating contractor to be certified true copies duly signed, dated and stamped by the Chamber of Commerce of the coating material in the manufacturing country. In absence of requested documents, MECON reserves the right to reject the proposal without making any reference to the contractor

ANNEXURE-I

LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

The following combinations of coating materials are considered acceptable. In the event of award of contract, CONTRACTOR shall furnish the combination(s) proposed and reconfirmation of compatibility & properties of the proposed combination (s) from the raw materials Manufacturers & system properties.

Epoxy Powder (Manufacturer)	Adhesive (Manufacturer)	PE Compound (Manufacturer)
CORRO-COAT EP-F 2001 (JOTUN)	FUSABOND 158D (DUPONT)	SCLAIR 35 BP HDPE (NOVACOR)
CORRO-COAT EP-F 2002HW (JOTUN) or SCOTCHKOTE 226N (3M)	LUCALEN G3710E (LYONDELLBASELL)	LUPOLEN 4552 D SW 00413 (LYONDELLBASELL)
PE 50-6109 (BASF) or CORRO-COAT EP-F 2001/ 2002HW/1003HW (JOTUN) or SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	HE 3450 (BOREALIS/BOROUGE)
CORRO-COAT EP-F 2001 (JOTUN)	LE – 149 V (HYUNDAI ENGINEERING PLASTICS)	ET 509 B (HYUNDAI ENGINEERING PLASTICS)
SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	PB 48A004 (GAIL)

Although the above combinations would be acceptable to COMPANY, the responsibility of suitability for application, performance, properties and compliance to the coating system requirements shall unconditionally lie with the CONTRACTOR.

ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)

QUALITY ASSURANCE PLAN
(GUIDELINE)

(MR No. : MEC/23U1/05/21/M/001/S012)

MECON LIMITED
DELHI - 110 092

QAP No. : 05/21/12/001

I N D E X

1.0 INTRODUCTION

This specification establishes the Quality Assurance (QA) requirements to be met by the item rate contractor during execution of work.

Requirements stipulated in this specification conform to ISO:9002 & IS:14002.

2.0 SCOPE

2.1 Prior to award of Contract

Following documents shall be submitted along with the tender :

Quality Assurance Manual of their organisation covering :

- Policy statement QA indicating approach for achieving quality assurance.
- Organisation structure for QA/QC programme.
- Responsibility and authority of personnel for QA/QC programme.
- Communication system.
- List of written down job procedure they have for major activities for the work put to tender.
- Incoming material control, storage and transportation procedure.
- Procedure to deal with non conformance in case these crop up during job execution.

2.2 After award of Contract (Prior to start of job)

2.2.1 a) **Quality Plan**

The sample formats for preparation of the quality plan is enclosed. Contractor shall list all the major activities in their area/ scope and prepare the quality plan accordingly.

2.2.2 b) Inspection and Test Plan (ITP) for detailed activity of the job.

Sample format of ITP is enclosed. Contractor shall develop ITPs for job activities in his scope in line with sample ITP format.

2.2.3 The Contractor shall obtain approval of his detailed quality assurance programme and quality plans for all the works under his scope. This quality programme is tailored system which Contractor shall be using for the job giving details of JOB PROCEDURES and construction technologies for all major activities.

2.2.4 **During Job Execution**

Implement agreed Quality Assurance Programme and submit the reports as per the programme.

ANNEXURE-I

GUIDELINES TO BIDDERS FOR PREPARATION FOR QUALITY PLAN

QUALITY PLAN

One of the special features of this specification is "Quality Plan". The format is designed to include important information such as :

- List of all major activities i.e. Work Break-down Structure (WBS).
- Job Procedure Number for each activity covering construction technology to be adopted.
- Responsibility.
- Controls for Quality at Contractors end.
- Inspection and Test requirement for clients witness.
- Record generation.

While finalising the "QUALITY PLAN" for the particular job following is the sequence of actions.

Break-down of work into activities

Break-down the entire project work under the scope into smallest identifiable activity, in sequence. The column "Activity Description" is provided for the purpose.

Decide Work Method

Well laid down, step-by-step procedure totally covering the activity are to be specified under the column "Procedure No". Applicable Standards can also be specified under this column.

Code of conformance as per tender specification can be specified under the column provided.

Assign Responsibilities

Under the "Performer" column, the job performer level is identified as per experience level and designation.

Decide Internal Controls

The type of internal controls that shall exercise to produce Quality shall be identified under columns :

- Checker
- Reviewer/ Approver.

Decide number of Inspection & Test Plans (ITPs) and Record Requirements.

Under this column the number of Inspection & Test Plan, that shall be developed by Contractor shall be indicated.

QUALITY PLAN

Company Name : Client : Project :

General		Contractor's Performing Functions/ Responsibility			Owner / MECON Inspection/ Record Functions	Remarks
Activity Description	Procedure Number	Performer	Checkers	Reviewer/ Approver		

INSPECTION AND TEST PLAN

Sl. No.	Activity	Examination by Contractor	Inspection by MECON	Records to be submitted by Contractor

INSPECTION AND TEST PLAN

FOR

LONGITUDINAL SEAM SUBMERGED ARC WELDED LINE PIPES (ON SHORE)

1	SEP-18	ISSUED FOR IMPLEMENTATION	Sachin Kumar	Sachin Singhal	A.K.Gupta
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

1.0 SCOPE:

This Inspection Test Plan covers the minimum testing requirements of LONGITUDINAL SEAM SUBMERGED ARC WELDED LINE PIPES (ON SHORE)

2.0 REFERENCE DOCUMENTS:

1) POIPR/ Standards referred there in Job specifications / Approved documents.

3.0 INPECTION AND TEST REQUIREMENTS:

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
1	Hydro Test, Heat Treatment, NDT, Hot Forming, Expansion And Other Procedures	Documented Procedures.	100%	Procedure Documents	-	P	-	R
2	First day production test	All testing requirements as per PR	As per PR	Test report	-	H	H	H

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
3	Raw Material Inspection	Heat No., Plate No., Method of Manufacturing, Heat Treatment Condition	100% By Supplier & Supplier appointed TPI and Random By MECON / OIL	Inspection Report	-	H	W	W
4	Plate UT	1) 25mm (Min) From Edges 2) 20% Min Coverage In Bal. Part of late	100%	Inspection Report	-	W	W	Calibration-W Plate UT-RW
5	Pipe Forming	Bending surface	100%	Inspection Report	-	W	W	M
6	Pipe Welding (SAW)	1) Automatic Tack Welding 2) ID & 00 Welding	100%	Inspection Report	-	W	W	RW
7	Visual Welding Inspection	Examination Of Welding Defects Inside & Outside	100%	Inspection Report	-	W	W	RW

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
8	Cold Expansion	Expansion Ratio	100%	Inspection Report	.	W	W	RW
9	Hydro Test	Leakage & Pressure Drop, Calibration of Gauges Recorder	100%	Inspection Report	-	W	100% W	RW
10	Calibration of Seam U/T M/C & Final Automatic U/T Inspection	Calibration, Seam Tracking. & Examination of Welding Defects	Calibration -Start & End of Every Shift, Seam UT 100% By Supplier & Supplier appointed TPI and Random By MECON / OIL.	Inspection Report	-	W	100% W	RW
11	Manual Off On Pipe Ends	Lamination	100%	Inspection Report	-	W	100% W	RW

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
12	Inspection Of Pipe Ends RT	Welding Defects	203 Mm Length of Both Ends Of Each Pipe As Per PR/Specification	RT Films	-	R	Evaluation of Films	R
13	Inspection Of Pipe Ends MPI	1) Examination of Surface Defects After Bevelling. 2) Demagnetisation	100% By Supplier & Supplier appointed TPI and Random By MECON / OIL.	Inspection Report	-	H	W	RW
14	Final Inspection	1) Visual Examination 2) Dimensional Check 3) Weight	100%	Inspection Report	-	H	W	RW
15	Mech Properties & Testing	1) Chemical Analysis 2) Tensile Tests of Base Metal 3) Tensile Tests of Weld (Transverse) 4) Guided Bend Tests 5) Macro & Hardness Tests 6) Impact Tests 7) Dwtt	As Per PR	Inspection Report	-	H	W	RW

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
16	Marking	Pipe No, Acceptance No., H.No. , Size, Grade, Thickness & Colour Code	100%	Inspection Report	-	H	W / R	RW

Legends: CCE or CCOE-Chief Controller of Explosives, DT- Destructive Testing, HT- Heat treatment, H- Hold (Do not proceed without approval), IBR-Indian Boiler Regulations, ITP-Inspection and Test Plan, NDT- Non Destructive Testing, P-Perform., PO- Purchase Order, PR-Purchase Requisition, PQR- Procedure Qualification Record, QAP-Quality Assurance Plan, Random -10% (min. 1 no.) of each size and type of Bulk item, R-Review, RT- Radiography Testing, RW- random Witness, TC-Test Certificate, VDR- Vendor Data Requirements, WPS-Welding Procedure Specification, WPQ- Welders Performance Qualification, W-Witness (Give due notice, work may proceed after scheduled date).

NOTES (As applicable):

1. Wherever W/R or H/W is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier.
2. Supplier's in house procedures may be accepted in case MECON is satisfied with adequacy of procedures to comply with Purchase order / Specifications requirements. In case of non availability of suitable procedures fresh procedures may be qualified under MECON witness.
3. In case of conflict between purchase specification, contract documents and ITP, more stringent conditions shall be applicable.
4. This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable.
5. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in / Job Specification / Approved Documents
6. All items shall be provided with EN 10204-3.2 Certificates.

INSPECTION AND TEST PLAN

FOR

HELICAL (SPIRAL) SEAM SAW LINE PIPES (ON SHORE)

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
1	SEP-18	ISSUED FOR IMPLEMENTATION	Sachin Kumar	Sachin Singhal	A.K.Gupta

1.0 SCOPE:

This Inspection and Test Plan covers the minimum testing requirements of Helical (Spiral) Seam SAW Line Pipes (Onshore)

2.0 REFERENCE DOCUMENTS:

PO/PRI Standards referred there in! Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS:

S. NO	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
1	Hydro Test, Heat Treatment, Non Destructive Testing, Hot Forming, Expansion and Other Procedures	Documented Procedures	100%	Procedure Documents	-	P	-	R
2	First day production test	All testing requirements as per PR	As per Purchase Requisition	Test report	-	H	H	H
3	Raw material inspection	Marking & Correlation with TC	100% By Supplier & Supplier appointed TPI and Random By MECON / OIL	Inspection Report	-	H	W	W

S. NO	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
4	Continuous UT of Plate / Coil	1) 25mm (min) front edges. 2) 20% Min. coverage.	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	W	RW
5	Pipe Welding (Submerged Arc Welding)	Welding parameters, Auto Tracking of weld	100% by supplier, supplier appointed TPI & Random by MECON	Inspection Report	-	H	W	RW
6	Visual Welding Inspection	Examination of welding defects in ID & OD	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	W	RW
7	Hydro testing	I) Calibration of pressure gauge 2) Leakage	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	100% W	RW
8	Final Automatic UT Inspection of weld Seam	Internal imperfections of weld seam	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	100% W	RW

S. NO	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
9	Manual Ultrasonic Testing of pipe ends	Lamination	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	100% W	RW
10	X-ray of pipe ends	Internal imperfections of weld seam	203mm on both ends of each pipe	-do-	-	H	Evaluation of Films	R
11	MPT of beveled edges	Examination of surface imperfections after beveling	100% by supplier, supplier appointed TPI & Random by MECON	Inspection Report	-	H	100% W	RW
12	Final Inspection Pipe	I) Surface condition 2) Straightness 3) End Finish 4) Bevel Angle 5) Root face 6) OD 7) Thickness 8) Square ness 9) Residual Magnetism	100% by supplier, supplier appointed TPI & Random by MECON	-do-	-	H	100% W	RW
13	Product Analysis Pipe	Chemical composition	One sample per heat per lot of 100 pipes	-do-	-	H	100% W	RW

S. NO	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / OIL
14	Destructive testing Pipe	I) Tensile tests of base metal 2) Tensile tests of weld 3) Macro & Hardness test 4) Impact test 5) Guided bends tests 6) Drop weight tear tests 7) Residual stress	One sample per heat per lot of pipe	-do-	-	H	100% W	RW
15	Marking pipe	Pipe No., Heat Number, Acceptance No., Size, Grade Thickness, API- Monogram & colour coding	100% by supplier	Inspection Report	-	H	W / R	RW
16	Documentation	Verification & compliance of inspection & tests reports for submission to client	100% by supplier	Dossier	-	H	H	H

Legends: CCE or CCOE-Chief Controller of Explosives, DT- Destructive Testing, HT- Heat treatment, H- Hold (Do not proceed without approval), IBR-Indian Boiler Regulations, ITP-Inspection and Test Plan, NDT- Non Destructive Testing, P-Perform., PO- Purchase Order, PR-Purchase Requisition, PQR- Procedure Qualification Record, QAP-Quality Assurance Plan, Random -10% (min. 1 no.) of each size and type of Bulk item, R-Review, RT- Radiography Testing, RW- random Witness, TC-Test Certificate, VDR- Vendor Data Requirements, WPS-Welding Procedure Specification, WPQ- Welders Performance Qualification, W-Witness (Give due notice, work may proceed after scheduled date).

NOTES (As applicable):

1. Wherever W/R or H/W is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier.
2. Supplier's in house procedures may be accepted in case MECON is satisfied with adequacy of procedures to comply with Purchase order / Specifications requirements. In case of non availability of suitable procedures fresh procedures may be qualified under MECON witness.
3. In case of conflict between purchase specification, contract documents and ITP, more stringent conditions shall be applicable.
4. This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable.
5. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in / Job Specification / Approved Documents
6. All items shall be provided with EN 10204-3.2 Certificates.

INSPECTION AND TEST PLAN

FOR

3-LAYER PE COATING OF LINE PIPES

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
1	SEP-18	ISSUED FOR IMPLEMENTATION	Sachin Kumar	Sachin Singhal	A.K.Gupta

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR	VENDOR APPOINTED TPI	MECON / OIL
1a	Raw material inspection	Epoxy powder, Adhesive polyethylene compound, shots, grils and chronic acids and phosphoric acids	Batch nos. and date of manufacturing and correlation with MTC	Review of records & visual	100%	PO, Material specification	PO, Material specification for each batch of raw material used in PQT	Inspection report	W	R	R
1b	Raw material inspection	Epoxy powder, Adhesive polyethylene compound, shots, grils and chronic acids and phosphoric acids	In addition to mfc, contractor shall test samples as per spec.	In-house testing	One Sample per each batch per item	PO, Material specification	PO, Material specification	Inspection report	W	W	W
2a	Surface preparation (1st blast cleaning)	Each bare pipe	Oil free, preheating, blast cleaning and free from salt contamination, phosphoric and treatment followed by De-ionized water wash	As per internal QA Plan	100%	QA plan	Internal standard	Inspection report	W	W/R	W/R
2b	Surface preparation (2nd blast cleaning)	Each bare pipe	Relative humidity, degree of cleaning, degree of dust and roughness	As per internal QA Plan	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
3	Chromate treatment	Each bare pipe	Application as per manufacturer's recommendation and data sheet	As per internal QA Plan	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
4	Coating application 1) Pipe heating	Each bare pipe	Pre-heating pipe surface temperature prior to epoxy powder application	Infrared camera/thermal sticks	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR	VENDOR APPOINTED TPI	MECON / OIL
5	2) Epoxy powder application	Each pipe	Application as per manufacturer's recommendation and data sheet	Set pressures and thickness	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
6	3) Adhesive layer application	Each pipe	Application as per manufacturer's recommendation and data sheet	Film Thickness	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
7	PE Layer application	Each pipe	PE Film application temperature, finished coating thickness	Film thickness	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
7a	Final inspection	Each pipe	Visual & identification	Visual	100%	QA plan	PO, specifications	Inspection report	W	W/R	W/R
8	Coating procedure & qualification (PQT)	Tests on pipe coated partly with epoxy and partly with epoxy & adhesive layers	Air pressure, Application window, dew point of dry air	As per PQT procedures and specifications	5 samples from coated pipes/as per specifications for each pipe diameter\, and for each plant	QA plan	PO, specifications	Inspection report	H	H	H
8a	Tests on pipe coated with all three layers	Coated pipe	1) Impact test 2) Indentation 3) Elongation 4) Bond strength	As per specification and PQT requirements	1) Min. 30 impacts on body along, the length, no holiday allowed. 2) Two samples for both temp. 3) Six samples from 3 coated pipes 4) From 3 coated pipes	QA plan	PO, specifications	Inspection report	H	H	H

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR	VENDOR APPOINTED TPI	MECON / OIL
8b	Tests on pipe coated with all three layers	Coated pipe	1) Cathodic disbondment 2) Holiday inspection 3) Coating thickness 4) Visual inspection	As per specification	1) One sample 2) On all pipes 3) On all points 4) On all pipes	QA plan	PO, PR & specifications	Inspection report	W	W	W
9	On line inspection and testing	Coated pipe	Start of production	By thickness gauge epoxy thk. Adhesive thk.	Start of production, i.e. first pipe	QA plan	PO, PR & specifications	Inspection report	W	W	W
9a	Holi day detection at 25 kV	Coated pipe	To find surface discontinuities	Holiday detector	Every pipe	QA plan		Inspection report	W	W/R	W/R
9b	Overall coating thckness	Each coated pipe	Thickness of coating	Every pipe	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W/R	W/R
10	Off line tests a) Impact test	Coated pipe	Energy absorbed by impact	Impact test instrument	Two pipes per shift	QA plan	PO, PR & specifications	Inspection report	W	W	W
10a	ERsistance to peel test	Coated pipe	To measure peel load	Peel test machine	One in 15 pipes / as per specification	QA plan	PO, PR & specifications	Inspection report	W	W	W

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR	VENDOR APPOINTED TPI	MECON / OIL
10b	Resistence to indentation test	Coated pipe		Indentation bath, with heater, dial gauge & thermostat	Two pipes per shift	QA plan	PO, PR & specifications	Inspection report	W	W	W

Legends: H- Hold (Offer for witness & obtain clearance), W – Witness, R – Review, A – Approval, I – Information, X – Submit, PO – Purchase Order, PR – Purchase requisition, N – Normalizing & Tempering, SA – Solution annealing, N & SR – Normalizing & Stress relieving, PR – Purchase Requisition, Ref. Doc: ASTM D-149, D-257, D-570, D-638, G-42 & DIN 53735 and SIS 055900.

All the NDT / Leak testing / Heat treatment / Special manufacturing procedures have to be specially approved or only previously approved procedures have to be used. In case of conflict between purchase specification, contract documents and ITP more stringent conditions shall be applicable. This document describes generally the requirements pertaining to 3-layer PE coating of pipes.

All items shall be provided with EN 10204-3.2 Certificates.

STANDARD SPECIFICATION
NO. MEC/TS/05/21/012E

Raw Material (HR COIL/PLATE) Quality Requirements for Line Pipes

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
1	APR-16	ISSUED FOR IMPLEMENTATION	Sachin Singhal	K.P.Singh	O.P.Jain

ITP No. : ITP No. : 05/21/12B/006

1.0 SCOPE:

This Inspection and Test Plan covers the minimum inspection & testing requirements for Rolling process for manufacturing of Hot Rolled Coil & Plates as part of raw material quality requirements for line pipes

2.0 INSPECTION AND TEST REQUIREMENTS:

		Client	**:**						
		Standards	**:**			**Date**	**:----------**		
		Size & Grade	**:**			**Page no.**	**:**	**Scope Of Inspection**	
NO	**Sl. No.**	**Components & Operations**	**Characteristics / Type of check**	**Quantum of check**	**Reference document and Acceptance norm**	**Responsibility**	**Format of records**	Steel Manuf.	Pipe Manuf.& TPI
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	**Rolling department**	Slab preheating	Heating parameters per zone	1 slab/Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW (20%)
3	**Hot rolling department**	Rolling and accelerated cooling of coils	Rolling parameters and temperature tolerances.	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW (20%)

4	**Ultrasonic of plates**	Automatic Ultrasonic machine	Internal imperfections& lamination	1 Plate/Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	W
5	**Sampling department**	Sample removal	Check sample position (end or within body)	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	W
6	**Sampling department**	Inspection of coil end surface quality and dimensions	Surface of coil	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW
7	**Sampling department**	Mechanical, chemical and hardness tests	Chemical analysis, Tensile Test, Bend Test, Impact Test, Hardness Test, DWTT Test Ferritic Grain Size	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format & inspections reports	P	W

8	**Packing and shipping department**	Marking	No hard stamping	Each coil/Plate	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW
9	**Packing and shipping department**	Production of test certificates	Manuf. INSPECTION CERTIFICATE as per EN 10204-3.2	Each heat of Coil & plate	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	C
10	**Packing and shipping department**	Shipping	Correct loading	Each coil/Plate	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW

Legends:, HT- Heat treatment, H- Hold (Do not proceed without approval), , ITP-Inspection and Test Plan, NDT- Non Destructive Testing, P-Perform(100%)., PO- Purchase Order, PR-Purchase Requisition, QAP-Quality Assurance Plan, RW-Random witness-Min 10% or min. 1 no. (Whichever is higher), R-Review, TC-Test Certificate, , W-Witness (Give due notice, work may proceed after scheduled date).,M-Monitor, C-Certify

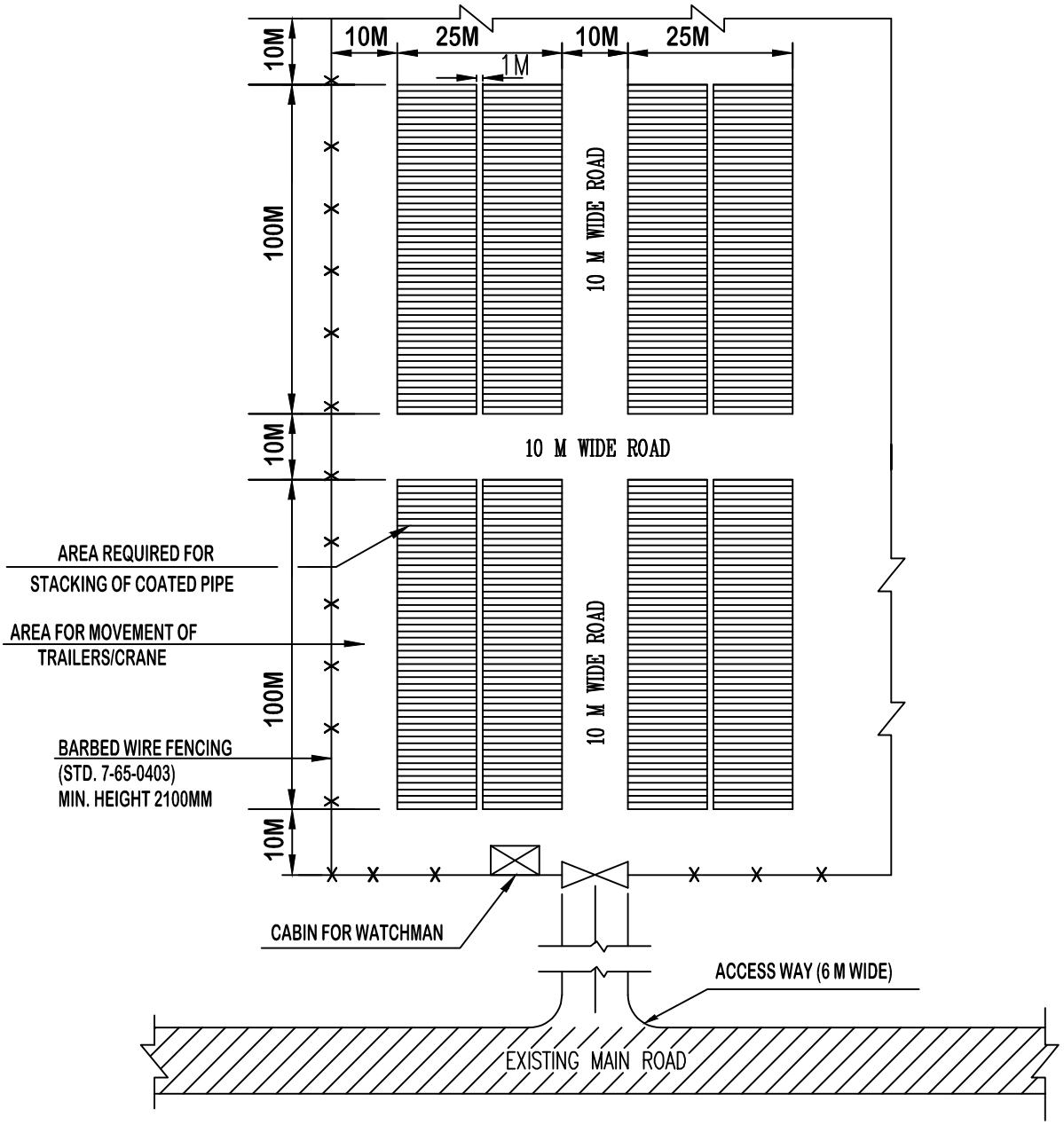
NOTES (As applicable):

1. Successful pipe Manufacturer has to submit latest audit report of offered Coil /Plate mill along with Inspection Test plan.
2. Wherever W/R is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier.
3. Wherever RW is indicated, Inspection engineer shall witness at least 10% quantity (Minimum 1No.) randomly in a specific time interval.
4. Steel Manufacture's in house procedures may be accepted in case MECON is satisfied with adequacy of procedures

to comply with Purchase order / Specifications requirements. In case of non availability of suitable procedures, fresh procedures may be submitted to MECON.

5. In case of conflict between purchase specification, contract documents and ITP, more stringent conditions shall be applicable.
6. The Line Pipe Manufacturer shall be completely responsible for the design, materials, testing, inspection, preparation for shipment, loading of the supplied item strictly in accordance with the Material Requisition and all attachments thereto.
9. All items shall be provided with EN 10204-3.2 Certificates.
10. Scope of inspection for Quantity less than 10,000MT shall be finalized after award of contract.

Annexure-3



NOTES :

1. ARRANGEMENT SHOWN IS INDICATIVE ONLY AND SHALL BE MODIFIED BY CONTRACTOR/VENDOR DEPENDING UPON THE AREA AVAILABILE.
2. DEVELOPMENT OF DUMP SITE SHALL BE AS PER SCOPE OF WORK
3. AREA FOR STORAGE YARD SHALL BE FINALISED BASED ON LINE PIPE QUANTITIES (TO BE STORED) INDICATED ELSE WHERE IN TENDER DOCUMENT.
4. NO. OF PIPE LAYER AND STACKING SHALL BE AS PER COMPANY APPROVED DOCUMENT.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	

PROJECT: JHPL (PHASE–I) PROJECT

DRG. NO.

SECTION:				
	NAME	DATE	CHKD	DATE
DSGN		01.08.15		01.08.15
DRWN	SUNIL		S.SINGHAL	

APPROVED BY ANIL KUMAR

TYPICAL LAYOUT PLAN FOR STORAGE YARD

मेकॉन लिमिटेड

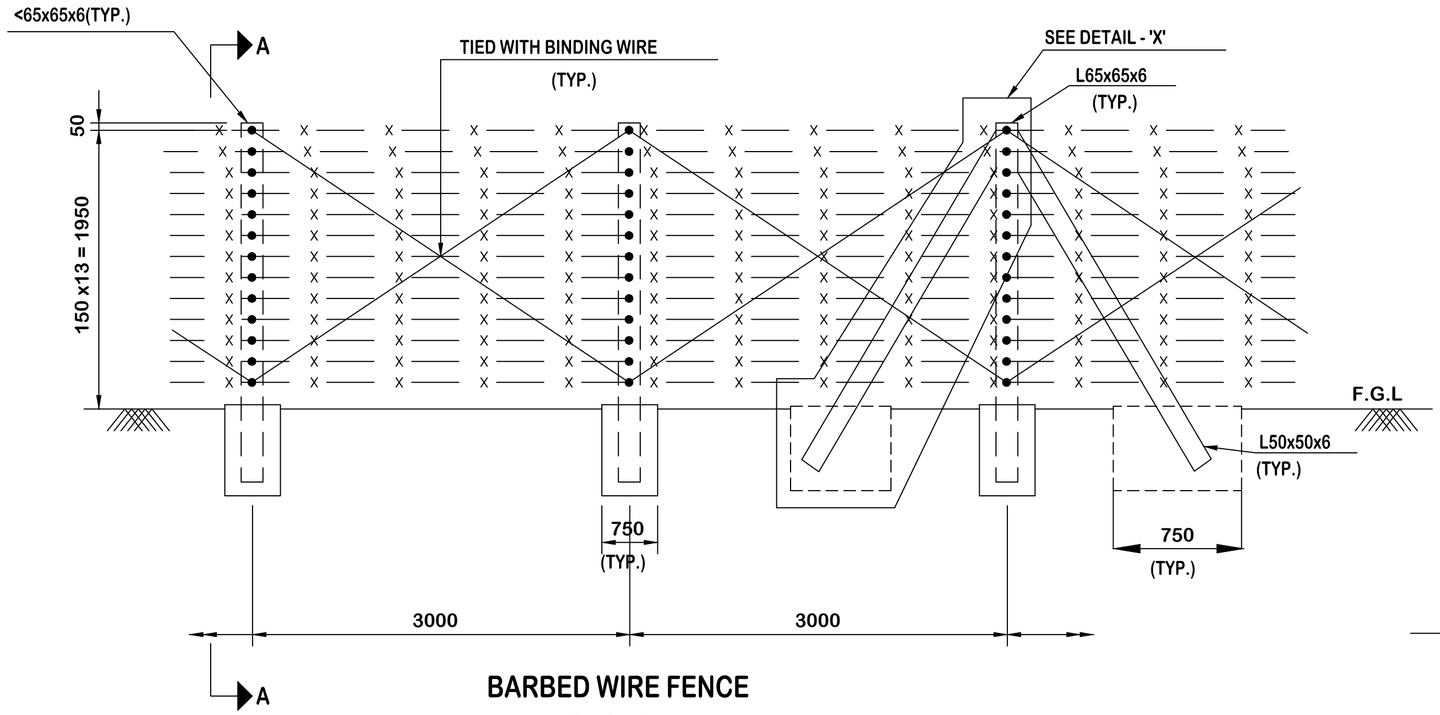
MECON LIMITED

SCALE :

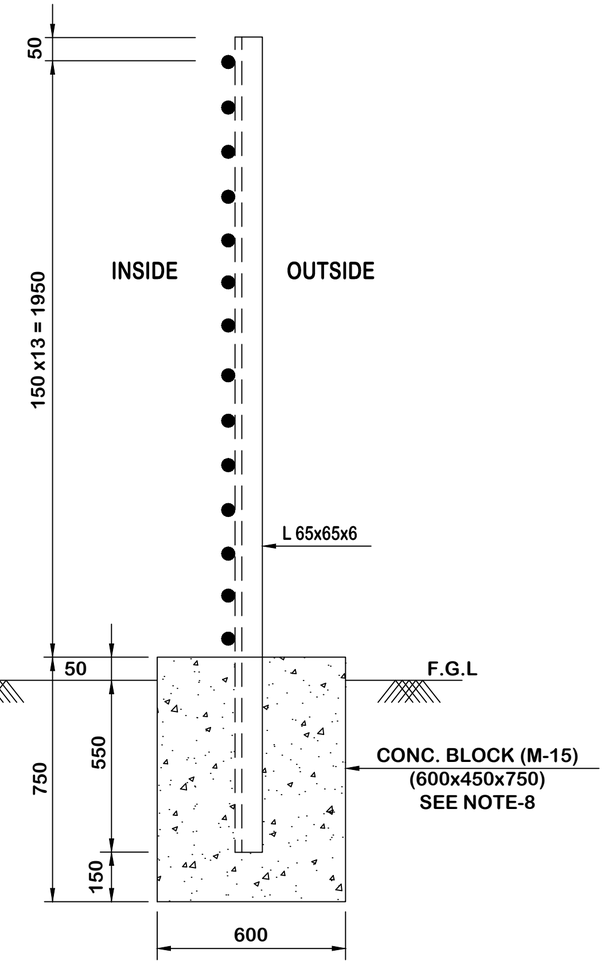
DRG.NO MEC/05/28/23QY/014/01

REV A

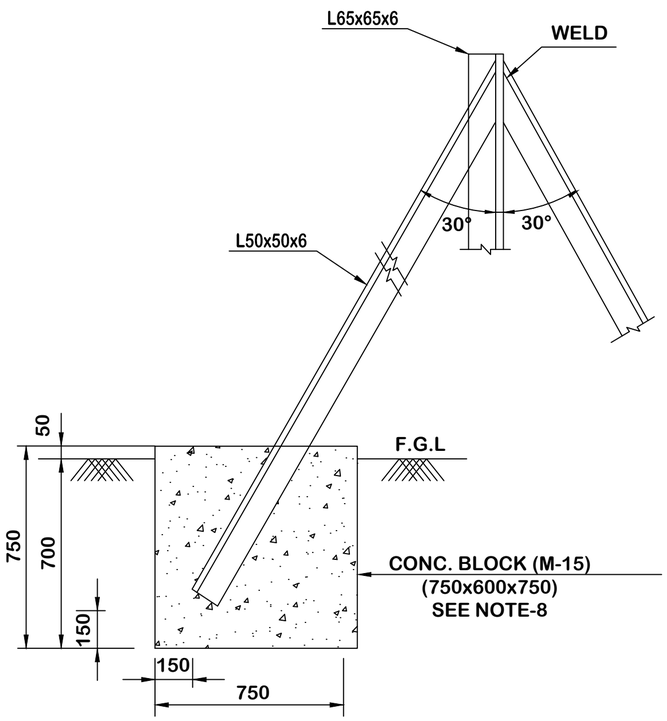
DRG.NO .: MEC/05/28/23QY/014/02



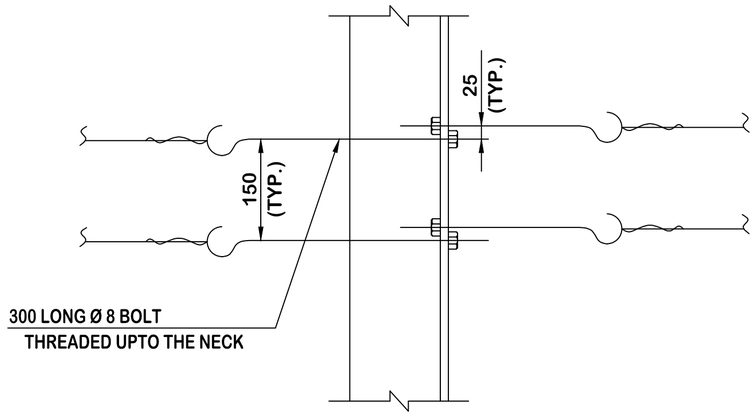
BARBED WIRE FENCE
(OUTSIDE)



SECTION ELEVATION-AA



DETAIL - X



FIXING DETAIL OF STRAINING BOLT WITH POST

NOTES:-

1. ALL DIMENSIONS ARE IN MM.
2. THE GALVANIZED STEELBARBED WIRE SHALL CONFORM TO IS:278 DESIGNATED AS STEEL BARBED WIRE A-1 TO IS:278".
3. LINE POST SHALL BE PLACED AT 3.0M C/C.
4. STRUT SHALL BE PROVIDED AT EVERY 15TH. POST ON BOTH SIDE & END POST ON ONE SIDE.
5. STRAINING BOLTS SHALL BE PROVIDED AT THE END POST & AT PLACES AS DIRECTED BE ENGINEER INCHARGE.
6. EXPOSED FOUNDATION BLOCK AT GROUT LEVEL SHALL BE FINISHED SMOOTH IN CEMENT MORTAR 1:6.
7. GALVANISED BARBED WIRE SHALL BE TIED TO THE ANGLE IRON POST EITHER WITHWELDED M.S. NIBS OR WITH G.I WIRE THROUGH HOLES IN THE POST.
8. GRADE OF CONCRETE SHALL BE M-15 IN GENERAL BUT M-20 FOR AGGRESSIVE SOIL.

REV NO	DATE	ZONE	DESCRIPTION / REVISION	BY	VERIFIED

REFERENCES | DRG.NO.

REV / SEC — CONCURRED BY

GAIL (INDIA) LIMITED

मेकॉन लिमिटेड

MECON LIMITED

SECTION	CIVIL
LOCATION	NEW DELHI
DESIGNED	SACHIN
DRAWN	SUNIL
CHECKED AND VERIFIED	ANIL KUMAR
APPROVED	SIG (R.K.N)
	DATE 01.08.2015

JHPL (PHASE-I) PROJECT

DETAIL OF BARBED WIRE FENCING (WITH ANGLE IRON POST)

SCALE : NTS | SHEET 1 OF 1 | REV 0

DRG.NO .: MEC/05/28/23QY/014/02