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

NORTH -EAST GAS GRID PIPELINE PROJECT

BID DOCUMENT FOR

PROCUREMENT OF BARE / COATED LINE PIPES FOR DULIAJAN FEEDER LINE PROJECT

OPEN DOMESTIC COMPETITIVE BIDDING

GeM Bid No. GEM/2026/B/7527403

Tender Ref. No.: 05/51/E0085/IGGL/012

VOLUME – II OF II

PREPARED AND ISSUED BY
MECON LIMITED
(A Govt. of India Undertaking)
Delhi, India

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MATERIAL REQUISITION

MATERIAL REQUISITION

(MR No.: MEC/E/0085/05/21/M/001/S012A)

PROJECT: DULIAJAN FEEDER LINE PROJECT

CLIENT: INDRADHANUSH GAS GRID LIMITED (IGGL)

TENDER NO.: 05/51/E/0085/IGGL/012

Item: Supply of Coated Carbon Steel Pipes including Engineering, Manufacturing, Inspection, factory testing in accordance with the requirements of this tender:

MR Item No.	Description							Qty. (m)	Manufacturing Process (SAWL/ SAWH/ HFW)	Designated "Place of Delivery of Bare/ Coated Pipe" *
	Line Pipes as per API 5L, PSL-2 (46th edition) and Technical Specifications Nos. MEC/TS/05/21/012, MEC/TS/05/21/012B & MEC/TS/05/21/012C and 3LPE Coating & Internal Epoxy Coating as per Technical Spec. No. MEC/S/05/21/014 & MEC/S/05/21/14 B respectively and Amendment to Tech. Specs.									
	Specified OD Inch (mm)	Specified W.T. (mm)	Ends	Std./ Code	Material Grade	Finish	Min. 3LPE External Coating / Internal Liquid Epoxy Coating Thickness (mm/µm)			
Group I										
1.1	24" (610)	11.13	PE	API 5L	X-70	Coated	3.0/ 100	29,838	Bidder to indicate	SY-01
Group II										
2.1	24" (610)	12.70	PE	API 5L	X-70	Coated	3.0/ 100	156,382	Bidder to indicate	SY-02/ SY-03
Group III										
3.1	24" (610)	12.70	PE	API 5L	X-70	Bare	---	285	SAWL	SY-03
3.2	24" (610)	17.48	PE	API 5L	X-70	Bare	---	89	SAWL	SY-03
Group IV										
4.1	24" (610)	15.88	PE	API 5L	X-70	Coated	3.0/100	2,812	Bidder to indicate (SAWL/ SAWH)	SY-03
4.2	24" (610)	15.88	PE	API 5L	X-70	Bare	---	1,188	SAWL	SY-03

LEGEND

WT = Wall Thickness
PE = Plain End (Ends shall be beveled as per API 5L)

1. Brief of scope are as follows:

(i) **For Group I:**

Manufacturing and Supply of Coated Line Pipes (3LPE External coating & Internal Liquid Epoxy coating), transportation to designated Dumpsites / Storage Yards (SY-01), Development of dumpsites/storage yard including all arrangements and maintenance, but not limited to insurance, documentation, record keeping, making arrangement of cranes, tools and tackles, manpower, power requirement, compliance to the complete dumpsite management, material handling (unloading, stacking and loading of pipes on to trailers of IGGL designated contractor) of all coated lines pipes.

(ii) **For Group II:**

Manufacturing and Supply of Coated Line Pipes (3LPE External coating & Internal Liquid Epoxy coating), transportation to designated Dumpsites / Storage Yards (SY-02 & SY-03), Development of dumpsites/storage yards including all arrangements and maintenance, material handling (unloading, stacking and loading of pipes on to trailers of IGGL designated contractor) of all coated lines pipes.

Pipes to be supplied under Group III (item nos. 3.1 & 3.2) and Group IV (item nos. 4.1 & 4.2) (as detailed at Para (iii) below) shall also be kept in the dumpsite (SY-03), developed & maintained by supplier quoting for Group II.

Unloading of pipes to be supplied under Group III (item nos. 3.1 & 3.2) and Group IV (item nos. 4.1 & 4.2) from trailers at Dumpsite/Storage Yard, stacking, loading on to trailers of IGGL designated contractors, shall be in the scope of Group II successful bidder only.

In addition to similar requirements for Group II, various activities at Dumpsite/ Storage Yard related to pipes supplied under Group III (item nos. 3.1 & 3.2) and Group IV (item nos. 4.1 & 4.2), such as but not limited to insurance, documentation, record keeping, making arrangement of cranes, tools and tackles, manpower, power requirement, compliance to the complete dumpsite management scope etc. as per dumpsite scope requirements shall be in the scope of successful bidder for Group II.

(iii) **For Group III & Group IV:**

Manufacturing and Supply of Coated Pipes including Transportation and handling of Coated Line Pipes till designated Dumpsite/Storage Yard (SY-03) and handing over the pipes at dumpsite to the successful bidder of Group II. Unloading at dumpsites will be under the scope of supplier of Group II.

Important Note:

1. Manufacturing & supply of coated/ bare pipes from pipe mill(s) in India, transportation of all coated/ bare pipes to storage yards including arrangement & maintenance of storage yards.

2. Bidder quoting for Group-I, II, III & IV may quote for any number of groups out of the 4 groups. Bidder must quote for all the items in a particular group and complete quantity against each item in the respective group(s), else bidder's offer shall not be considered for evaluation.

3. Item Nos. 1.1, 2.1 & 4.1 have external & internal coatings.

4. Items Nos. 3.1, 3.2 & 4.2 shall be supplied in bare condition only.

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

6. Color bands of 50 mm width to be placed at both the ends, on outside surface of 3LPE Coated Pipes at a distance of 450 mm from the pipe ends.

7. White Band marking inside for all the items.

8. Yellow, Green, Violet, Pink, Red & Blue Band Marking on outside of each Pipes for Item nos. 1.1, 2.1, 3.1, 3.2, 4.1 & 4.2 respectively, as per instruction given in the MR.

9. Bidder shall submit Pipe Mill Capability Certificate (F-10A) & Coating Plant Capability Certificate (F-13A) as per requirements of this Tender.

10. Raw Material (Steel Plate/ HR Coil) Inspection will be witnessed by Vendor appointed TPIA. TPIA shall issue MTC as per EN 10204-3.2 certification. Vendor shall submit QAP/MPS for procurement of raw material before start of production, to be reviewed under reference category, to MECON/IGGL.

11. Inspection of Pipes & Coating by vendor appointed TPI shall performed as per approved QAP and TPIA shall issue MTC as per EN 10204, 3.2 certification.

12. Sufficient number of qualified inspectors (from approved TPI Agency) shall be appointed by the vendor in order to cover complete scope of inspection detailed in the QAP. In case any inspector does not reflect on a particular day, vendor shall make immediate replacement of the inspector from the same TPI Agency. All cost towards inspection by TPIA, as per scope defined in the approved QAP, shall be borne by the Vendor.

13. Inspection of Pipes & Coating shall also be performed by MECON/IGGL as per approved QAP.

2.0 Proposed Delivery locations shall be as detailed below:-

Details of the proposed Storage Yard (SY)/ Dumpsite locations are as follows:

Item No.	Pipe Dia. (inch) & W.T (mm)	Total Qty. (m)	Progressive delivery from date of FOA (in meters)							
			Lot-1		Lot-2		Lot-3		Lot-4	
			3-4 months (i.e. 4th Month)		4-5 months (i.e. 5th Month)		8-9 months (i.e. 9th Month)		9-10 months (i.e. 10th Month)	
Group-I										
Storage Yard →			SY-01		SY-01					
1.1	24" x 11.13	29,838	12,000		17,838		-	-	-	-
Group-II										
Storage Yard →			SY-02	SY-03	SY-02	SY-03	SY-02	SY-03	SY-02	SY-03
2.1	24" x 12.70	1,56,382	19,000	19,000	20,000	20,000	19,000	19,000	20,000	20,382
Group-III										
Storage Yard →						SY-03				
3.1	24" x 12.70	285	-	-	-	285	-	-	-	-
3.2	24" x 17.48	89	-	-	-	89	-	-	-	-
Group-IV										
Storage Yard →						SY-03				
4.1	24" x 15.88	2812	-	-	-	2812	-	-	-	-
4.2	24" x 15.88	1188	-	-	-	1188	-	-	-	-

Note: IGGL/MECON has the right to revise the priority of pipe required lot wise on particular dumpsite & same will be intimated to the Supplier in advance prior to dispatch. Maximum of 10% of total quantity can be re-allocated between SY-02 and SY-03 without any price implication.

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) Arrangement
of land for Dump Sites adjacent to State highway/ National highway/ Railway approach and near to RoU.

c) Development of Dump Sites as detailed in the Material requirement.

d) Handling, loading and transportation of bare and coated pipes to designated Dump Sites including arrangement & provision of required number of trailers/trucks for transportation including marine/rail transportation if required.

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

f) Management and Maintenance of Dump Sites.

g) Handing over of coated Line pipes to the Pipeline Laying/ Installation agency progressively including loading of pipes on trailers provided by Laying/ Installation agency.

h) 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: -

a) 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 IGGL/ MECON prior approval.

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

c) GAIL is manufacturing 3LPEcompound-PB48A004 and coating contractor can opt for external coating of pipes with GAIL's 3LPEcompound-PB48A004 on the prevailing rate.

e) GAIL's PE-compound can be issued from any place out of the five locations viz. Daman, Silvassa, Dadra, Malanpur (Gwailor) and Ghaziabad. Exact location shall be decided by GAIL at the time of issuing compound material. The transportation of compound material from the place decided by GAIL shall be in the scope of coating contractor.

1.1 Works associated with External & Internal 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 & internal liquid epoxy 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

Top coat – HDPE – 3.0 mm (For 24")

3LPE coating shall be used for buried pipeline sections. The 3LPE coating

system consists of three layers as below:

Layer	**Coating**
Primer	FBE
Mid-coat	Grafted co-polymer Adhesive
Top-coat	High Density/Medium density polyethylene

iii) The pipes shall be furnished with liquid epoxy internal painting conforming to ISO 15741, "Friction reduction coatings for the interior of on and offshore steel pipe lines for non-corrosive gases". The coating material shall typically be two pack epoxy paint.

iv) The minimum dry film thickness shall be 100 micron & extremities of pipes shall be free of painting over a length of 50±5 mm.

v) 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.

vi) 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.

vii) Bidder shall submit the brief product information, application procedure and the Properties of epoxy along with write up with respect to similar earlier jobs performed (to be specified by the supplier).

viii) The coating plant details shall be included in the bid.

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

Bidder will be responsible for maintaining suitable warehouse facilities including preservation, traceability, security and insurance at place as defined in MR. The size of warehouse shall be adequate for storage of maximum quantities.

Note: Chain-age wise village to be indicated later to the successful bidder are approximate and may vary depending on availability of land, which however, has to be acquired & established by Bidder.

The exact quantity to be stacked at each 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 finally selected 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 own dump site (s) near same location corresponding to ordered quantity.

Bidder(s) shall arrange for land for Ware House adjacent to State highway/National highway and near to ROU, adequate to store pipes as per the requirements stipulated and beyond the octroi limit applicability. Bidder shall enter into lease agreement with the various land owners for usage of land adequate as per the Ware House plan. The area of Ware House and number of layers for pipes shall be chosen so as to ensure safe handling of pipes and free movement of trailers. Bidder shall submit the Ware House location and layout plan for MECON/IGGL'S review/approval prior to actual acquisition of land for the said purpose.

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 temporary land acquisition for Ware House, making approach road as required to the Ware House from the nearest main road including compensation to land owner(s) for the approach road, permission for the approach road, etc.

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/IGGL'S approval prior to acquisition of land and commencement of Ware House development works. The area of Ware House shall be chosen so as to ensure safe handling of pipes and free movement of trailors.

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

iii) The 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 rubber sheet 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/IGGL.

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) Dumpsite(s) shall have round the clock security arrangements, moreover a person shall be available at all times at the dumpsite(s) for issue of pipes at any time. Also, contractor to ensure availability of un-interrupted electricity / lighting & necessary arrangements of water.

vi) 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/IGGL including providing security guard etc.

vii) The Storage yards/ Ware House shall be restored to original status before handing over to the land owner. Bidder shall carry out all activities related to restoration. The rates quoted shall include all such aspects.

viii) Bidder shall furnish No Dues/ No Objection certificate from land owner upon handing over the land to its owner after completion of works.

ix) 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 pipes on to the truck/ trailer (arranged by Laying/ Installation Agency) at the Storage yards/ Ware House during handing over as and when required. In case the bidder fails to deploy the cranes/ hydra (with operator, rigger, helper and consumables) within 72 hours of intimation, IGGL/ MECON is free to take the services from another agency at risk & cost of the successful bidder and the amount paid to that agency shall be recovered from RA bill of the bidder.

x) Handing over of all surplus coated pipes to laying contractor/ IGGL at the Storage yards/ Ware House at the end of work as per tender terms stated elsewhere.

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 specified 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**

Inspection shall be in accordance with EN 10204, 3.2 certification by TPIA and shall be issued for each dispatched pipe.

Vendor shall appoint anyone of the TPIA for inspection purpose from the list below. Vendor has to intimate the TPIA name from below listed agencies to IGGL/ MECON prior to perform any inspection activity.

1. Société Générale de Surveillance (SGS)
2. Gulf Lloyds Industrial Services (India) Pvt. Ltd (GLISPL)
3. International Certification Services (ICS)
4. Bureau Veritas (Ind.) Pvt. Ltd (BVIS)
5. DNV GL
6. TUV Rheinland (India) Pvt. Ltd.
7. TÜV SÜD South Asia Pvt. Ltd.
8. TUV India Pvt. Ltd. (TÜV Nord Group)
9. Intertek India Pvt. Ltd.
10. Moody International (India) Pvt. Ltd.
11. RINA India Pvt. Ltd.
12. Tata Projects Ltd.
13. Competent Inspectorate and Consultants LLP
14. Apave TIV India Pvt. Ltd. [formerly known as ABS Industrial Verification (India) Pvt. Ltd.]

In case of any updation in TPIA list, the same shall be intimated to successful bidder.

Apart from inspection by TPIA, Inspection shall also be performed by IGGL 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.

Bidder shall provide separate office along with desktop, furniture for IGGL and MECON/ TPIA personnel for entire duration of the pipe manufacturing/Coating. Office shall have table/ Chair/internet connectivity/stationary/courier and printing facilities for inspection officers for round the clock inspection during pipe manufacturing.

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/ HR Coils

5.1 List of acceptable Steel Plate/HR Coils Manufacturer

The following steel manufacturers are acceptable for the supply of Steel Plates/Coil/Billets 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/Billets 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. JSW Steel Limited, Anjar (earlier Welspun PCMD)
13. Baoshan Iron & Steel Co. Ltd, Shangai, China
14. Arcelor Mittal Nippon Steel India (earlier Essar Steel, India)
15. Jindal Steel & Power Ltd,Angul (up to WT 20.6 mm)
16. Rourkela Steel Plant (SAIL) (up to WT 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. Arcelor Mittal Nippon Steel India (earlier 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 (WT up to 10.3mm)
23. JSW Steel Limited, Dolvi, India (earlier Ispat (WT up to 11.7mm)
24. SAIL, Bokaro,India (WT up to 11.1mm)
25. JSW Steel Limited, Vijayanagar, Bellary, India

26. Tata Steel Limited, Jamshedpur (up to API 5L X-60 & WT up to 9.35 mm)
27. Tata Steel Limited, Kalinganagar (WT up to 16.0 mm)
28. Tata Steel Limited, Meramandali (WT up to 12.7 mm)
29. Inner Mongolia Baotou Steel Union Co. Ltd. China (WT up to 12.8 mm)
30. Baosteel Zhanjiang Iron & Steel Co. Ltd., China (WT up to 12.8 mm)
31. Jindal Steel Power Ltd, Raigarh (up to WT 16.0 mm)
32. Jindal Steel Odisha Ltd. (JSOL) (up to WT 12.7 mm)
33. SAIL, Rourkela Steel Plant, Rourkela (Grade up to API 5L X-70 & WT up to 16.0 mm)

Legend WT: Wall Thickness

5.2 In case bidder proposes steel plate/coil manufacturer(s) not covered in the above list, then the proposed steel plates/ coils manufacturer must meet the following criteria:

5.3 Steel plate/coil manufacturer(s) must have manufactured and supplied in a single order, at least 5000 MT steel plate/coil for the production of line pipes conforming to API 5L (PSL-2) of the same or higher grade as quoted for in the last seven (07) years from the bid due date.

5.4 The steel plate/coil manufacturer have manufactured plate/coils conforming to API 5L (PSL-2) of same or higher wall thickness as quoted for in the last seven (07) years from the bid due date.

5.5 The steel plate/coil manufacturer must have manufactured plate/coils conforming to API 5L (PSL-2) which are equal or higher in terms of plate width as quoted for in case of SAWL option.

5.6 A letter of commitment from proposed steel plate/coil manufacturer for supply of steel plates/coils required from two (2) manufacturers for the manufacture of line pipes under present bid.

5.7 Confirmation regarding compliance with applicable requirements for steel plates/coils specified in Technical Specifications/ Material Requisition of this Bid Document from the proposed steel manufacture shall be furnished.

Pipe Manufacturer must submit the track record, along with bid, in duly filled up "Annexure A" with documentary evidence (of steel plate/Coil manufacturer) to establish the above qualification criteria indicated above at clause No.5.3,5.4,5.5,5.6 & 5.7 Such as Purchase order/work order, inspection release4 note/completion certificate of relevant previous supplies

In the absence of such documentary evidence, Owner/ Consultant reserve the right to reject the bid without making any reference to the bidder.

5.8 Bidder to note that steel plate/coil manufacturer shall be qualified at bid stage only.

5.9 The techno commercially qualified bidder(s) will be informed prior to price bid opening on acceptance of the proposed steel plate /coil manufacturer(s), if any.

5.10 Bidder's offer shall be unconditional irrespective of the finally qualified steel plate /coils manufacturer(s).

5.11 Steel Mill qualified for one bidder during bidding stage shall be considered qualified for other bidders also. The list of all acceptable steel manufacturers shall be communicated to all qualified bidders.

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 "**E/0085"**

Item is COAT (coated - 3LPE & IE)

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 IGGL/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 IGGL/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	2	2 weeks +weekly	2	2 weeks after approval
2	Fabrication//Rolling, test and delivery schedule (per item)	FTD	1	2	2 weeks +weekly	2	1 within weeks
3	Progress report	PRT		2	Daily +weekly		Daily +weekly
4	Catalogues / References	CRS	1				
5	Code compliance certificate	CCC		2	2 weeks	2	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	2	Within 2 weeks		1 week after approval + with final techn. file
7	QA/QC program	QAP	1	2	2 weeks	2	
8	Inspection and test procedure	ITP	1	2	2 weeks	2	

Item	Documents and Data	Document Index No.	A	B		C	
			No. of copies	No. of copies	Required date	No. of copies	Required date
9	NDE reports	NDR		2	When available	2	1 week after approval + with final techn. file
10	Hydro-test report	HTR		2	When available	2	2 weeks after approval + with final techn. file
11	List of subcontractors with their scope	LSS		2	2 weeks		With final tech.. file
12	Copy of purchase orders to subcontractors	CPS		2	2 weeks		With final tech.. file
13	Copy of purchase order	CPO					With final techn. file
14	Packing/shipping list w/weights and dimensions	PSD		2	2 weeks	2	2 weeks before shipping
15	Final technical file	FTF				Hard Copy- 2 Set & Soft copy- 4 Set in Pen Drive	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 weeks after test

3) Final technical file shall be supplied in hard copy- 2 set as indicated, and in electronic format (.pdf Acrobat files) on four (4) Flash Drives/ HDDs.

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

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

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

AMENDMENT STATUS

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

Abbreviations:

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

CONTENTS

1 SCOPE

This specification establishes the minimum requirements for the manufacture of high frequency welded steel line pipe in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty-Fifth Edition, 2012 and makes restrictive amendments to API Specification 5L. Unless modified and/or deleted by this specification, the requirements of API Specification 5L shall remain applicable.

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

The coverage by this specification is limited to line pipe to be used in onshore pipelines transporting non-sour hydrocarbons in liquid or gaseous phase. The product specification level for line pipe to be supplied as per this specification shall be "PSL 2".

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

1.1 (New) Pipe Size

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

1.2 (New) Grades

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

3 NORMATIVE REFERENCES

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

ASTM

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

BS

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

6 PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

6.1 Pipe grade and steel grade

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

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

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

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

6.2 Delivery condition

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

8 MANUFACTURING

8.1 Process of Manufacture

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

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

Table 3 - Acceptable manufacturing routes for PSL 2 pipe

Type of pipe	Starting Material	Pipe forming	Pipe heat treatment	Delivery condition
HFW	Thermo mechanical-rolled coil	Cold forming	Heat treating[a] of weld area only	M
a See clause 8.8 of this specification for applicable heat treatment				

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

- Welding Temperature
- Welding speed
- Current and Voltage

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

8.3 Starting Material

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

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

8.8 Treatment of weld seams in EW pipes

8.8.2 **PSL 2 HFW pipe**

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

8.9 Cold sizing and cold expansion

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

8.11 Jointers

8.11.1 Jointers on pipes are not permitted.

9 ACCEPTANCE CRITERIA

9.2 Chemical composition

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

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

Table 5 - Chemical composition for pipe

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

Notes to Table 5:

a	Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the CE_{Pcm} limits apply if C ≤ 0.12% and CE_{IIW} limits apply if C > 0.12%. For pipes of all grades, sizes and wall thicknesses, Carbon Equivalent shall comply with the following limits: $CE_{Pcm} \leq 0.23$ $CE_{IIW} \leq 0.43$ 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 (after all heat treatment & sizing operations) shall conform to the requirements of Table 7 of API Spec 5L and as modified herein.

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

API Spec 5L Grade	Permissible inexcess of SMYS. MPa (psi)
Up to and including X46M	131 (19,000)
X52M to X60M	125 (18,000)
X65M to X70M	120 (17,400)
X80M	120 (17,400)

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

The tensile strength of the weld (after heat treatment of the weld seam) shall be equal to or higher than the specified minimum tensile strength of the base metal.

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

9.6 Flattening test

Acceptance criteria for flattening tests shall be as follows:

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

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

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

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

9.8 CVN impact test for PSL 2pipe

9.8.1 **General**

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

9.8.2 **Pipe body tests**

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

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

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

Pipe Grade	Full-size CVN absorbed energy (K_vT) [a, b] [J]	
	Average	*Minimum*
BM	40	32
X42M	40	32
X46M & X52M	40	32
X56M & X60M	40	32
X65M	41	33
X70M	55	44
X80M	80	64

a) The required K_vL (longitudinal direction test pieces) values shall be 50% higher than the required KvT values.
b) Testing shall be performed at a test temperature of 0°C (32°F) or at a lower temperature as specified in the Purchase Order.

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

9.8.3 **Pipe weld and HAZ tests**
9.8.4

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

9.10 Surface conditions, imperfections and defects

9.10.1 General

9.10.1.2 All pipes shall be free from cracks, sweats, leaks and slivers. Pipe containing such defects shall be treated in accordance with clause C.3 of this specification.

9.10.3 Arc burns

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

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

9.10.4 Laminations

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

9.10.5 Geometric deviations

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

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

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

9.10.6 **Hard Spots**

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

9.10.7 **Other surface imperfection**

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

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

b) Imperfections that have a depth > 0.05 *t* and do not encroach on the minimum permissible wall thickness shall be classified as defects, and shall be dressed-out by grinding in accordance with Clause C.2 of API Spec 5L and as modified in this specification or shall be treated in accordance with Clause C.3 of this specification.

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

9.11 Dimensions, mass and tolerances

9.11.3 Tolerances for diameter, wall thickness, length and straightness

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

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

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

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

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

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

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

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

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

9.11.3.4 The tolerances for straightness shall be as follows:

a) The total deviation from a straight line over the entire pipe length shall not exceed 12 mm, as shown in Figure 1 of API Spec 5L.

b) The local deviation from straight line in 1.0 m (3.0 ft) portion at each pipe end shall be ≤ 3.0 mm (0.120 in), as shown in Figure 2 of API Spec 5L.

9.12 Finish of pipe ends

9.12.5 Plain ends

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

9.12.5.7 (New) **Bevel Protectors**

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

9.16 (New) **Reverse Bend Test**

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

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

10 INSPECTION

10.1 Types of inspection andinspection documents

10.1.3 Inspection documents for PSL 2pipes

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

10.2 Specific inspection

10.2.1 **Inspection frequency**

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

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

Table 18 - Inspection frequency of pipe

Sl. no.	Type of inspection	Frequency of inspection
1.	Heat analysis [a]	One analysis per heat of steel
2.	Product analysis [b]	Two pipes per lot (maximum 100 pipes) per heat
3.	Tensile testing of the pipe body	Two pipes per test unit of not more than 100 pipes per heat
4.	Tensile testing of the longitudinal weld seam of pipe [c]	Two pipes per test unit of not more than 100 pipes per heat
5.	CVN impact testing of the pipe body	One set of three transverse specimen per test unit of not more than 50 pipes per heat
6.	CVN impact testing of the weld and HAZ of pipe [c]	One set of three transverse specimen per test unit of not more than 50 pipes per heat
7.	Flattening test of pipe	As shown in Figure 6 a) of API Spec 5L
8.	Reverse Bend Test (New)	Same as Figure 6 a) of API Spec 5L
9.	Hardness testing	Any hard spot exceeding 50 mm (2.0 in) in any direction
10.	Hydrostatic testing	Each pipe
11.	Weighing of pipe	Each pipe shall be measured and recorded
12.	Wall thickness measurement [d]	Each pipe
13.	Pipe diameter and out-of- roundness [d]	Each pipe
14.	Length	Each length of pipe shall be measured and recorded
15.	Straightness [d]	Each pipe
16.	Tolerances for the weld seam [d] a) Radial offset of coil edges b) Height of flash and c) Depth of groove after trimming of inside flash	Each pipe

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

a) Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of pipe production.
b) Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented.
c) Pipe produced by each welding machine shall be tested at least once per week,
d) Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum),
e) "Test unit" is as defined in clause 4.62 of API Spec 5L.

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

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E 1806. Samples used for product analysis shall be taken from finished pipes only.

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

10.2.3.1 **General**

In addition to API Spec 5L requirements, samples and test pieces for various types of tests shall be taken from Figure 5 b) and Figure 6 a) of API Spec 5L and Figure 10.2.4.9.1 & 10.2.5.3.2 of this specification, whichever is applicable, and as given in Table 20 of this specification.

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

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

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

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

10.2.3.2 **Test pieces for the tensile test**

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

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

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

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

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

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

The test pieces shall be prepared in accordance with ASTM A370. Non-flattened test pieces shall be used. The axis of the notch shall be perpendicular to the pipe surface.

Charpy V-notch impact testing shall be performed on full-sized test pieces. However, if preparation of full size test piece is not possible, then standard sub-sized test pieces shall be prepared as per ASTM A370. In case of 4½" (114.3mm) OD line pipe, if preparation of standard sub-sized test piece as per ASTM A370 is not possible, CVN impact testing with transverse test specimen may not be carried out.

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

10.2.3.7 **Test pieces for flattening test**

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

Minor surface imperfections may be removed by grinding.

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

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

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

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

10.2.4 **Test methods**

10.2.4.3 **CVN impact test**

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

10.2.4.7 **Flattening test**

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

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

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

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

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

Selection of Mandrel

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

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

Where,

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

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

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

10.2.5 **Macrographic and metallographic tests**

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

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248HV_{10} for grades BM through X70M and not exceed 285 HV_{10} for grade X80M. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80HV_{10}. Modalities of retest shall be in accordance with clause 10.2.12.7 of API Spec 5L.

10.2.6 **Hydrostatic test**

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

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

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

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

10.2.7 **Visual inspection**

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

10.2.8 **Dimensional testing**

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

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

10.2.10 **Non-destructive inspection**

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

10.2.11 Reprocessing

This clause of API Spec 5L stands cancelled.

10.2.12 (New) Retesting

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

10.2.12.1 Recheck analyses

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

10.2.12.9 Reverse bend retests

Reverse bend retest provisions shall be same as specified for retests in clause 10.2.12 of this specification.

11 MARKING

11.1 General

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

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

11.2 Pipe markings

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

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

11.2.3 The pipe number shall be placed by cold rolling or low stress dot marking on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of no availability of either cold rolling or low stress dot marking facility in pipe mill, an alternative marking scheme of a permanent nature may be proposed by the Manufacturer.

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

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

12 COATINGS AND THREAD PROTECTORS

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

13 RETENTION OF RECORDS

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

14 PRODUCTION REPORT
(New)

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

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

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

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

The certificates shall be valid only when signed by the Purchaser's Representative. Only those pipes, which have been certified by the Purchaser's Representative, shall be dispatched from the pipe mill.
In the event of small quantities of pipes supplied against this specification, the production report may consist of only test certificates required as per clause 10.1.3 of API Spec 5L and as modified herein and other test reports/results required as per this specification.

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

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

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

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

16 **Pipe Loading**
(New)

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

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

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

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

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

Annex B

Manufacturing Procedure Qualification for PSL 2 Pipe

B.1 INTRODUCTION

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

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

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

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

Note: In the event of small quantities of pipes ordered against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the manufacturing procedure qualification test as per clause B.5.1 of this specification shall not be carried out. Pipes in such case shall be accepted based on regular production tests. However, waiver of MPQT for any item shall be specifically as per instruction in Material Requisition (MR).

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION

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

B.5 MANUFACTURINGPROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

a. **Visual Examination**

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

b. **Ultrasonic Examination**

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

c. **Mechanical Properties**

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

The following tests shall be conducted:

i. **Flattening test**

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

ii. **Tensile test**

Tensile tests shall be conducted on:

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

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

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

iii. **Metallographic tests**

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

iv. **CVN impact testing**

CVN impact test shall be performed on test pieces extracted as follows:
- Four sets of three (3) transverse test pieces each from base metal
- One set of three (3) transverse test pieces with weld in middle
- One set of three (3) transverse test pieces with HAZ in middle

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

v. **Fracture toughness testing**

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

d. Burst Test (New)

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

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

Annex C

Treatment of surface imperfections and defects

C.I TREATMENT OF SURFACE IMPERFECTIONS

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

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

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

C.3 TREATMENT OF NON-DRESSABLE SURFACE DEFECT

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

a) Deleted

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

c) The entire pipe length shall be rejected.

Annex E
Non-destructive inspection for other than sour service or offshore service

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

E. 1 QUALIFICATION OF PERSONNEL

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

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

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

(i) For UT

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

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

(ii) For all other NDT methods

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

E.3 METHODS OF INSPECTION

E.3.1 **General**

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

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

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

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

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

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

E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION

E.5.1 **Equipment**

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

E.5.2 Ultrasonic and electromagneticinspection reference standards

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

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

E.5.2.3 **Reference standards**

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

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

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

Table E.7 — Reference indicators

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

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

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

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

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

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

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

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

E.5.3 **Instrument standardization**

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

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

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

E. 5.5 **Acceptance limits**

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

a) Locations showing indications above the acceptance limits during automatic

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

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

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

E.7 RESIDUAL MAGNETISM

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

E.10 DISPOSITION OF PIPES CONTAINING DEFECTS

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

E.11 ROTARY ULTRASONIC INSPECTION OF PIPE (ALTERNATIVE METHOD)

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

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

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

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

Annex Q (New)

Purchaser Inspection

Q.1 INSPECTION NOTICE

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

Q.2 PLANT ACCESS

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

Q.3 COMPLIANCE

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

Q.4 REJECTION

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

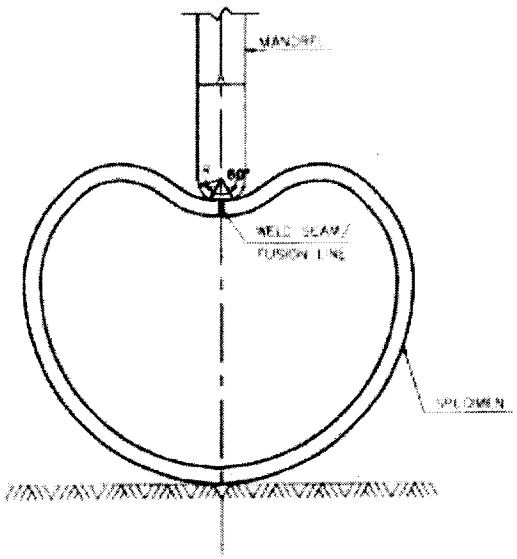


FIGURE: 10.2.4.9.1

REVERSE BEND TEST

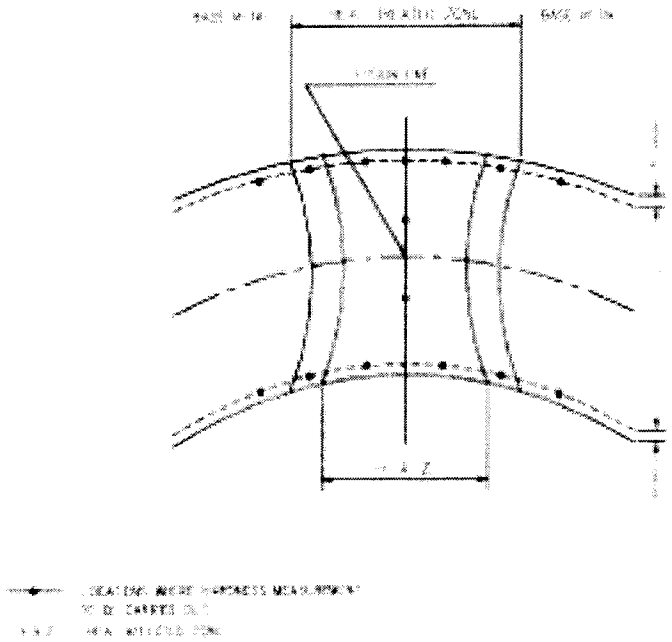
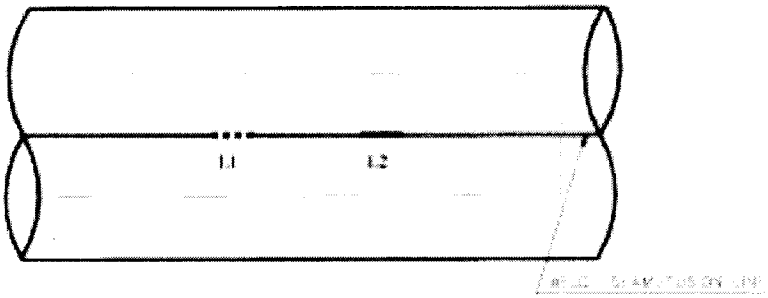


FIGURE: 10.1.5.3

METALLOGRAPHIC SPECIMEN AND LOCATIONS FOR HARDNESS MEASUREMENT



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

FIGURE: E.1

REFERENCE STANDARD FOR UT OF LONGITUDINAL WELD SEAM

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 EI806. Samples used for product analysis shall be taken from finished pipes only.

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

10.2.3.1 General

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

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

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

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

10.2.3.2 Test pieces for the tensile test

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

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

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

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

10.2.3.3 Test pieces for the CVN impact test

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

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

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

10.2.3.4 Test pieces for the DWT test

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

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

10.2.3.8 Test pieces for Macrographic and metallographic tests
(New)

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

10.2.4 Test methods

10.2.4.3 CVN impact test

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

10.2.4.4 Drop-weight tear test

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

10.2.4.6 Guided-bend test

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

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

10.2.5 **Macrographic and metallographic tests**

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

Vickers hardness tests shall be carried out on each test piece taken for metallographic examination in accordance with ISO 6507-1, at locations indicated in Fig. 10.2.5.3.2 of this specification. Indentation in the HAZ shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 HV_{10} for grades BM through X70M and not exceed 285 HV_{10} for grade X80M. Modalities of retest shall be in accordance with clause 10.2.12.7 of API Spec 5L.

10.2.6 **Hydrostatic test**

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

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

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

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

10.2.7 **Visual inspection**

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

10.2.8 **Dimensional testing**

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

10.2.10 Non-destructive inspection

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

10.2.11 Reprocessing

This clause of API Spec 5L stands cancelled.

10.2.12 Retesting

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

10.2.12.1 Recheck analyses

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

11 MARKING

11.1 General

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

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

11.2 Pipe markings

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

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

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

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

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

12 COATINGS AND THREAD PROTECTORS

12.1.1 Unless otherwise specified in the Purchase Order, the pipes shall be delivered bare,

free of any trace of oil, stain, grease and paint. Varnish coating shall be applied on the marking area. Bevels shall be free of any coating.

13 RETENTION OF RECORDS

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

14 PRODUCTION REPORT
(New)

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

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

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

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

The certificates shall be valid only when signed by the Purchaser's Representative. Only those pipes, which have been certified by the Purchaser's Representative, shall be dispatched from the pipe mill.
In the event of small quantities of pipes supplied against this specification, the production report may consist of only test certificates required as per clause 10.1.3 of

API Spec 5L and as modified herein and other test reports/results required as per this specification.

15 (New) Online Pipe Tracking Data

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

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

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

16 (New) Pipe Loading

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

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

17 (New) INSPECTION OF FIELD TESTS & WARRANTY

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

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

Annex B

Manufacturing Procedure Qualification for PSL 2 Pipe

B.1 INTRODUCTION

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

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

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

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

Note: In the event of small quantities of pipes ordered against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the manufacturing procedure qualification test as per clause B.5.1 of this specification shall not be carried out. Pipes in such case shall be accepted based on regular production tests. However, waiver of MPQT for any item shall be specifically as per instruction in the Material Requisition (MR).

B.3 CHARACTERISTICS OF THEMANUFACTURINGPROCEDURE SPECIFICATION

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

B.5 MANUFACTURINGPROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

a. Visual Examination

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

b. Ultrasonic Examination

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

c. Radiographic Examination

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

d. Mechanical Properties

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

The following tests shall be conducted:

i. Guided bend test

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

ii. Tensile test

Tensile tests shall be conducted on:

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

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

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

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

iii. Metallographic tests

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

iv. CVN impact testing

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

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

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

v. Fracture toughness testing

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

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

e. Burst Test (New)

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

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

Annex C

Treatment of surface imperfections and defects

C.1 TREATMENT OF SURFACE IMPERFECTIONS

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

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

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

C.4 REPAIR OF DEFECTS BY WELDING

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

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

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

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

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

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

Annex-D

Repair Welding Procedure

D.2 REPAIR WELDING PROCEDURE QUALIFICATION

D.2.3 **Mechanical Testing**

D.2.3.2 **Transverse Tensile Test**

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

D.2.3.3 **Transverse Guided bend test**

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

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

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

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

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

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

Annex E

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

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

E.1 QUALIFICATION OF PERSONNEL

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

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

Inspector Qualification

Acceptable qualification for NDT inspectors shall be as specified below:

(i) For UT

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

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

(ii) For all other NDT methods

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

E.3 METHODS OF INSPECTION

E.3.1 **General**

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

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

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

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

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

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

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

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

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

E.4 RADIOGRAPHIC INSPECTION OF WELD SEAMS

E.4.2 Radiological Inspection Equipment

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

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

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

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

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

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

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

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

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

E.5 **ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1 **Equipment**

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

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

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

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

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

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

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

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

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

Table E.7 — Reference indicators

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

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

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

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

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

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

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

E.5.3 **Instrument standardization**

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

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

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

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

E.5.5 **Acceptance limits**

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

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

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

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

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

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

E.7 RESIDUAL MAGNETISM

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

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

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

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

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

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

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

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

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

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

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

per clause E.5.6 of this specification.

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

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

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

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

E. 10 DISPOSITION OF PIPES CONTAINING DEFECTS

The repaired area shall be 100% rechecked by magnetic particle or ultrasonic inspection to ensure complete removal of defects. However for repair of cosmetic type of defects, MP1 may not be conducted if so directed by Purchaser's Representative on case to case basis. The pipes having a thickness less than the minimum allowed in accordance with this specification, after repair by grinding shall be treated for disposition in accordance with (e) or (f) of E.10 of API Spec 5L.

Annex Q (New)

Purchaser Inspection

Q.1 INSPECTION NOTICE

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

Q.2 PLANT ACCESS

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

Q.3 COMPLIANCE

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

Q.4 REJECTION

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

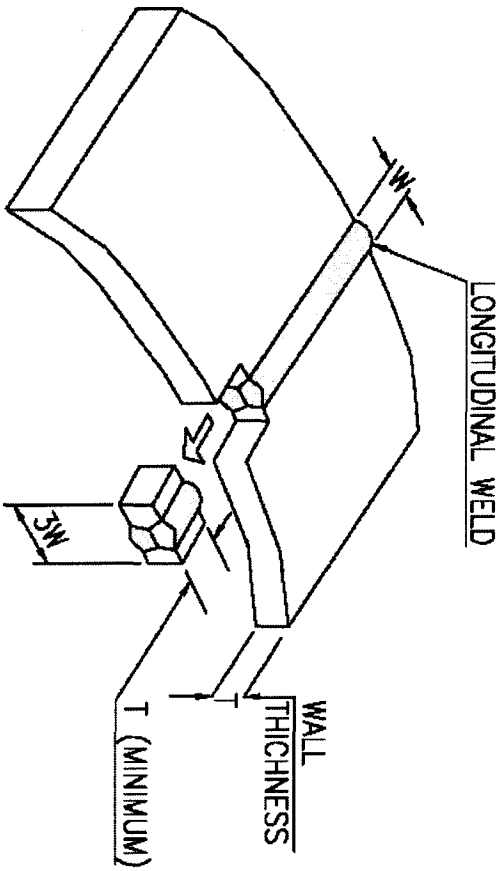
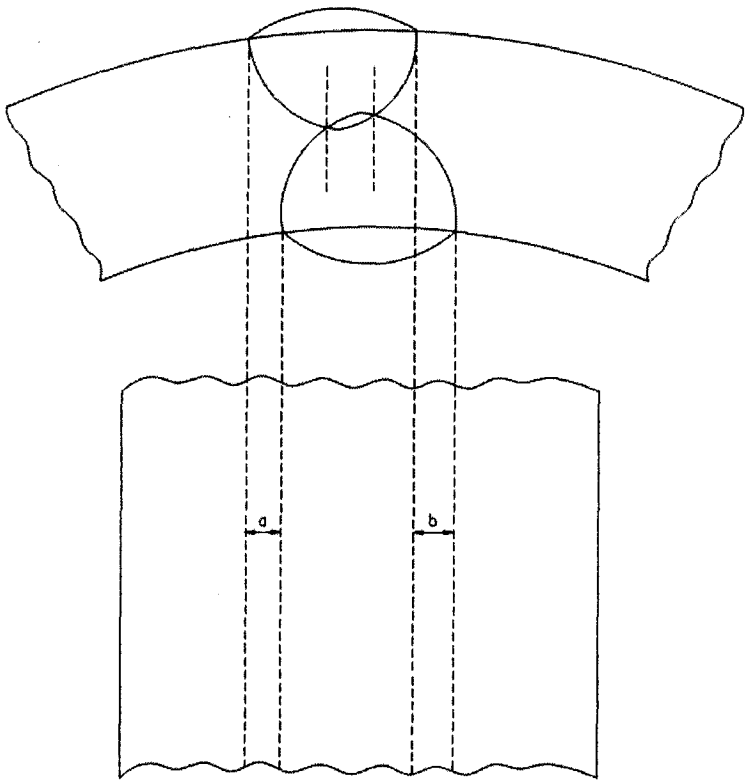
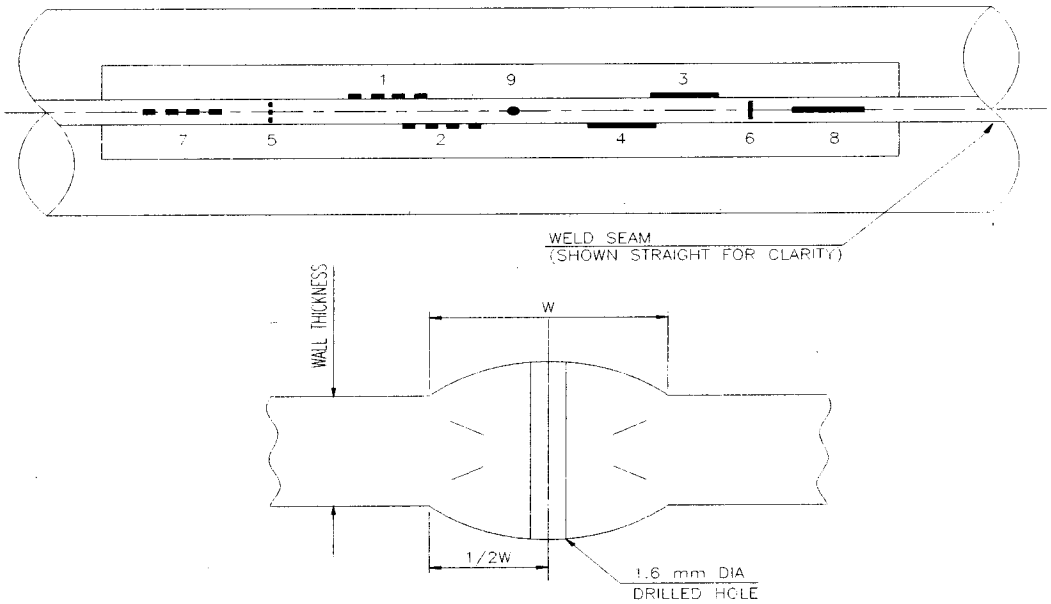


FIGURE 10.2.5.3.1

METALLOGRAPHIC SPECIMEN EXTRACTION PLAN



X-RAY FILM
PROCEDURE FOR MEASUREMENT OF OUT OF LINE WELD 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 (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 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.

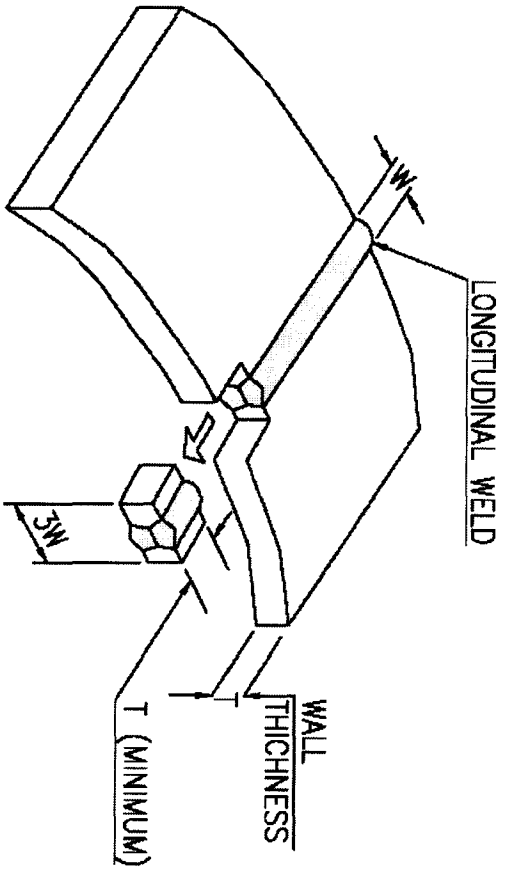
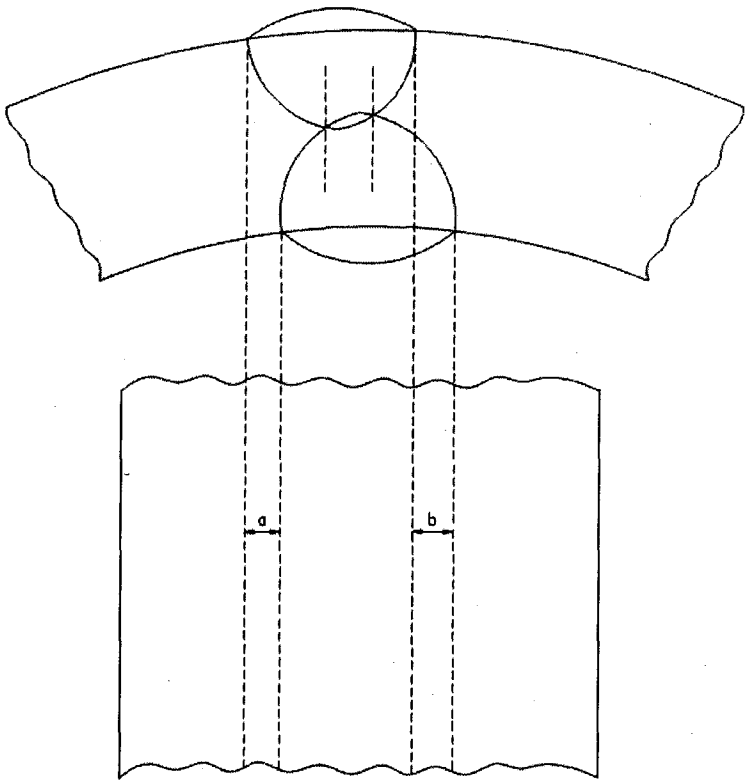
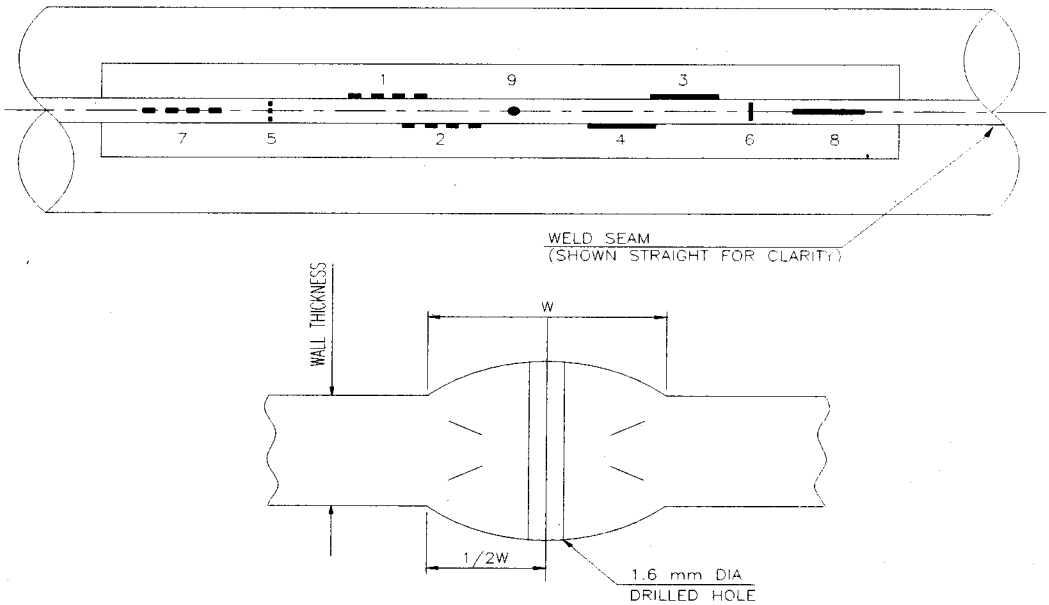


FIGURE 10.2.5.8.1

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. : 1
Edition : 2

SPECIFICATION
FOR
3-LAYER POLYETHYLENE COATING OF LINEPIPES

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Sachin Kumar, Mgr.)	(Sachin Singhal, Sr. Mgr.)	(K. P. Singh, GM)	June 2020

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 ISO 21809-1: 2018, `Petroleum and Natural, Gas Industries – External Coatings for Buried or Submerged Pipelines used in Pipeline Transportation System – Part 1: Polyolefin Coatings' and the requirements of this specification.

2.0 REFERENCE DOCUMENTS

2.1 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.

- ISO 21809-1: 2011 : Petroleum and Natural, Gas Industries – External Coatings for Buried or Submerged Pipelines used in Pipeline Transportation System – Part 1: Polyolefin Coatings.
- ASTM D-149 : Standard Test Methods of Dielectric Breakdown voltage and Dielectric strength of solid electrical insulating materials at commercial frequencies.
- ASTM D-257 : Standard Test Methods for D-C Resistance or conductance of insulating materials.
- ISO 15512 : Plastics – Determination of water content.
- ISO 527-2 : Plastics —Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.
- ISO 527-3 : Plastics —Determination of tensile properties — Part 3: Test conditions for films and sheets.
- ASTM D-792 : Standard Test Method of Specific Gravity and Density of Plastics by Displacement.
- ASTM D-1238 : Test Method for Flow Rate of Thermoplastics by Extrusion.
- ISO 306 : Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)
- ASTM D-1603 : Test Method for Carbon Black in Olefin Plastics.

•	ASTM D-1693 of Ethylene Plastics.	:	Test Method for Environmental Stress Cracking
•	ISO 868	:	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness).
•	API RP 5L1	:	Recommended Practice for Railroad Transportation of Linepipe.
•	API RP 5LW	:	Transportation of Line Pipe on barges and marine vessels.
•	API RP 5LT	:	Recommended Practice for Truck Transportation of Line Pipe.
•	DIN EN 10204	:	Metallic Products – Types of Inspection Documents.
•	ISO 1133	:	Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.
o	ISO 8501-1:	:	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
•	ISO 8502-3	:	Preparation of Steel Substrates before Application of Paints and Related Products – Part-3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method).
•	ISO 11124	:	Preparation of Steel Substrates Before Application of Paints and Related Products.
•	ISO 11357	:	Plastics — Differential scanning calorimetry (DSC)
•	APL 5L	:	Specification for Line Pipe
•	ASME B 31.8	:	Gas Transmission and Distribution Piping Systems
o	ASME B 31.4	:	Liquid Transportation systems for Hydrocarbons, Liquid petroleum Gas Anhydrous ammonia and Alcohols

2.2 The Applicator 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.

2.3 In case of conflict between the requirements of this specification, ISO 21809 —1 and the codes, standards and specifications referred in clause 2.1 above, requirements of this specification shall govern.

3.0 PLANT SCALE AND INSTALLATION

3.1 Applicator shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), both new and 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 Applicator 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 at least meet the job requirements of quality and production. Worn out and improvised plants are not acceptable.

3.3 The Applicator 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, Applicator 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 Plant shall have pipe internal blow-out and debris collection system to remove loose scale dirt and abrasive from the pipe interior.

3.5 The air used for the fluidization of epoxy powder shall be free from moisture. For this purpose dehumidifiers and/ or air dryer, as necessary shall be provided along with necessary monitoring and control system. Fluidized bed shall have magnets adequate to remove iron and steel shaving contaminant from recycled powder.

3.6 Applicator 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.

3.7 Applicator 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.

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

3.9 The Applicator 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 COATING CLASSIFICATION

4.1 General

The three layer coating as per this specification shall correspond to coating Class B of ISO 21809-1: 2018 and shall be suitable for design temperature range of (—) 29 °C to (+) 80 °C.

4.2 Coating thickness

Minimum overall thickness of finished coating shall be as per Table 1 below:

Table 1— Minimum thickness of finished coating

Pipe Size (Specified Outside Diameter)	Minimum Coating Thickness (mm)	
	Standard	Severe
≤10 ¾" (273.1 mm)	2.5	3.2
≥12 ¾" (323.9 mm) to ≤18" (457 mm)	2.8	3.5
≥20" (508.0 mm) to ≤30" (762 mm)	3.0	3.7
≥32" (813.0 mm)	3.5	4.2

All coating thickness readings must meet the minimum requirements. However, localized 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 5 cm^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.

5.0 MATERIALS

5.1 The three layer coating system shall comprise of a powder epoxy primer, grafted co-polymeric adhesive and a high density polyethylene (HDPE) topcoat. 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. Applicator shall obtain prior approval from COMPANY for the coating system and coating of all materials.

5.2 The coating materials Manufacturer shall carry out tests for all properties specified in Table 2, Table 3 & Table 4 for each batch of epoxy, adhesive and polyethylene compound respectively. 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, 3.1 for each batch of materials supplied to Applicator and the same shall be submitted to COMPANY for approval prior to their use.

5.2.1 **Properties of Epoxy Powder**

The colour of epoxy powder shall be either green or dark red or any other colour approved by COMPANY except grey colour.
Epoxy properties shall meet the properties listed in Table 2 below:

Table 2 — Epoxy properties

Sl.No.	Properties	Unit	Requirement	Test Method
Raw Material				
1.	Density	g/cm³	Within ± 0.05 of the manufacturer's specified nominal value	ISO 21809-1 Annex M
2.	Gel time at 205° C ± 3° C	s	Within 20% of the nominal value specified by the manufacturer	ISO 21809-1 Annex J
3.	Particle size	–	Within manufacturer's specification	ISO 21809-2 Annex A.6
4.	Moisture Content	% mass	≤ 0.5	ISO 21809-1 Annex K
5.	Minimum glass transition temperature (Tg_2)	°C	≥ 95 and within manufacturer's specification	ISO 21809-1 Annex D
6.	Infrared scan	%transmittance	As per manufacturer's specification	—
As Applied				
7.	Hot water adhesion 24 *h@65* °C	–	Rating of 1 to 2	ISO 21809-2, Clause A.16
8.	Hot water adhesion 28 *d* @ 65 °C (*)	–	Rating of 1 to 3	ISO 21809-2, Clause A.16
9.	Flexibility at 0 °C	–	No cracking, tears, disbondment or delamination at 2.0° ppd length	ISO 21809-2, Clause A.13
10.	Impact resistance at 0 °C	J	≥ 1.5	ISO 21809-2, Clause A.14

(*) In case the raw material manufacturer produces batch report for Hot water adhesion test of epoxy as under testing, in that case coating applicator shall produce to the company the final results just after completion of 28 days of the test start date.

5.2.2 **Properties of Adhesive Material**

Grafted Co-polymeric adhesive material shall meet the properties listed in Table 3 below:

Table 3 — Grafted Co-Polymeric Adhesive material properties

SI.No	Properties	Unit	Requirement	Test Method
Raw Material				
1.	Density	g/cm^3	≥ 0.93 and within manufacturer's specification	ISO 1183
2.	Melt flow rate	g/10 minutes	≥ 1.0 and within manufacturer's specification	ISO 1133
3.	Water Content	%	≤ 0.1	ISO 15512
As nApplied				
4.	Elongation at break at 23°C±2°C	%	≥ 600	ISO 527-2
5.	Tensile yield strength at 23°C ± 2 °C	MPa	≥ 8	ISO 527-2
6.	Vicat softening temperature A/50 (9.8 N)	°C	≥ 100	ISO 306
7.	Flexural Modulus	MPa	≥ 350	ASTM D790

5.2.3 **Properties of Polyethylene Compound**

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 up to +80° C). No visible changes shall occur during exposure to such environments up to at least a period of 8500 hours. The Applicator shall submit certificate from Manufacturer in this regard.

PE material shall meet the properties listed in Table 4 below:

Table 4 — PE (top coat) material properties

SI.No	Properties	Unit	Requirement	Test Method
Raw Material				
1.	Density	g/cm^3	≥ 0.94 and within manufacturer's specification	ISO 1183
2.	Melt flow rate	g/10 minutes	≥ 0.25 and within manufacturer's specification	ISO 1133
3.	Water Content	%	≤ 0.05	ISO 15512
4.	Carbon black content	%	≥ 2	ASTM D1603
5.	Melting point	°C	≥ 120	ISO 3146

As Applied				
6.	Hardness	Shore D	≥ 55	ISO 868
7.	Elongation at break at 23°C±2°C	%	≥ 600	ISO 527
8.	Tensile yield strength at 23°C ± 2 °C	MPa	≥ 17	ISO 527
9.	Vicat softening temperature A/50 (9.8 N)	°C	≥ 110	ISO 306
10.	Environmental Stress Cracking Resistance (ESCR) (50°C, F50, cond. B)	h	≥ 300	ASTM D1693
11.	Oxidative induction time (intercept in the tangent method) in oxygen at 220°C, Aluminium pan, no screen	minute	≥ 10	ISO 11357
12.	UV resistance and thermal Ageing (*)	%	ΔMFR ≤35	ISO 21809-1 Annex G
13.	Thermal Ageing (*)	%	ΔMFR ≤35	DIN 30670 Annex L
14.	Indentation (mass 2.5 kg)	mm	≤ 0.2 @ 20 °C ≤ 0.4 @ 80 °C	ISO 21809-1 Annex F
15.	Impact resistance	J/mm	≥ 7	ISO 21809-1 Annex E
16.	Volume Resistivity @ 23°C ± 2 °C	Ohm-cm	≥ 10^{16}	ASTM D257
17.	Dielectric withstand, 1000 Volts/second rise @ 23°C ± 2°C	V/mm	≥ 30000	ASTM D149

(*) Test carried out in an independent laboratory of national/ international recognition on PE top coat is also acceptable. Certificate shall be valid for 3 years.

5.3 In addition to Manufacturer's certificate, the Applicator 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 (T_{g1}, T_{g2}, ΔH)

b) **Adhesive**

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

c) **Polyethylene**

i. Melt Flow Rate
ii. Specific Gravity
iii. Vicat Softening Point
iv. Water Content
v. Thermal stabilization (as per ASTM D3895)

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 Table 2, Table 3 & Table 4 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.

5.4 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/ 'use by' date (if applicable)
f. Quantity
g. Temperature requirement for transportation and storage

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/ store and replaced by Applicator at its expense.

In case manufacturer does not provide all the details on packing itself, in that case information on packaging must have correlation with MTC/Batch Test Certificate with all the required information.

5.6 Applicator 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.

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

6.0 MEASUREMENT AND LOGGING

Vendor 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 Owner considers to be relevant and required for all incoming bare pipes and Owner approved outgoing coated pipes as applicable. Vendor's documentation shall be designed to ensure full traceability of pipe and coating materials through all stages of coating and testing. Vendor shall submit this information in the form of a report at the agreed intervals. The above data shall also be provided in MS ACCESS format in Compact Disc (CD). Vendor shall provide one Computer Terminal to Owner Representative for monitoring/tracking of the above. The Vendor shall also submit the material balance details to Owner for information at the end of each shift.

7.0 COATING PROCEDURES AND QUALIFICATION

Properties of coating system and as-applied coating material shall comply the requirements indicated in Table 5 of this specification. 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.

7.1 Upon the award of the CONTRACT, the Applicator 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 Applicator's methods, material proposed, etc., shall be formulated by Applicator 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 and Procedure for pipe tracking.

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 and

m. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per requirement 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.

s. Procedure for preparation of coating cutback area.

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 Procedure Qualification Tests

7.3.1 Prior to start of production, the Applicator 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 Table 5 of this specification, relevant standards, specifications and material manufacturer's recommendations. Applicator shall give seven (7) working days notice to witness all procedures and tests.

7.3.2 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 the Company has given approval. However, unavoidable changes shall be executed only after obtaining written approval from Company.

7.3.3 A batch representing a normal production run, typically fifteen (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.

7.3.4 At least 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.

7.4 Properties of the applied coating system

Properties of the applied coating system and different in-process application parameters shall meet the minimum requirements with their test frequencies as per Table 5 below:

Table 5

Sl. No.	Properties	Requirement	Test Method	Test Frequency	
				PQT	Regular
I	**Epoxy Layer**				
1.	Pipe feed speed	As per approved procedure	As per approved procedure	Each pipe	Continuous Monitoring [a]
2.	Air pressure in epoxy spray guns	As per approved procedure	As per clause 9.2.5 & 9.2.8 of this specification	Each pipe	Continuous monitoring & recording
3.	Induction coil setting	As per approved procedure	As per approved procedure and clause 9.1.2 of this specification	Each pipe	Continuous monitoring [a]
4.	Pipe surface temperature	As per clause 9.1.3 of this specification	As per clause 9.1.3 of this specification	Continuous monitoring & recording	Continuous monitoring & recording
5.	Minimum epoxy layer thickness (DFT)	≥ 200 µm	ISO 2808 [e]	One pipe [d]	once/shift [f]
6.	Degree of Cure - Percentage Cure, ΔH - ΔT_g	95% ≤ 5°C	ISO 21809-1 Annex D and clause 10.9 of this spec.	4 samples on one pipe [d], [g]	once/shift [h]
7.	Holiday detection (test voltage set to exceed 5V per µm of epoxy thickness	No holidays	ISO 21809-2, Cl. No. 10.2.3.6.1	One Pipe [d]	Not required
8.	Dry adhesion test	Rating 1 or 2	ISO 21809-2 Clause A.4 & clause 10.10 of this spec.	One Pipe	once/shift
9.	Cross-section porosity	≤ compared with Fig. A.11 of ISO 21809-2	ISO 21809-2 Clause A.12	One Pipe [d]	Not required
10.	Interface porosity	≤ compared with Fig. A.12 of ISO 21809-2	ISO 21809-2 Clause A.12	One Pipe [d]	Not required
11.	Hot water adhesion 24 h @ 65 °C	Rating of 1 to 3	ISO 21809- 2, Clause A.16	One Pipe	Not required
12.	Flexibility at 0 °C	No cracking, tears, disbondment & delamination at 2.0° ppd engtth	ISO 21809-2, Clause A.13	One Pipe [d]	Not required
II	**Adhesive Layer**				
13.	Minimum thickness	≥ 200 µm	ISO 2808 [e]	One pipe [d]	once/shift [f]

Sl. No.	Properties	Requirement	Test Method	Test Frequency	
				PQT	Regular
14.	Extrusion temperature of adhesive	As per approved procedure	As per clause 9.2.6 of this specification	Continuous monitoring & recording	Continuous monitoring & recording
III	**PE Layer**				
15.	PE extrusion temperature	As per approved procedure	As per approved procedure	Each pipe	Continuous monitoring & recording
16.	Coating thickness	Table 1 of this Specification (as mentioned in MR for Standard or Severe service)	ISO 2808 & clause 10.3 of this spec.	Each pipe	Each pipe [h]
17.	Tensile strength @ 23°C ± 2°C	≥ 17 MPa	ISO 527	One Pipe	Not required
18.	Air entrapment test	≤ 10% & as per clause 10.8 of this specification	As per clause 10.8 of this specification	2 samples from 4 pipes (1body + 1 weld, if there)	2 samples (1body + 1 weld, if there)/shift
19.	Elongation at break	≥ 400%	ISO 527-3/ ISO 527-2 & clause 7.6.2(d) of this spec.	6 samples each from 3 pipes	Once per PE batch
IV	**All Three Layers**				
20.	Water quenching	As per approved procedure	As per approved procedure	Each pipe	Continuous monitoring & recording
21.	Visual inspection	As per clause 10.2 of this specification	Visual	Each pipe 100% surface area	Each pipe 100% surface area
22.	Holiday detection (test voltage shall be min. 25 kV & travel speed shall not exceed 300 mm/s)	As per clause 10.4 of this specification	As per ISO 21809-1, Annex B and clause 10.4 of this spec.	Each pipe 100% surface area	Each pipe 100% surface area
23.	Bond Strength (Peel Test) - @ 23±2°C - @ 80±2°C	≥ 15 N/mm ≥ 3 N/mm (No disbondment between steel & epoxy)	ISO 21809-1 Annex C, (clause C.2 or C.5 hanging mass) and clause 10.5(a) & 7.6.2(a) of this spec.	3 tests on each 4 pipes (at both ends & middle) [d] [for both temperatures]	Every 15 for pipe ends (cutback portion) & 60 for middle of pipe. [for both temperatures]
24.	Specific electrical coating resistance @ 23 °C ± 2 °C	≥ 10^8 Ωm^2	Annex J of DIN 30670	One Pipe	Not required
25.	Impact Strength (min. of	≥ 7 J/mm of		3 pipes	2 pipes/

Sl. No.	Properties	Requirement	Test Method	Test Frequency	
				PQT	Regular
	30 impacts located equidistant on body along the length)	coating thickness (No breakdown allowed when tested at 25 kV)	ISO 21809-1 Annex E and clause 10.6 & 7.6.2(b) of this spec.		shift [h]
26.	Indentation Test - @ 23±2°C - @ 80±2°C	 0.2 max 0.3 max	ISO 21809-1 Annex F and clause 10.7 & 7.6.2(c) of this spec.	2 samples from each 4 pipes [i] [for both temperatures]	2 pipes/ shift [i] [for both temperatures]
27.	Cathodic Disbondment Test - @+65°C for 24 h; -3.5 V - @+23°C for 28 d; -1.5 V - @+80°C for 28 d; -1.5 V	≤ 7 mm ≤ 7 mm ≤ 15 mm (Average disbondment radius)	ISO 21809-1 Annex H and clause 10.11 & 7.6.2(e) of this specification	One pipe for each condition [k]	Once/day (only 1st condition i.e. @+65°C for 24 h; -3.5 V)
28.	Hot Water Immersion test	Avg. ≤ 2 mm & max. ≤ 3 mm, 48 hours	ISO 21809-1 Annex M and clause 10.12 & 7.6.2(f) of this spec.	One pipe	Once/day
29.	Flexibility	No cracking at an angle of 2.0° ppd length	ISO 21809-1 Annex I	One Pipe	Not required
30.	Hardness	≥ 55 Shore D	ISO 868	One Pipe	Not required
31.	Residual magnetism of line pipe	Avg. of the four readings ≤ 20 gauss & no single reading ≥ 25 gauss	Hall — effect Gaussmeter	4 readings on One pipe (approx. 90° apart around the circumference of both endsof the pipe)	Once/shift

Notes:

a) Parameter shall be recorded at least once per shift.

b) Lead pipe shall be subjected to this test and thereafter pipes 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 Applicator for this purpose.

c) Shift duration shall be maximum 12 hours.

d) The value obtained from the test shall meet the specified requirement. None of the test value shall fail.

e) Thickness shall be checked at every one metre spacing at 3, 6, 9 and 12 o'clock positions.

f) 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 pipes shall be at Applicator's expense.

g) Epoxy film samples (minimum 4 no.) shall be scratched from the coated pipe. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris.

h) Test shall be carried out at every change in batch of PE. Frequency of test may be reduced to one pipe per week depending upon the consistently acceptable results at the sole discretion of Company's Representative.

i) Test shall be carried out at every change in batch of PE. Frequency of test may be reduced to one test each on 2 coated pipes per week at random, after 1 week of consistently acceptable results.

j) Test carried out in an independent laboratory of national/international recognition on PE topcoat is also acceptable.

k) In case of PQT necessitated for different pipe size with same coating material combination, 24 hours test shall only be conducted and 28 days test is not mandatory.

l) If any one of these samples fails to satisfy the specified requirements, then the test shall be repeated on four more samples. In this case, none of the samples shall fail.

7.5 Qualification of Procedures

7.5.1 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 Applicator 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, Applicator shall not the use the reclaimed powder during the regular production. he proportion of the reclaimed powder in the working mix shall not exceed 10% at any time.

7.5.2 Pipe Pre-Heating

The Applicator 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.

7.5.3 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.

7.5.4 Chemical Pre-Treatment

7.5.4.1 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.

7.5.4.2 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 chromate application and time limit within which the pipe to be heated, testing & control, rectification measures, shall be clearly established during PQT.

7.5.5 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.

7.6 **Qualification of Applied Coating**

7.6.1 **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 with 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 with 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**

Adhesion Test shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply with clause A.4 of ISO 21809-2.

f. **Flexibility Test**

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 with clause A.13 of ISO 21809-2.

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 with clause A.12 of ISO 21809-2.

h. **Hot Water Adhesion Test**

Hot Water Adhesion Test shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply with clause A.16 of ISO 21809-2.

7.6.2 **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 tests shall be performed for each specified temperature i.e. one at each end and one in the middle of the pipe and specified requirements of bond strength shall be complied with. Test shall be carried out as per ISO 21809-1, Annex C. None of these samples shall fail.

In case of small diameter pipes, Coating applicator shall perform the test at maximum feasible distance from pipe end and location will be decided by customer/customer's representative at the time of PQT.

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 three coated pipes i.e. 18 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. Two test shall be carried out for 28 days duration and one test for 24 hours duration The tests shall comply the specified requirement. Whenever Procedure Qualification is necessitated for different pipe size with same coating material combination, 24 hours test only be conducted. 28 days CD test is not mandatory in this case.

f. **Hot Water Immersion Test**

Hot Water Adhesion Test shall be carried out as per ISO 21809-1, Annex M.

g. **Coating Thickness Measurement**

All pipes shall be subject to coating thickness measurement. Acceptance criteria shall be as per Table-1 for Standard or Severe service, as specified in the Material requisition/ Purchase Order.

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.

7.6.3 **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.

7.7 After completion of the qualification tests and all subsequent inspections, the Applicator 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, Applicator shall commence production coating.

7.8 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 Applicator'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.

7.9 The Applicator 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.

7.10 COMPANY reserves the right to conduct any or all the test required for qualification through an independent laboratory or agency at the cost of Applicator 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, Applicator shall visually examine all the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The Applicator 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. Any grinding of steel defects shall not reduce the wall thickness of the pipes below the specified wall thickness of the pipe.

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 blast cleaning.

8.4 The Applicator shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers to ensure traceability of pipe after coating.

8.5 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. Pipe Temperature shall be checked every hour during production. 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 Applicator, chemical pre-treatment with phosphoric acid solution as per para 8.6 may be carried out after the second abrasive blaster.

8.6 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.

Silica sand or copper slag shall not be used as abrasive material.

8.7 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 Applicator may link pipes suitably together to prevent the entry of any short/grit into the pipe.

8.8 Chemical Pre-treatment with Phosphoric Acid Solution

8.6.1 All pipes shall provided chemical pre-treatment with phosphoric acid solution. 10±1% solution of phosphoric acid, Oakite 31 / 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminations.

The Applicator 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 demonized water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of demonized water with respect to 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-ionized 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-ionized water wash : 1 to 2
After de-ionized water wash : 6 to 7

8.6.4 After the de-ionized 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-ionized 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. Test shall be performed on each pipe during production and on each end of every pipe at the time of PQT.

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 ISO 8501-1. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 70 to 100 microns(Rz). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge as per ISO 8503-4.

8.8 In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness and degree of dust and shall comply with the requirements of ISO:8502 – 3. Acceptance limit shall be max. Class 2 for both size and quantity. Pressure shall be exerted on the applied tape using a 4 kg roller, prior to peeling-off to assess the degree of dust.

8.9 The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall the surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating.

8.10 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.

8.11 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The Applicator shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point. It shall be checked every ½ hour during PQT and every hour during production and shall be recorded.

8.12 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 the 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.

8.13 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 Applicator'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.

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

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

8.15.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically Pre-treated with a 10±1% strength chromate solution.

8.15.2 The Applicator 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.

8.15.3 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.

8.15.4 The Applicator 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 Applicator 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.

8.15.5 The Applicator 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.

8.15.6 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.

8.16 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.

8.17 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 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. However, application and curing temperature shall not exceed 250°C in any case. 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. Any equipment which cannot be calibrated in-house, such equipments shall bear valid calibration certificate from the reputed agency and the same shall be verified with other similar equipment.

9.1.6 Applicator 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 **Perquisites for Coating Plant**

9.2.1.1 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 dry air as per the directions of Company Representative.

9.2.1.2 The epoxy spray booth shall be sized to accommodate the number of spray guns required for the application of required quantity of epoxy powder to be electrostatically sprayed on to the pipe to achieve specified thickness. Under no circumstances epoxy powder shall escape from the booth.

9.2.1.3 Plant shall have a powder storage room hermetically controlled with power back up for Air conditioning capable of storing the coating materials as per coating manufacturer's recommendations. Temperature and relative humidity shall be recorded continuously (every hour).

9.2.1.4 The air used for the fluidization of epoxy powder shall be free from moisture. For this purpose dehumidifiers and/ or air dryer, as necessary shall be provided along with necessary monitoring and control system. Fluidized bed shall have magnets adequate to remove iron and steel shaving contaminant from recycled powder.

9.2.1.5 Plant shall have pipe internal blow-out and debris collection system to remove loose scale, dirt and abrasive from the pipe interior.

9.2.1.6 Only those coating materials which are pre-qualified and approved by Company in accordance with provisions of Annexure 1 of this specification and qualified in accordance with the requirements of clause 4.2 i.e. Table 2, Table 3 and Table 4 of this specification shall be utilized for coating. All coating application processes shall be carried out as per manufacturer's recommendations and procedure qualification tests (PQT) as per clause 6.3 and Table 5 of this specification.

9.2.1.7 Plant shall have efficient cleaning system for all the coating application equipments.

9.2.2 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 200µm, 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 200µm.
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, at least up to 80°C to permit handling and inspection. Minimum overall thickness of finished coating shall be as per Table 1 of this specification.

9.2.3 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 10% 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 in Table 2.

9.2.4 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.

9.2.5 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.

9.2.6 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 Applicator 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 Applicator shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.

9.2.7 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.

9.2.8 Applicator 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, Applicator shall supplement by other method to avoid air entrapment. The methods used shall be witnessed and approved by COMPANY.

9.2.9 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. Applicator 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 Applicator's expense.

10.0 INSPECTION AND TESTING

10.1 General

Applicator 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 at least 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. Results of 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 Applicator's expense.

c. Coated pipes not meeting the above requirements shall be rejected. The Applicator 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 Applicator'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 as per Annexure B of ISO

21809-1. The set voltage for inspection shall be 25 kV. Travel speed shall not exceed 300 mm/s.

c. Applicator shall calibrate the holiday detector at least once every 4 hours of production. Applicator 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 Applicator's expense.

10.5 **Bond Strength Test**

a. Applicator shall conduct bond strength test for composite coating as per clause 7.6.2 (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. Disbondment/ separation at epoxy to steel interface shall not be permitted.

c. In case the above tests do not comply with the above requirement, Applicator 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 Applicator'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 ISO 21809-1 Annex E. Initially the frequency of test shall be 2(two) coated pipes per shift, which may be further reduced to one pipe per week, 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 ISO 21809-1 Annex F. 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 Applicator for this purpose.

c. In case of test failure, production carried out during the entire shift shall be rejected, unless the Applicator 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 as per ISO 21809-2 Clause A.4.

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**

In case the test fails to conform to the specified requirement, at the option of the Applicator, 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 Applicator.

10.12 **Hot water immersion**

In case the test fails to comply with the specified requirement, the Applicator shall test the two preceding and two succeeding coated pipe. If both pipes pass the test,

then the remainder of the pipe joints in that day shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated in that day shall be tested until the coating is proved acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at Applicator's expense.

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

10.13 After cutting of pipes for samples of CD Test, Hot Water Immersion Test & Flexibility Test, pipe shall be re-beveled with required cutback and NDT (UT & MPI) shall be performed on the pipe ends.

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

10.15 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. Applicator 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 Applicators obligation to perform the required inspection and tests.

10.16 In case rate of defective or rejected pipes and/ or samples tests are 10% or more for a single shift (typically 8 hours), Applicator shall be required to stop production and carry out a full and detailed investigation and shall submit findings to COMPANY for approval. Applicator 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 Applicator of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plants unless authorized by COMPANY in writing.

11.0 HANDLING, TRANSPORTATION AND STORAGE

11.1 The Applicator 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 Applicator 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

Applicator has taken delivery such as dents, flats, or damage to the weld ends shall be cut off or removed and pipes re-beveled 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 Applicator's account. All such works shall be carried out after written approval of the COMPANY. Any reduction in length shall be indicated in the Applicator's pipe tracking system.

11.2 The Applicator 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 Applicator shall stockpile the bare pipes at the storage area of the coating plant. The Applicator 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 Applicator 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. Applicator 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 adverse weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at Applicator'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.

Applicator 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 Applicator 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. Applicator 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 Applicator 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

Applicator 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 at least +80°C, without impairing its serviceability and properties. Applicator 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, Applicator 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 Applicator.

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 Applicator 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. Applicator shall test repairs to coating as and when required by COMPANY.

13.0 MARKING

Applicator 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

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

14.0 QUALITY ASSURANCE

14.1 The Applicator shall have established within the organization 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 Applicator shall have established a Quality Assurance Group within its organization that shall be responsible for reviewing the Quality System and ensuring that it is implemented.

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

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

14.5 The Applicator 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-Applicators 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 Applicator's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the Applicator 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, Applicator 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/JOTAPIPE AC 1003 (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 Applicator.

Edition	02
Revision	00

SPECIFICATION FOR
INTERNAL EPOXY COATING FOR LINE PIPES

SPECIFICATION NO.: MEC/TS/05/21/014B

(OIL & GAS SBU)
MECON LIMITED DELHI 110 092

CONTENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE:
(Sachin Kumar)	(Sachin Singhal)	(A. K. Jha)	Jan. 2026

AMENDMENT STATUS

Sl. No.	Clause/ Paragraph/ Annexure/ Exhibit/ Drawing Amended	Page No.	Edition	Revision	Date	Prepared by		Checked by		Approved by	
						Name & Designation	Signature	Name & Designation	Signature	Name & Designation	Signature
1.	Overall Revision	All	2	0	19.01.2026	Sachin Kumar (AGM)		Sachin Singhal (DGM)		A. K. Jha (CGM-O&G)	

1 SCOPE

The intent of this specification is to set forth the minimum requirements for supply / arrangement of all materials, plant, equipments, plant sites consumables, utilities and application including all labour, supervision, inspection & test etc. for application of Internal Liquid Epoxy coating. The applied and cured paint film must be smooth to give the desired reduction in friction. Brush application is only used for small repair jobs.

2 DEFINITIONS

The **COATING CONTRACTOR** is the party, who will do coating, supplies equipment and services to perform the duties specified by the contractor.

CONTRACTOR / VENDOR means the person(s) named as contractor in the FORM OF AGREEMENT and the legal successors in title to this person (s).

The word shall indicate a requirement
The word should indicate a recommendation

3 ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
BS	-	British Standards
DIN	-	Deutsche Industries Normen
ISO	-	International Organisation of Standardisation
NACE	-	National Association of Corrosion Engineers
SSPC	-	Steel Structures Painting Council

3.1 Codes, Regulations and Standards

The latest edition of the following codes and standards shall establish the minimum standards for the work. VENDOR may use alternate standards that meet or exceed those if approved by OWNER.

- ISO 2409, Paints and varnishes — Cross-cut test
- ISO 2811 (all parts), Paints and varnishes — Determination of density
- ISO 2812-1:2007, Paints and varnishes — Determination of resistance to liquids — Part 1: Immersion in liquids other than water
- ISO 2812-2, Paints and varnishes — Determination of resistance to liquids — Part 2: Water immersion method

- ISO 2815, Paints and varnishes — Buchholz indentation test
- ISO 3233-1, Paints and varnishes — Determination of the percentage volume of non-volatile matter — Part 1: Method using a coated test panel to determine non-volatile matter and to determine dry film density by the Archimedes principle
- ISO 3251, Paints, varnishes and plastics — Determination of non-volatile-matter content
- ISO 6743-4, Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)
- ISO 6860, Paints and varnishes — Bend test (conical mandrel)
- ISO 8501-1, Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
- ISO 8503-1, Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces
- ISO 8503-2, Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure
- ISO 9227, Corrosion tests in artificial atmospheres — Salt spray tests
- ISO 19840:2012, Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces
- ISO 9002, Quality System – Quality Assurance in Production, Installation and Servicing

3.4 Document Precedence

The VENDOR shall notify OWNER / CONSULTANT of any conflict between this specification, the related data sheets, the Codes and Standards and any other specifications noted herein. Resolution and / or interpretation precedence shall be obtained from OWNER / CONSULTANT in writing before proceeding with the design & manufacture.

In case of conflict, the order of precedence shall be:

- QAP/ITP
- Technical Specification
- Design Codes/ Standards
- Industry Codes and Standards

4 INTERNAL LIQUID EPOXY COATING

Each pipeline shall be provided with an internal liquid epoxy coating by the Vendor. The internal coating shall be as per ISO 15741 – 2016 (E).

5 COATING MATERIAL

5.1 General

The coating material shall typically be a two-pack epoxy paint. It shall not contain any substances which will be released from the paint film after it has cured and are proven to be detrimental to the operation of the pipeline and the quality of the gas.

Unless otherwise agreed, the coating material shall be qualified in accordance with 5.2 and 5.3 and shall not be changed after qualification. The qualification of coating material shall be established during "First Day Production Coating".

The manufacturer of the coating material shall provide on request infrared spectrograms of the base component and the curing agent component (see 5.2.8)

In addition, the manufacturer shall provide a product data sheet (see 5.6), a health and safety data sheet and a certificate stating the test results obtained in accordance with 5.2 and 5.3 respectively and, if applicable, deviating test conditions.

The manufacturer shall also provide with every batch of the coating material a batch test certificate stating the information as given in 5.8.

Unless otherwise agreed, the applied coating shall provide corrosion protection during storage and transport for a minimum period of one year without significant breakdown of the coating.

The curing of the internal coating has to be such that frequent and prolonged contact with methanol with a concentration of 100% or less does not lead to any deterioration of the characteristics of the internal coating. No softening, wrinkling or blistering of the coating may be observed.

The composition and chemical resistance of the coating shall be such that it will never be possible to find any trace of the coating or one of its components in solid, liquid or gaseous form in the natural gas transported by the pipeline.

The typical operating-temperature range for this type of coating is between -20 °C and 110°C.

Where, subsequently, external coatings have to be applied, care shall be taken not to allow the internal coating to be damaged by the elevated temperatures which may occur.

5.2 Particular requirement for qualification of the coating material

5.2.1 General

The following sub clauses describe the laboratory test methods which are required for qualification of the coating material.

5.2.2 Non-volatile matter (by mass)

When determined in accordance with ISO 3251, the non-volatile matter (by mass) of the coating material shall comply with the value specified by the coating material manufacturer in the qualification certificate (Table 2).

5.2.3 Non-volatile matter (by volume)

When determined in accordance with ISO 3233-1, the non-volatile matter (by volume) of the coating material shall comply with the value specified by the coating material manufacturer in the product data sheet (Table 1).

5.2.4 Viscosity

When determined by the method specified by the manufacturer, the viscosity of the ready- mixed coating material shall comply with the value specified by the coating material manufacturer in the qualification certificate (Table 2).

The viscosity should preferably be measured with ISO 2431.

5.2.5 Density

When determined in accordance with one of the parts of ISO 2811, the density of the coating material shall comply with the value specified by the coating material manufacturer in the product data sheet (Table 1).

5.2.6 Ash (residue on ignition)

When determined in accordance with the method described in annex A, the ash (residue on ignition) of the coating material shall comply with the value specified by the coating material manufacturer in the qualification certificates (Table 2).

5.2.7 **Pot life**

The pot life is considered to be the time taken by the ready-mixed coating material to reach a condition at which it can no longer be applied satisfactorily. The pot life shall be specified in the product data sheet (see 5.6).

5.2.8 **Infrared spectrograms**

Infrared spectrograms of the base component and the curing agent component shall be submitted on request.

5.2.9 **Appearance**

The appearance and continuity of the coating shall be inspected visually without any magnification.

5.3 **Particular requirement for qualifications of the cured paint film**

5.3.1 **Preparation of test panels**

Perform the tests specified in 5.3.3 to 5.3.12 on coatings applied to the required dry film thickness specified in 5.3.3 by spraying on to test panels (steel or glass). Prepare steel test panels as specified in 6.2 and glass panels as specified each test at least in duplicate.

5.3.2 **Conditions of test panels**

If specified, condition the coated test panels using one of the following cycles, depending on the substrate and on the individuals test. Cycle B and cycle C are optional and the choice of the conditioning cycle depends on the time available to perform the test procedure.

Cycle A

Substrate: Steel or Glass

- Condition at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity until the coating is at least tack-free.
- Dry for 30 minutes in a circulating-air oven at (75±2) ^{0}C
- Condition for a minimum of 30 minutes at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity before testing.

Cycle B

Substrate: Steel or Glass

- Condition at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity until the coating is at least

tack-free.

- Dry for 30 minutes in a circulating-air oven at (150±2) °C
- Condition for a minimum of 30 minutes at 18 °C to 25 °C and ≤ 80% relative humidity before testing.

Cycle C

Substrate: Steel or Glass

- Condition at 18 °C to 25 °C and ≤ 80% relative humidity until the coating is at least tack-free.
- Dry for 30 minutes in a circulating-air oven at (40±2) °C
- Condition for a minimum of 30 minutes at 18 °C to 25 °C and ≤ 80% relative humidity before testing.

5.3.3 **Dry film thickness**

Unless otherwise agreed, the dry film thickness of the coating, applied on a glass or steel panel, shall be minimum 80 µm except for the test described in 5.3.6 (resistance to neutral salt spray).
Unless otherwise agreed, the dry film thickness shall be measured in accordance with ISO 1984097.

5.3.4 **Adhesion**

When determined in accordance with ISO 2409, the cross-cut classification of the coating applied on steel panels and conditioned using cycle B (see 5.3.2) shall be equal to or lower than 1.

5.3.5 **Buchholz hardness**

When determined in accordance with ISO 2815, the Buchholz hardness of the coating, applied on glass or steel panels and conditioned using cycle B (see 5.3.2) shall have a value of 94 or more.

5.3.6 **Resistance to neutral salt spray**

The coating, applied on steel panels with a dry film thickness of 60 µm to 75 µm, conditioned using cycle B (see 5.3.2), and with an X-cut down to the substrate at least 20 mm from any edge, shall be tested in accordance with ISO 9227 for 480 h.

After the test, allow the test panels to dry for at least 30 min at 18 °C to 25 °C and ≤ 80% relative humidity.

The coating shall be free from any signs of deterioration, for example blistering (except in the area within 2.0 mm from the X-cut), cracking and staining. Any corrosion shall extend not more than 2.0 mm at the most from the X-cut. It shall not be possible to remove by means of clear plastic tape more than 3.0 mm of the coating in any direction from the area around the X-cut.

5.3.7 **Resistance to artificial ageing**

Prepare two different sets of coated test panels, each set consisting of 3 steel panels. The dimensions of the panels shall be approx. 100 mm X 50 mm X 0.8 mm.

Carry out the following procedure:

- Condition set 1 using cycle C (see 5.3.2)
- Condition set 2 using cycle C (see 5.3.2) and then age the panel 80 ^{O}C in a circulating-air oven for 100 h followed by conditioning for 24 h at 18 0C to 25 0C and ≤ 80% relative humidity.
- After ageing, subject the test panels to a bend test in accordance with 5.3.8 The

result of the bend test shall comply with the requirement specified in 5.3.8.

5.3.8 **Bend test (conical mandrel)**

Prepare steel panels and condition them using cycle B (see 5.3.2). When the panel are tested in accordance with ISO 6860, the maximum extent of cracking along the panel from the small and of the mandrel shall be less than or equal to 13 mm, and there shall be no loss of adhesion.

5.3.9 **Resistance to gas pressure variations**

Prepare steel panels and condition them using cycle B (see 5.3.2). When the panels are tested with annex C, they shall have a generally good appearance when examined in accordance with 5.2.9 and shall not show any blistering. The adhesion value shall fulfil the requirements are given in 5.3.4 after conditioning for 24 h and 40 h at 18 ^{O}C to 25 ^{O}C and ≤ 80% relative humidity.

5.3.10 **Resistance to water immersion**

Prepare steel panels and conditions them using cycle B (see 5.3.2). When the panels are tested in accordance with ISO 2812 – 2 for 480 h, the coating shall not show any blistering or appreciable softening.

The examination shall be carried out 3 min after the panels have been removed from the test liquid.

5.3.11 **Resistance to chemicals**

Prepare steel panels and condition then using cycle B (see 5.3.2). When the panels are tested in accordance with ISO 2812-1:1993, Method No. 1, Procedure a, for 168 h, the coating shall not show any blistering or appreciable softening. Use the following test liquid: cyclo hexane; 95% by volume di-ethylene glycol solution in water; hexane; methanol; toluene and lubricating oil (e.g. compressor shall oil in accordance with ISO 6743-4). The test panels shall be completely immersed in the test liquid.

The examination shall be carried out at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity 3 min after the panels have been removed from the test liquid. After conditioning for 24 h at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity, the adhesion value shall fulfil the requirements given in 4.3.4. A change in the color of the coating shall not be considered as an indication of inferior coating quality.

5.3.12 **Resistance to hydraulic blistering**

Prepare steel panels and condition them using cycle B (see 5.3.2). When the panels are tested in accordance with annex D, the coating shall not show any blistering. The examination shall be carried out at 18 ^{0}C to 25 ^{0}C and ≤ 80% relative humidity 3 min after the panels have been removed from the test liquid.

The adhesion value shall fulfil the requirements given in 5.3.4 after conditioning at 18 0C to 25 0C and ≤ 80% relative humidity for 24 h.

5.4 **Packaging, labelling and storing**

All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instruction. At least the following information shall be shown on the label:

- The name of the coating material;
- The name of the manufacturer of the coating material;
- The color of the coating material;
- The batch number;

- Instructions and warnings regarding health, safety and environmental protection; a reference to the relevant product data sheet;

5.5 **Quality Assurance**

It necessary to ensure that the goods or services supplied comply in all respects with the requirements of this International Standard. The coater shall therefore set up and maintain a quality assurance system as, for example, detailed in ISO 9001.

The purchaser shall have the right to undertake inspection and testing of the coated goods during any stage of coating at which the quality of the finished goods may be

affected and to undertake inspection or testing of coating materials, or other materials used, to ensure compliance with the requirement given in 5.2 and 5.3.

5.6 **Product data sheet**

The coating material manufacturer's product data sheet give information regarding at least the items listed in Table 1.

Table 1 – Minimum information to be included in product data sheet

Date of issue	
Name of coating material	
Name of coating material manufacturer	
Color of coating material	
Type of curing agent	
Shelf life	
Non-volatile matter by volume[a]	Test method used (see5.3.2)
Density [b]	Test method used (see 5.2.5)
Pot life [a]	(see 5.2.7)
Flash point [c]	
Time to complete curing	
Recommended thinner	
Maximum allowed quantity of thinner, in %	
Recommended surface preparation grade	
Recommended method of application	
Recommended maximum / minimum dry film thickness of the applied coating	
Recommended cleaning solvent (for the application equivalent)	
Recommended application conditions (air and steel temperature and relative humidity)	
Recommended minimum curing conditions	
Recommended maximum / minimum service temperature	
Recommended storage conditions	
Reference to instruction and warnings regarding health, safety and environmental protection	
Theoretical spreading rate (l/m2 or kg/m2) for a given dry film thickness.	
a. Only for the mixed coating material. b. Give separately for base component and curing agent component (if pigmented)	

Give separately for base component, curing agent component and mixed coating material.

Recommended minimum curing conditions
Recommended maximum / minimum service temperature
Recommended storage conditions
Reference to instruction and warnings regarding health, safety and environmental protection
Theoretical spreading rate (l/m2 or kg/m2) for a given dry film thickness.
c. Only for the mixed coating material. d. Give separately for base component and curing agent component (if pigmented) Give separately for base component, curing agent component and mixed coating material.

5.7 Qualification certificate

The qualification certificate shall give, as a minimum, the values of the properties listed in Table 2.

Table 2 – Minimum information to be included in qualification certificate

Date of issue		
Name of coating material		
Mane of coating material manufacturer		
Authority of issue		
Property	**Test Method**	**Sub Clause**
Non-volatile matter by mass a	ISO 3251	See 5.2.2
Ash b	Annex A	See 5.2.6
Viscosity c		See 5.2.4
Adhesion	ISO 2409	See 5.3.4
Buchholz hardness	ISO 2815	See 5.3.5
Resistance to neutral salt spray	ISO 7253	See 5.3.6
Resistance to artificial ageing		See 5.3.7
Bend test (conical mandrel)	ISO 6860	See 5.3.8
Resistance to gas pressure variations	Annex C	See 5.3.9
Resistance to water immersion	ISO 2812-2	See 5.3.10

Resistance to chemicals - Resistance to cyclohexane - Resistance to 95% by volume diethylene glycol solution in water		
- Resistance to hexane	ISO 2812-1	See 5.3.11
- Resistance to methanol - Resistance to toluene - Resistance to lubricating oil (e.g. compressed seal oil)		
Resistance to hydraulic blistering	Annex D	See 5.3.12

a. Separate for base component, curing agent component and mixed coating material.

b. Separate for base component and curing agent component (if pigmented).

c. Only for the mixed coating material.

5.8 **Batch test certificate**

The batch test certificate shall give, as a minimum, the information and test results for the items listed in Table 3

Table 3 – Minimum information to be included in batch test certificate

Item	Test Method	Information from the Coating Material Manufacturer	Test Results
Date of issue			
Batch number			
Name of coating material			
Name of coating material manufacturer			
Production date			
Expiry date for use			
Non-volatile matter by mass – base component	See 5.2.2		
Non-volatile matter by mass – curing agent component [a]	See 5.2.2		

Item	Test Method	Information from the Coating Material Manufacturer	Test Results
Viscosity – base component	b		
Viscosity – curing agent component	b		
Density – base component	See 5.2.5		
Density – curing agent component	See 5.2.5		
Ash – base component [c]	See 5.2.6		
Ash – curing agent component [c, d]	See 5.2.6		
Infrared spectrogram [d, e]	See 5.2.8		

a. The non-volatile matter by mass of the curing agent component shall not be used for any purposes other than batch consistency checks.
b. As specified by the coating material manufacturer.
c. If required.
d. If pigmented.
Separately for base component and curing agent component.

6 APPLICATION OF THE COATING MATERIAL

6.1 General

During application of the coating material, all steps in the coating process shall be assessed and recorded.

The parameters listed in Table 4 shall be included.

Table 4 – Minimum items to be checked and recorded during the coating process

Items	Method	Frequency	Acceptance criteria
Coating material: • Name of product • Name of manufacturer • Batch number	Visual examination	At every change of shift	As specified
Surface condition prior to surface preparation	Visual examination	Every pipe	Minimum 100 µm
Surface condition after surface preparation: • Surface cleanliness • Surface profile	ISO 8501-1 ISO 8503-2	Twice per shift	30 – 60 µm
Surface imperfections e.g., dents, laps etc.	Visual examination	Every pipe	In line with Bare Pipe Specification (SAWL/ SAWH/ HFW/ SMLS)
Wet paint (mixed) Viscosity and temperature	As specified	Every time paint is mixed and every time painting is interrupted and at least every 4 hours	As specified in Qualification Certificate
Environmental conditions in the painting area: • Ambient temperature • Steel temperature • Relative humidity • Dew point	Instrumental	At start of each shift & every 4 hours	As specified as specified
Cured paint film on pipes • Appearance and continuity • Dry film thickness • Porosity (pinholes)	• Visual examination • ISO 2808:2007, Table A.2 • Wet-sponge test (Annex G)	• Spot test • Every hour • Twice per shift [a]	• No sagging • As specified • As required
Cured paint film on steel test panels As described in Table 5	See table 5	Twice per shift	As specified in Table 5

Paint film on glass test panels Porosity (pinholes)	Annex E	At every change of shift	Max. 5 pores
a. The wet sponge test shall be carried out only if the porosity test on glass panels constitutes a failure			

6.2 **Surface preparation**

First check that the surface is free from any foreign matter such as welding flux, welding spatter, salts, oil or grease. If necessary, wash the surfaces with a high-pressure jet of fresh water. Removed organic contaminants using detergents or suitable organic solvents.

Then blast-clean the surfaces to surface preparation grade Sa 2 ½ in accordance with ISO8501-1.

Removed, using suitable methods, any surface irregularities or imperfections which may have become visible.

Check the surface profile. Unless otherwise agreed, it shall be such that R_{y5} (see ISO 8503- 1) is between 30 µm and 60 µm.

During and after blast-cleaning and prior to application of the coating material, the temperature of the steel surface shall be at least 3 ^{o}C above the dew point or the minimum curing temperature given by the coating material manufacturer, whichever is the higher.

6.3 **Paint preparation**

Before removing each component from its container, stir or agitate it until it is homogeneous, using equipment which is capable of homogenizing the entire contents of the container without excessively entraining air into the material. Mix the two components (base component and curing agent component) thoroughly and, if necessary, dilute in accordance with the coating material manufacturer's instructions. After the material has been homogenized, it shall be continuously mixed at a slow speed. The mixed paint shall be free of any lumps and pieces of skin. Measure the viscosity in accordance with the method recommended by the manufacturer and record it. Check whether it complies with the value specified by the manufacturer and keep it constant during application procedure.

6.4 **Paint application**

Check the surface to be coated to see whether it still complies with the specified surface preparation grade and profile (see 6.2).

Apply the paint in a covered or enclosed space, shielded from wind, blowing dust and

inclement weather, using the application parameters recommended bt the coating material manufacturer and approved by the coater.
The ambient temperature and relative humidity and the temperature of the steel surface application and subsequent drying/ curing shall be in accordance with the recommendations of the manufacturer of the coating material. The temperature of the steel shall be at least 3 ^{0}C above the dew point. In the case of accelerated curing, the temperature shall be as agreed between the coating material manufacturer and the coater.

Spray the paint continuously and uniformly on to the whole surface to be coated. The coating shall be uniform, and particular attention shall be given to achieving the specified dry film thickness. Unless otherwise specified or agreed, maintain a cutback length of (50 ± 5) mm.

6.5 Health and safety and protection of the environment

It is the duty of clients, specifiers, contractors, coating material manufacturers, inspectors and all other personnel involved in the undertaking to carry out the work for which they are responsible in such a manner that they do not endanger the health and safety of themselves or others.

In pursuance of this duty, each person shall ensure that all the statutory requirement of the country in which their work, or any part of the work, is carried out are complied with.

7 PRODUCTION CONTROL

Bidder shall submit its methods and material proposed to be used for executing the internal coating to Company and shall receive approval from Company prior to start of production. The material being proposed shall have been applied successfully in at least one project in last five years. The coating material shall be qualified as per ISO 15741/ API RP 5L 2 Latest Edition and all qualification testing should be performed by an independent laboratory. If testing is undertaken at the coating manufacturer's premises, the test shall be witnessed by the Company or by third party. The coating manufacturer shall obtain the results in the form of a full qualification report showing test method and results.

7.1 First Day Production Coating

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.

A detailed procedure/ write up covering each step, starting from selection of raw material, preparation for coating, detailed coating steps, including First Day

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.

Production test, in-house inspection, rejection and repair procedure shall be furnished.

7.2 Assessment of the coating on the pipes

7.2.1 Appearance

Inspect the coating visually for uniformity of color, smoothness and freedom from runs, holidays and other defects that could be detrimental to its quality.

7.2.2 Dry film thickness

Unless otherwise specified or agreed, the minimum dry film thickness of the coating shall be 100 µm above the peaks in the profile of the substrate and shall be determined in accordance with annex B.

7.3 Assessment of the coating on steel panels

7.3.1 Preparation of test panels

Perform the tests specified in 7.2.2 to 7.2.5 on coating applied by spraying on to steel test panels, to give dry film thickness specified in 5.3.3. Prepare the test panels as specified in 6.2 and apply the paint in accordance with the instructions of the coating material manufacturer. Use conditioning cycle B or C (see 5.3.2). Perform each test at least in duplicate.

Table 5 shows the required frequency of the tests specified in 7.2.2 to 7.2.5

7.3.2 Adhesion

When determined in accordance with ISO 2409, the cross-cut classification of the coating shall be equal to or lower than 1.

7.3.3 Buchholz hardness

When determined in accordance with ISO 2815, the Buchholz hardness of the coating shall be at least 94.

7.3.4 **Bend test**

When determined in accordance with ISO 6860, the maximum extent of cracking along the panel from the small end of the mandrel shall be less than or equal to 13 mm, and there shall be no loss adhesion.

7.3.5 **Curing test**

When tested in accordance with Annex F, the coating shall not show any softening, wrinkling or blistering.

7.3.6 **Porosity test**

The porosity of both the wet and the dry film shall be checked on glass panels by the method given in Annex E. Porosity is considered to be any coating defect (pinhole) through which light can pass directly.
More than 5 pinholes shall constitute a failure.

If the porosity test on a glass panel is deemed a failure, the wet-sponge test given in Annex G shall be carried out on the surfaces painted with the coating material which failed the glass –panel test, testing at least ten areas, excluding welds. The coating on these surfaces shall not have more than 1 pinhole per 100 cm2

Table 5 – Required frequency of, and acceptance criteria for, the production –control tests specified in 7.2.2.to 7.2.5

Test	Method	Frequency	Acceptance criteria
Adhesion	ISO 2409	Twice per shift	Classification ≤ 1
Bend test	ISO 6860	Twice per shift	No loss of Adhesion
Buchholz hardness	ISO 2815	Twice per shift	Hardness ≥ 94
Curing test	Annex F	Twice per shift	No softening, wrinkling or blistering

8 REPAIRS

Defective coating, or areas with insufficient dry film thickness, shall be repaired in accordance with the coating material manufacturer's recommendations.

9 HANDLING, TRANSPORTATION AND STORAGE

9.1 Handling

Coated pipes shall be handled in such a way that no damaged is caused to the coating.

9.2 **Transportation to the storage area**

During transportation to the storage area at the coater's workshop, the coater shall take all relevant precautions to avoid damaged to the coating.

9.3 **Storage**

Coated pipes shall be stored in such a way that the quality of the coating will not be affected.

9.4 **Loading coated pipes for transportation**

When loading pipes at the workshop or in the field, all relevant precautions shall be taken to avoid the possibility of damage to the pipes or to the coating during transportation.

The coater is responsible for ensuring that all pipes delivered to the purchaser are correctly coated and the coating is properly cured.

ANNEX A : (NORMATIVE) DETERMINATION OF ASH (REFER TO SUB CLAUSE 5.2.5)

A.1 **General**

This annex describes a method for determining the ash residue from a coating.

A.2 **Apparatus**

Ordinary laboratory apparatus, together with following:

A.2.1 Porcelain crucible

A.2.2 Muffle furnace

A2.3 Desiccator, containing an active desiccant

A2.4 Analytical balance, capable of weighing to 1 mg

A.3 **Procedure**

Weigh, to the nearest 1 mg, between 3g and 5 g of the product into a porcelain crucible (A.2.1).

Place the crucible in a hood and heat with a low flame until the contents of the crucible are a dry, charred mass. Transfer to the muffle furnace (A.2.2) and ignite the residue at red heat (not exceeding 600°C) until the ash is free of carbon.

Cool in the desiccator (A.2.3) and weigh.

Repeat the igniting, cooling and weighing until the difference between successive weighing does not exceed 1 mg.

A.4 **Expression of results**

Calculate the ash WA, as a percentage by mass, using the following equation: WA =

$(m_1/m_0) \times 100$ (A.1)

Where,
m_1 is the mass, in grams, of the residue after ignition. m is the mass, in grams, of the test portion.

ANNEX B : (NORMATIVE) DRY FILM THICKNESS (REFER TO SUB CLAUSE 5.3.3 AND 7.1.2)

B.1 General

This annex describes the measurement of the dry film thickness of a coating on a blast- cleaned steel surface using an instrument based on the permanent-magnet principle or the inductive-magnet principle.

If a coating has been applied to a blast-cleaned steel substrate, the measurement of the dry film thickness is more complicated than for smooth, flat surfaces. The effect of a surface roughness on the result increase with profile depth also related to the design of the measurement probe and the thickness of the coating.

B.2 Apparatus

Unless otherwise specified or agreed, the minimum dry film thickness of the coating shall be determined in accordance with ISO 2808:1997, Method No.10, using a single-pole instrument of the permanent-magnet or inductive-magnet type.

B.3 Procedure

Before use, ascertain that the instrument is in good working order (see manufacturers).

Calibrate the instrument on a smooth, flat, level steel plate, using ISO 2808:1997, Method No.10. It will then be necessary to determine a "correction factor" by taking a series of readings on the unpainted blast-cleaned surface and calculating the average. All readings subsequently taken on the painted surface are then reduced by the "correction factor" to give the true value of the thickness above the peaks.

Check the calibration at frequent intervals.

For each pipe or fitting tested, at least 8 values shall be recorded. Each value shall be constituted by the arithmetic mean of 5 difference measurement taken very close to the point at which the thickness is to be measured. When during a series of measurement an individual dry film thickness value does not meet the specified criterion, a repeat measurement not more than 10mm from the point of first measurement shall be carried out. The first value shall then rejected and replaced by the result of the repeat measurement. The maximum number of repeat measurements permitted is 2.

If any measurement are less than 80% of the nominal dry film thickness (NDFT). Then the specimen fails this test.

B.4 **Results**

Calculate the arithmetic mean of the measurement values. Unless otherwise specified or agreed, the minimum dry film thickness of the coating shall be 80µm above the perks.

In cases of dispute the result at one point, recalibrate the instrument and carry out five measurements, again very close to the point. Recalculate the arithmetic mean of the 5 measurements.

ANNEX C : (NORMATIVE) RESISTANCE TO GAS PRESSURE VARIATION (REFER TO SUB CLAUSE 5.3.9)

C.1 General

The test consists of verifying, by evaluation of visual appearance and determination of the adhesion, the behaviour of the applied coating after it has been subjected to pressure variation in a gaseous environment (N2).

C.2 Apparatus and materials

C.2.1 Sealed chamber, capable of resisting the test pressures during the whole of the test

C.2.2 Nitrogen, as pressurizing gas

C.2.3 Pressurizing system, capable of increasing the pressure by 1 bar per minute

C.3 Test specimens

Substrates can be of two types:

- approx. 100mm x 50mm x 1mm steel panels;
- lengths of steel pipe approx. 100mm long with a minimum diameter of 80 mm or, if the diameter is too large for the pipe to fit into the chamber, specimens obtained from the pipe or fitting.

The surface of the test panels or lengths of the pipe shall be prepared and coated at the same time and in the same way as the corresponding production surfaces.

C.4 Procedure

C.4.1 General

Unless otherwise specified by the coating material manufacturer, wait a month after the coating has been applied to the test panels or lengths of pipe before carrying out any test.

C4.2 Cyclic pressure test

This test is carried out as a qualification test on the inside coating.
Put the specimen in the chamber and subject it to the set of 10 test cycles shown schematically in figure C.1, as follows:

- Progressively increase the pressure in the chamber to 100 bar.

- Keep the specimen under pressure for a fixed period of time to allow the pressurizing gas to penetrate into the coating:

  - 20 h for the 1st to 4th cycles and the 6th to 9th cycles,
  - 68 h for the 5th and 10th cycles;

- Release the pressure rapidly over a few minutes (not more than 5 minutes);

- Leave the coating at atmosphere pressure for 4 h to permit the development of any blisters on the coating, so that a cycle lasts either 24h or 72h (this latter period corresponds to the weekend, i.e. from Friday to Monday).

  Immediately at the end of the 10th test cycle, open the chamber and examine the appearance of the coating, noting all modifications (corrosion, spots or blisters).In addition, carry out an adhesion test in accordance with ISO 2409. Repeat the appearance examination after 24 h and after 48 h, again noting all modifications.

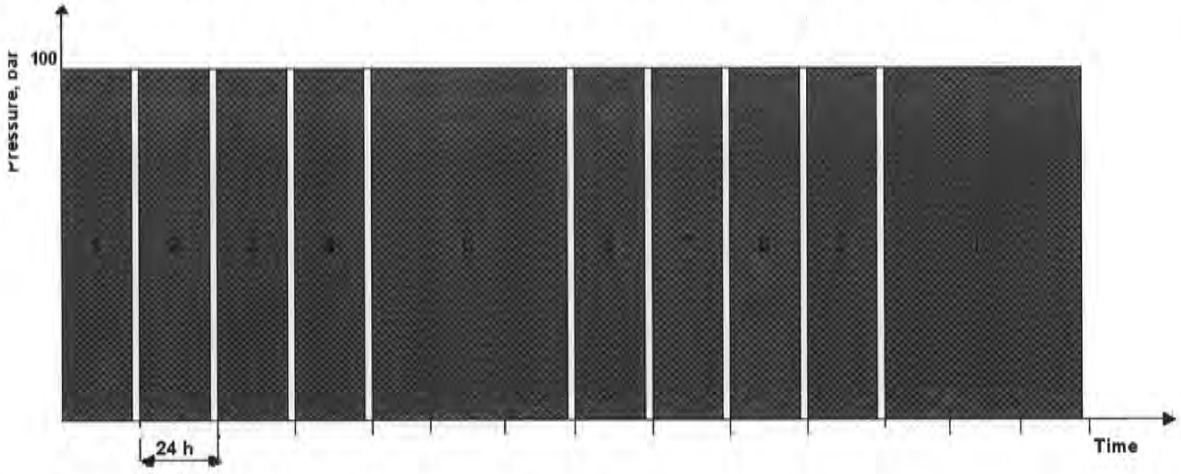


Figure C.1 – Complete set of pressure cycles

C.4.3 **Decompression blistering test**

The test is carried out only when the coated pipes are utilized at operating pressures higher than 100 bar. The test pressure shall be at least the pressure specified for that pipeline.
Put the specimen in the chamber and then subject it to the specified pressure for 24 h so that the pressurizing gas can penetrate into the coating.

Release the pressure rapidly over a few minutes (not more than 5 minutes)

Immediately at the end of the test cycle, open the chamber and examine the

appearance of the coating, noting all modifications (corrosion, spots or blisters).In addition, carry out an adhesion test in accordance with ISO 2409. Repeat the appearance examination after 24 h and after 48 h, again noting all modifications.

C.5 **Results**

Record any degradation observed immediately on removing the specimen from the chamber and indicates any further changes after 24 h and 48 h.

Record the adhesion of the coating measured in the adhesion test.

ANNEX D : (NORMATIVE) HYDRAULIC- PRESSURE BLISTERING (REFER TO SUB CLAUSE 5.3.12)

D.1 **General**

The test consists of verifying, by evaluation of the visual appearance and determination of the adhesion, the behavior of the applied coating when subjected to pressure variation in a liquid environment (water/CaCO3).

D.2 **Apparatus and materials**

D.2.1 Sealed chamber, capable of resisting the test pressure during the whole of the test.

D.2.2 Water saturated with CaCO3, as pressurizing liquid.

D.2.3 Pressurizing system, capable of increasing the pressure by 1 bar per minute.

D.3 **Test specimens**

Substrates can be of two types:

- approx. 100 mm x 1 mm steel panels;
- lengths of steel pipe approx. 100 mm long with a minimum diameter of 80 mm or, if the diameter is too large for the pipe to fit into the chamber, specimens obtained from the pipe or fitting.

The surfaces of the test panels or length of the pipe shall be prepared and coated at the same time and in the same way as the corresponding production surfaces.

D.4 **Procedure**

Unless otherwise specified by the coating material manufacturer, wait a month after the coating has been applied to the test panels or lengths of pipe before carrying out any test.

This test is carried out at least 100 bar if the maximum operating pressure is 100 bar or less. If the operating pressure is higher than 100 bar, the test pressure shall be at least the pressure specified for that pipeline.

Put the specimen in the chamber and then subject it to the specified pressure specified for 24 h so that the pressurizing liquid can be penetrate into the coating.

Release the pressure rapidly over a few minutes (not more than 5 minutes).

Immediately at the end of the test cycle, open the chamber and examine the

appearance of the coating, noting all modifications (corrosion, spots or blisters).In addition, carry out an adhesion test in accordance with ISO 2409. Repeat the appearance examination after 24 h and after 48 h, again noting all modifications.

D.5 **Results**

Record any degradation observed immediately on removing the specimen from the chamber and indicates any further changes after 24 h and 48 h.

Record the adhesion of the coating measured in the adhesion test.

ANNEX E : (NORMATIVE) POROSITY OF A FILM OF THE COATING MATERIAL ON A GLASS PANEL (REFER TO SUB CLAUSE 7.2.6)

Use a glass panel measuring approx. 75 mm x 25 mm x 2 mm and frosted on one side. Clean the panel by immersion in a suitable solvent and then in acetone. Allow the panel to dry in air for a few seconds.

Place a panel inside the pipe to be coated with non-frosted side facing the wall of the pipe; keep it in position at each end by means of adhesive tape (max. overlap on glass 10 mm). Just before coating, check that the panel is free from dust or pollution. Apply the coating material to glass panel during the pipe-coating process.

Then examine the panel as follows:

(a) **Wet film**- Five minutes after application of the coating material, place the glass panel over an opaque (dark) shield measuring approx. 300 mm x 300 mm with a 50 mm x 20 mm slot in the middle. Hold the panel, together with the shield, 130 mm from an illuminated 100 W bulb, with the shield facing the bulb. Check for pinholes. More than 5 pinholes shall constitute a failure.

(b) **Cured film**-If the coating is acceptable in the wet state, allow it to cure for an additional 30 min in air at 18 ° C to 25 ° C and a relative humidity of ≤ 80 %, and then place in a circulating-air oven at (75 ± 2) ° C for a minimum of 30 min. repeat the examination described above. More than 5 pinholes shall constitute a failure.

Another curing schedule may be agreed between the coater and the coating material manufacturer.

NOTE : if justified by the prevailing application and drying conditions or the type of paint used, the test conditions may be modified by agreement between the interested parties.

ANNEX F: (NORMATIVE) CURING TEST (REFER TO SUB CLAUSE 7.2.5)

Apply the coating material to steel panels and condition the coated panels as specified in 7.2.1. Test for resistance to the thinner which is recommended for thinning the coating material, in accordance with ISO 2812-1, for 4 h.

Examine the panels after a recovery period of 30 min at 18 ° C to 25 ° C and ≤ 80 % relative humidity following removal of the panels from the test liquid. The coating shall not show any softening, wrinkling or blistering.

ANNEX G : (NORMATIVE) WET-SPONGE TEST (REFER TO SUB CLAUSE 7.2.6)

G.1 **General**

The test consists of examining the coating for any porosity or other damage using a wet sponge, to which a low voltage is applied, as a scanning electrode.

Defects are indicated by an acoustic signal caused by the short circuit which occurs between the electrode (sponge) and the earth (steel substrate) at such defects.

G.2 **Apparatus and materials**

G.2.1 Adjustable low-voltage wet-sponge tester, equipped with an alarm, an electrode in the form of a sponge and conductors for connecting the coated pipe or fitting under test to earth

G.2.2 Tap water

G.3 **Procedure**

Set the test voltage to 9 V.

Connect up the instrument, connecting the earth lead, by means of a crocodile clip, to an uncoated section of the metal of the surface under test.

Moisten the sponge with tap water. Note that too much water will affect the performance.

Switch on the electrode and move it continuously in connect with the surface of the coating to be inspected; the rate of travel of the electrode is not limited, but it shall not be higher than the speed at which it can be demonstrated that a porosity defect can be detected.

The presence of a porosity defect is indicated by the emission of a high-pitched note from the alarm.

G.4 **Results**

Record the number of porosity defects per 100 cm^2.

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 & MEC/TS/05/21/14C

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

(Sachin Kumar)

(SACHIN SINGHAL)

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

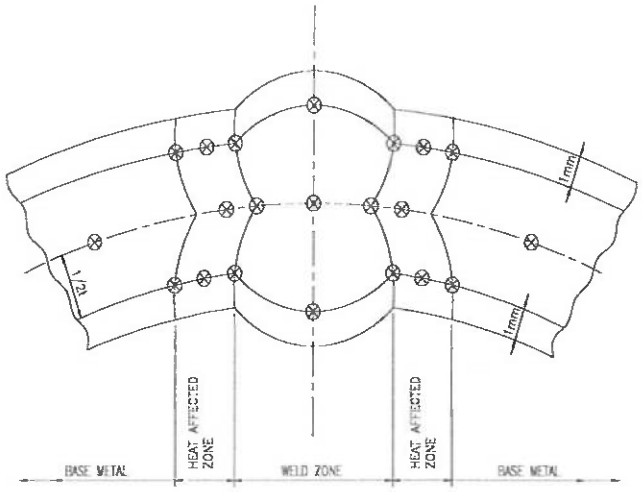
In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerances shall comply with the requirements of this specification. The tolerances on specified wall thickness shall be (+) 22.5% and (-) 0%. API Spec. 5LTable 9 stands cancelled

5. MECON Specification no. MEC/TS/05/21/012,MEC/TS/05/21/012A ,MEC/TS/05/21/012B and MEC/TS/05/21/012C

Clause No.1 of Technical specification regarding Scope (Modified)

The clause shall be read in conjunction with following:
"This specification establishes the minimum requirements for the manufacture of steel line pipe in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty-Sixth Edition, April 2018 & Errata 1 May 2018
The Manufacturer shall have a valid license to use API Monogram in accordance with the requirements of Specification 5L, Forty-Sixth Edition, April 2018 & Errata 1 May 2018 for line pipe as Product Specification Level PSL.

6. Figure corresponding to the cl. no. 10.2.5.3 shall be as below:



7. Straightness

The tolerances for straightness specified in cl. no. 9.11.3.4 of all Line Pipe Tech. Specs. shall be as modified as below:

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 **1.5 m (5.0 ft) portion at each pipe end shall be ≤ 3.2 mm (0.125 in)**, as shown in Figure 2 of API Spec 5L.

8. Specific **electrical coating resistance:**

The Test defined in Tech. Spec. no. **MEC/TS/05/21/01**4 for 3-Layer Polyethylene Coating of Line Pipes at sl. no. 24 of Table-5 shall be read in conjunction with foot-note "j" of Table-5. As such, foot-note "j" of Table-5 is applicable for sl. no. 24 of Table-5.

9. MECON Specification no. MEC/TS/05/21/012,MEC/TS/05/21/012A ,MEC/TS/05/21/012B and MEC/TS/05/21/012C

Bar Coding /QR coding (New)

Bar-coding of line pipes as a requirement so that the pipe can be traced using bar coding scanner in the field. We propose bar coding at 4 equal spaced points on the pipe at 3, 6, 9, 12 O'clock position for easy identification. Alternatively, bar-coding can be done at both ends at 4, 8 & 12 O'clock position.

Barcode directly printed on the pipe with permanent ink may be preferred.

1. PURPOSE

The purpose of this specification is to ensure the identification of pipes through barcode label.

2. SCOPE

This procedure defines to identify the pipes through barcode label scanning. This procedure covers the application of 3D type bar code and pipe marking on Bare Pipe, 3LPE coated pipes and 3LPP coated pipes after the final coating of bare pipes.

Bar code shall be applied after clearance from Third Party Inspection Agency (TPIA) upon final acceptance of external coated pipes/Bare pipes. Barcode shall have Pipe No., Type (ERW/LSAW/3LPE/3LPE), Heat No., Coat no., Diameter, Unit Length, Wall thickness, and item code.

Third party Inspection Agency (TPIA) shall verify barcode with hand held reader during inspection of pipe.

Contractor shall supply one barcode reader for each dumpsite.

3. METHOD

3.1 PROCEDURE FOR BARCODING OF BARE AND EXTERNALLY COATED LINE PIPE

3.1.1 ON BARE / EXTERNAL 3LPE AND 3LPP COATED PIPES

Pipe marking (stencil) shall be made from both end of the pipe opposite to the weld line. Pipe no. shall be printed on barcode at the bottom. VENDOR has to ensure physical correction of pipe no. as per stencil & barcode, before applying barcode. One 3D type barcode sticker shall be pasted at an angle of 180° from the stencil side at a distance of 200 mm from the cutback area.

1. For details refer Figure–I for pipe marking and bar coding procedure on the outside pipe surface.
2. In case any unfit pipes found for coating or for any reason pipes are cut, the actual length of pipe shall be given in barcode sticker.

3.1.2 PRINTING OF BARCODE/QRCODE LABELS

The barcode labels will be printed at the time of final inspection (label size 2"x 4") and will be printed by using printer. The pipe number and other details will be taken from the Final Visual and Dimension inspection report system. The label shall have details as per Owner/TPIA. The barcode and item code as per sample attached. The label shall have Pipe No., Type (ERW/3LPE/3LPP), Heat No., Coat no., Diameter, Unit Length, Wall thickness, and Item Code up-to 10 Digit (max.).

SAMPLE PIECE OF BARCODE/QR CODE LABEL

PIPE NO : XXXXXXXXX
TYPE : ERW/3LPE/3LPP
HEAT NO. : XXXXXXX
COAT NO. : XXXXXXX
DIA : XX INCH

2"

LENGTH : 12.05 M
WALL THICKNESS : CC MM
ITEM CODE : XXXX

4"

The barcode standard is symbology and the paper material used is 3D and tear-able.

3.1.3 FIXING OF LABELS ON PIPES

Ensure that the surface area in which labels are pasted should be clean, dry and free from dust. For each pipe two (2) labels shall be fixed, one for each end at outside (fixed approx. 200 mm from the cutback / bevel area at an angle of 180° on each end). Refer Figure -I, all bar code shall be oriented perpendicular to the weld seam. The barcode label shall be put on completely finished pipe. Barcode label should not be overlapped with stenciling or any other marking outside coated pipe. (i.e. external coated pipe surface).

3.1.4 VERIFICATION OF BARCODE/QR CODE LABELS

At the time of dispatching of pipes, QC personnel shall verify the barcode labels visually. If the barcode labels found damaged, missing or illegible for the purpose same shall be replaced by new one and applied as described in clause 3.1.1 & 3.1.2.

3.1.5 SCANNING OF BARCODES/QR CODES

The barcode can be read by scanning the codes by scanner provided by supplier at pipe mill and site. When the barcode is scanned the pipe number will be visually seen on the scanners monitor and same will be saved in its memory. The full details of the pipe can be obtained by connecting the computer with the scanner having database for these pipes.

1. First connect the scanner to the computer.
    a. One cable from CPU to scanner
    b. Second cable from power line to portable scanner for charging.
2. Make the data file in which details of the pipes are available.
3. Copy the data file and paste in the scanner.
4. The data will be loaded in scanner
5. Scan the barcode by scanner.
6. If the code matches with the available data in the scanner, it shows all the details of the barcode.
7. Scanner also shows the quantum of the data available in scanner and out of which how many are scanned.
8. If the data scanned does not match with the available data, the scanner shall show NA i.e not Available.

Figure 1

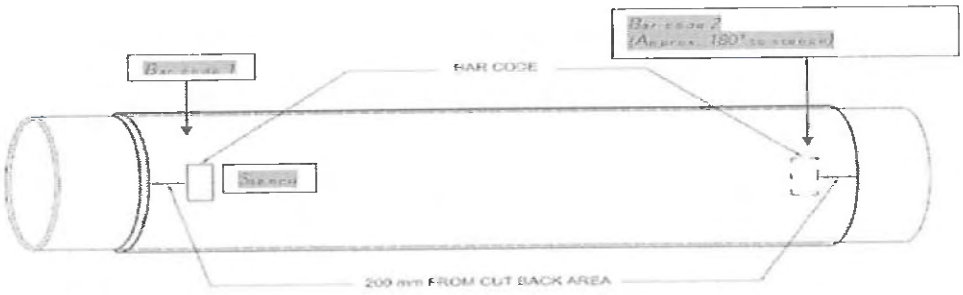


Figure – I
(Outside Surface – On External Coated Pipe / Bare Pipe)

INDRADHANUSH GAS GRID LIMITED (IGGL)

QUALITY ASSURANCE PLAN
(GUIDELINE)

(MR No. : MEC/E/0085/05/21/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

ELECTRIC WELDED LINE PIPES (ON SHORE)

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
1	MAY-2017	ISSUED FOR IMPLEMENTATION	Sachin Kumar	Sachin Singhal	Anil Kumar

ITP No. : 05/21/12/001

SCOPE OF INSPECTION

Sl. No.	Stage	Component	Characteristics	Method of check	Quantum of check	Reference documents	Record	MECON	Sub vendor	Vendor	VENDOR APPOINTED TPI	MECON / CLIENT
1a	Raw material inspection	HR coil	Chemical Composition CE, PCM, UTS, YS, %EL, Impact	Review of records & visual	100% By Supplier & Supplier appointed TPI and Random By MECON / Client	PO, Material specification	PO, Material specification	Inspection report	-	W	W/R	W
1B	Raw material inspection	HR coil	Laminations, internal imperfection	AUT	As per PR	Material specification	Material specification	Graphical Recording	-	W	W	R/W
2a	Manufacturing, Welding	Rolled pipe	Welding	Welding Speed Current, Voltage, Frequency, Squeeze out length	At random	Approved parameters	Approved WPS	Internal report	-	W	W	M
2b	Manufacturing	Pipe	Offset, Height of flash, Trim	Visual	As per ____	PR, API 5L	PR, API 5L	Inspection Report	-	W	W	RW
2c	Manufacturing Procedure Qualification (1st day production test)	Pipe	Workmanship, Chemical, Non destructive examination, Destructive examination	Visual destructive & Non destructive tests	As specified in PR	PR	PR		-	W	W	RW

Sl. No.	Stage	Component	Characteristics	Method of check	Quantum of check	Reference documents	Record	MECON	Sub vendor	Vendor	VENDOR APPOINTED TPI	MECON / CLIENT
3	Heat treatment (if applicable)	Pipe	Seam Annealing	Temperature Start & end length of Annealing	100%	PO, Material specification	PO, Material specification	Inspection Report	-	W	R	R
4	Hydro testing	Pipe	Leak Check	Visual	100% by vendor, At random by MECON	Material specification, PR	Material specification, PR	Inspection report, Hydrograph	-	W	W	RW
5	Non destructive testing (if applicable)	Test pipe calibration & pipes	Surface & internal imperfection	AUT, Eddy current or other as specified	Test pipe & 100% pipe	Technical Specification	Technical Specification	Inspection report, Graphical record	-	W	W	RW
6	Destructive testing	Pipe	Mechanical properties	Tensile Flattening, Reverse Bend, Hardness, Impact, Micro (incl. Grain size)	Material specification, 6-71-0005, PR	Technical Specification	Technical Specification	Lab report	-	W	W	RW
7a	Final inspection	Pipe	Bevel inspection for cracks, other defects	MPI	100%	API 5L, PR	API 5L, PR	Inspection report	-	W	W	RW
7b	Final inspection	Pipe	Ends Inspection for laminations	MUT	100%	API 5L, PR	API 5L, PR	Inspection report	-	W	W	RW
7c	Final inspection	Pipe	Residential magnetism	Gauss meter	100%	API 5L, PR	API 5L, PR	Inspection report	-	W	RW	RW

Sl. No.	Stage	Component	Characteristics	Method of check	Quantum of check	Reference documents	Record	MECON	Sub vendor	Vendor	VENDOR APPOINTED TPI	MECON / CLIENT
7d	Final inspection	Pipe	Pipe	Surface condition, Straightness, End finish, Bevel angle, Root face, Outer dia., (Pipe body, Pipe ends), out of Roundness, Thickness, Length, Coating, Marking, Colour coding, End caps	Visual dimensional	100% by vendor, at random by MECON	Technical Specification	Inspection report	-	W	W	RW
8	Weight checking	Pipe	Pipe	Weight	Weighing scale	100%	Technical Specification	Inspection report	-	W	RW	RW

Legends: H- Hold (Offer for witness & obtain clearance), W – Witness, R – Review, RW – Random Witness, A – Approval, I – Information, X – Submit, PO – Purchase Order, PR – Purchase requisition, AUT – Automatic ultrasonic testing, MUT – Manual ultrasonic inspection, MPI – Magnetic particle inspection, M – Monitoring.

Regular production shall commence only after tests, calibration, manufacturing procedures and approved and after first day production witness and qualification.

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, Purchase Specification shall be applicable.

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

ITP No. : 05/21/12/001

INSPECTION AND TEST PLAN

FOR

LONGITUDINAL SEAM SUBMERGED ARC WELDED LINE PIPES (ON SHORE)

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
1	APR-16	ISSUED FOR IMPLEMENTATION	Sachin Singhal	Anil Kumar	A.K.Sarkar

ITP No. : 05/21/12B/002

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 / CLIENT
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 / CLIENT
3	Raw Material Inspection	Heat No., Plate No., Method of Manufacturing, Heat Treatment Condition	100% By Supplier & Supplier appointed TPI and Random By MECON / CLIENT	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 / CLIENT
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 / CLIENT	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 / CLIENT
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 / CLIENT	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 / CLIENT
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	OCT-15	ISSUED FOR IMPLEMENTATION	Sachin Singhal	Anil Kumar	A.K.Sarkar

ITP No. : 05/21/12C/003

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 / CLIENT
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 / CLIENT	Inspection Report	-	H	W	W

S. NO	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION			
					Sub Supplier	Supplier	Supplier Appointed TPI	MECON / CLIENT
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 / CLIENT
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 / CLIENT
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
0	May-2020	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 /SUB-SUPPLIER	VENDOR APPOINTED TPI	MECON / CLIENT
1a	Raw material inspection	Epoxy powder, Adhesive polyethylene compound, shots, grits 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, grits 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 (Frequency of Phosphoric Acid Wash can be reduced after one week of consistency of salt contamination results at the sole discretion of Owner/MECON)	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	RW
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	RW
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	RW
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	RW
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	RW

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR /SUB-SUPPLIER	VENDOR APPOINTED TPI	MECON / CLIENT
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	RW
7	PE Layer application	Each pipe	PE Film application temperature, finished coating thickness	Film thickness	100%	QA plan	PO, specifications	Inspection report	W	W	RW
7a	Final inspection	Each pipe	Visual & identification	Visual	100%	QA plan	PO, specifications	Inspection report	W	W	RW
8	Coating procedure & qualification (PQT)	Tests on pipe coated partly with epoxy and partly with epoxy & adhesive layers	1) Degree of Cure 2) Epoxy layer thk. 3) Adhesive layer thk. 4) Holiday Test 5) Adhesion Test 6) Flexibility 7) Cross-section & Interface porosity 8) Hot Water Adhesion Test	As per PQT procedures and specifications	5 samples from partially 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 on 3 pipes, no holiday allowed. 2) Two samples for both temp. on 4 pipes 3) Six samples from 3 coated pipes 4) From 4 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 /SUB-SUPPLIER	VENDOR APPOINTED TPI	MECON / CLIENT
8b	Tests on pipe coated with all three layers	Coated pipe	1) Cathodic disbondment 2) Holiday inspection 3) Coating thickness 4) Visual inspection 5) Hot Water Immersion 6) Air Entrapment 7) Specific electrical coating resistance	As per specification	1) One sample for each condition 2) On all pipes 3) On all points 4) On all pipes 5) One pipe 6) 2 samples (1 body + 1 weld, if there) from 4 pipes 7) One Pipe	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	RW
9 a)	Holi day detection at 25 kV	Coated pipe	To find surface discontinuities	Holiday detector	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W	RW
9 b)	Overall coating thckness	Each coated pipe	Thickness of coating	Every pipe	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W	RW
9 c)	Lab test for Chromate, Phosphoric acid & de-ionized water (as applicable)	Samples from the tank	Concentration	Lab Testing	Every pipe	QA plan	PO, PR & specifications	Lab Report	W	W	RW

SL. NO.	STAGE	COMPONENT	CHARACTE-RSTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	VENDOR /SUB-SUPPLIER	VENDOR APPOINTED TPI	MECON / CLIENT
9 d)	Phosphoric acid wash followed by de-ionized water wash (as applicable)	Blasted pipes	Visual, PH Value, salt level etc.	Suitable means	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W	RW
9 e)	Chromate Treatment	Blasted pipes	Uniform application as per Manufacturer's recommendation	Visual	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W	RW
9 f)	Coating application	Coating Operation	Preheating temperature, Inter coat time, line speed, Adhesive / PE film temperature, Overlap of layers etc.	Visual and other measuring apparatus	Every pipe	QA plan	PO, PR & specifications	Inspection report	W	W	RW
10.	**Off line tests**										
10 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
10 b)	Resistance to peel test	Coated pipe	To measure peel load	Peel test machine	One in 15 pipes for ends & one in 60 for middle / as per specification	QA plan	PO, PR & specifications	Inspection report	W	W	W
10 c)	Resistance to indentation test	Coated pipe	Hardness against indentation	Indentation bath, with heater, dial gauge & thermostat	Two pipes per shift for both temp.	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 /SUB-SUPPLIER	VENDOR APPOINTED TPI	MECON / CLIENT
10 d)	Cathodic Disbondment test	Coated pipe	Disbonded area / Equivalent circle radius (ECR)	CD test apparatus with continuous tem. Monitoring	Once/day (as per specification)	QA plan	PO, PR & specifications	Inspection report	W	W	W
10 e)	Visual (Air Entrapment)	Coated pipe	Air entrapment between the layers	Magnifier	2 samples (1body + 1 weld, if there)/shift	QA plan	PO, PR & specifications	Inspection report	W	W	W
10 f)	Degree of Cure	Coated pipe	Cure %, Glass Transition Temp(ΔH and ΔTg)	DSC	once/shift (as per spec)	QA plan	PO, PR & specifications	Inspection report	W	W	W
11	Calibration	—	Valid Calibration Reports	Verification	Once/ as & when required	—	---	----	P	R	R
12	Handling, Loading & Transportation	Coated pipe	Loading & Stacking methods, Physical & weather protection	Visual	Each Trailer & Stack	Approved Procedures	PO, PR & specifications	Inspection report	P	RW	RW
13	Final Documentation & IC	—	Review of all stage reports/ lab test reports/ PQT report & Inspection Certificates	----	Each Lot	---	PO, PR & specification	----	P	H	H

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.

INSPECTION AND TEST PLAN

FOR

INTERNAL LIQUID EPOXY COATING

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
2	JAN-26	ISSUED FOR IMPLEMENTATION	Sachin Kumar (AGM)	Sachin Singhal (DGM)	A. K. Jha (CGM – O&G)

1.0 SCOPE:

This Inspection Test Plan covers the minimum testing requirements of Internal Coating.

2.0 REFERENCE DOCUMENTS:

PO/PR/ Standards referred there in / Job specifications / Approved documents.

INPECTION AND TEST REQUIREMENTS:

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					VENDOR	VENDOR APPOINTED TPI	MECON/ GAIL
1	Raw Material Inspection of Coating Paint & Hardener	Batch No. Date of manufacturing, correlation with MTC, Product data sheet, Batch Test Certificate	100%	Inspection Report	R	R	R
2.	**Coating Material Qualification (First Day Production Coating):** Manufacturer shall coat minimum 25 pipes for MPQT. Out of 25 pipes, TPIA/ GAIL/ MECON shall select 5 pipes for further testing as per Tech. Spec. MEC/TS/05/21/014B and Design Standard ISO 15741-2016(E). MPQT shall be performed on change of paint material manufacturer.						
2a.	Raw Material Inspection of Coating Paint & Hardener for qualification of coating material	Coating Applicator shall test sample as per specification as minimum but not limited to following: a) Non-volatile matter (by mass) b) Non-volatile matter (by volume) c) Viscosity d) Density e) Ash residue on ignition f) Pot life g) Appearance & Continuity	Each Batch	PQT Document / Report	P	W	W

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					VENDOR	VENDOR APPOINTED TPI	MECON/ GAIL
2b.	Surface preparation (Visual appearance prior to blast cleaning) Inside surface of each pipe	Free from foreign matter, welding flux, spatters, salts, oil & grease	100%	PQT Document / Report	P	W	W
2c.	Surface preparation (Visual appearance prior to blast cleaning) Inside surface of each pipe	Free from visual damage & other contaminations, surface, irregularities, dent, lap etc.	100%	PQT Document / Report	P	W	W
2d.	Surface preparation (after blast cleaning) Inside surface of pipe	Degree of cleanliness / dust	100%	PQT Document / Report	P	W	W
2e.	Surface preparation (after blast cleaning) Inside surface of pipe	Surface profile / roughness / surface preparation	100%	PQT Document / Report	P	W	W
2f.	Paint preparation (Wet paint mixture) Paint Mix ratio as per manufacturer recommendation	Viscosity & Temperature	Each time paint is mixed & at time of interruption if any and each start of shift	PQT Document / Report	P	W	W
2g.	Environmental conditions Plant conditions	Ambient temperature, pipe surface temp., relative humidity, dew point	Once every 4 hours	PQT Document / Report	P	W	W

SL. NO.	STAGE/ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					VENDOR	VENDOR APPOINTED TPI	MECON/ GAIL
2h.	Cured paint film on steel panel on 5 nos. sample.	1) Adhesion test 2) Buchholz hardness 3) Bend test (conical Mandrel) 4) Porosity (glass panel dry +wet) 5) WFT (on all 25 pipes) 6) DFT (on all 25 pipes)	On start of production / each change of manufacturer / each change of manufacturer / each change of plant.	PQT Document / Report	P	W	W
2i.	Cured paint film on steel panel for Procedure Qualification test - paint material manufacturer.	1) Resistance to neutral salt spray 2) Resistance to artificial ageing 3) Resistance to gas pressure variation 4) Resistance to water immersion 5) Resistance to chemicals 6) Resistance to hydraulic blistering	Review of Test Certificates supplied by paint material manufacturer. Certificate shall not be older than 24 months.	PQT Document / Report	P	R	R
3.	**Regular Production:**						
3a.	Surface preparation (Visual appearance prior to blast cleaning) Inside surface of each pipe	Free from foreign matter, welding flux, spatters, salts, oil & grease	100%	Inspection Report	P	RW (Min. 25%)	RW
3b.	Surface preparation (Visual appearance prior to blast cleaning) Inside surface of each pipe	Free from visual damage & other contaminations, surface, irregularities, dent, lap etc.	100%	Inspection Report	P	RW (Min. 25%)	RW
3c..	Surface preparation (after blast cleaning) Inside surface of pipe	Degree of cleanliness / dust	100%	Inspection Report	P	RW (Min. 25%)	RW

3d.	Surface preparation (after blast cleaning) Inside surface of pipe	Surface profile / roughness / surface preparation	100%	Inspection Report	P	RW (Min. 25%)	RW
3e.	Paint preparation (Wet paint mixture) Paint Mix ratio as per manufacturer recommendation	Viscosity & Temperature	Each time paint is mixed & at time of interruption if any and start of each shift	Inspection Report	P	W	RW
3f.	Environmental conditions Plant conditions	Ambient temperature, pipe surface temp., relative humidity, dew point	Once every 4 hours	Inspection Report	P	W	RW
4	Coating inspection (on pipe) Inside Coating of Pipe	a) Appearance and continuity	Each pipe	Inspection Report	P	W	RW
		b) WET Film Thickness	Each hour of production (at 4 circumferential equidistance points on both ends of pipes)	Inspection Report	P	W	RW
		c) Porosity (Pinhole)*	At start of production, change of paint / hardener batch, interruption if any	Inspection Report	P	W	RW
		d) DFT (At Yard)	Each pipe	Inspection Report	P	W	RW
		e) Visual & cut back length	Each pipe	Inspection Report	P	W	RW

5	Coating Repair Internal Coating Repair (Pinhole/ sagging etc.)	Defective coating	Each defective pipe	Repair Inspection Report	P	W	RW
6	Cured paint film on steel test panel Regular production test	a) Adhesion test	2/Shift	Inspection Report	P	W	W
		b) Bend Test	2/Shift	Inspection Report	P	W	W
		c) Buchholz Hardness	2/Shift	Inspection Report	P	W	W
		d) Curing Test	2/Shift	Inspection Report	P	W	W
7	Paint film on glass test panels Regular production test	* Porosity (PINHOLE) both wet film and dry film	2/Shift and each new batch	Inspection Report	P	W	W
11	Pipe handling and storage Storage in yard	Secured handling & storage	Accepted coated pipes	Inspection Report	P	W	M
12	Calibration of instruments	Calibration of thermometer, thickness gauge, roughness, gauge etc.	Once / Shift	Calibration Report	P	R	R
13	Final Documents	Final Documents completion	Each Set		P	H	H

* The wet sponge test shall be carried out if the porosity on glass panels constitute a failure as per ISO 15741 Annexure G

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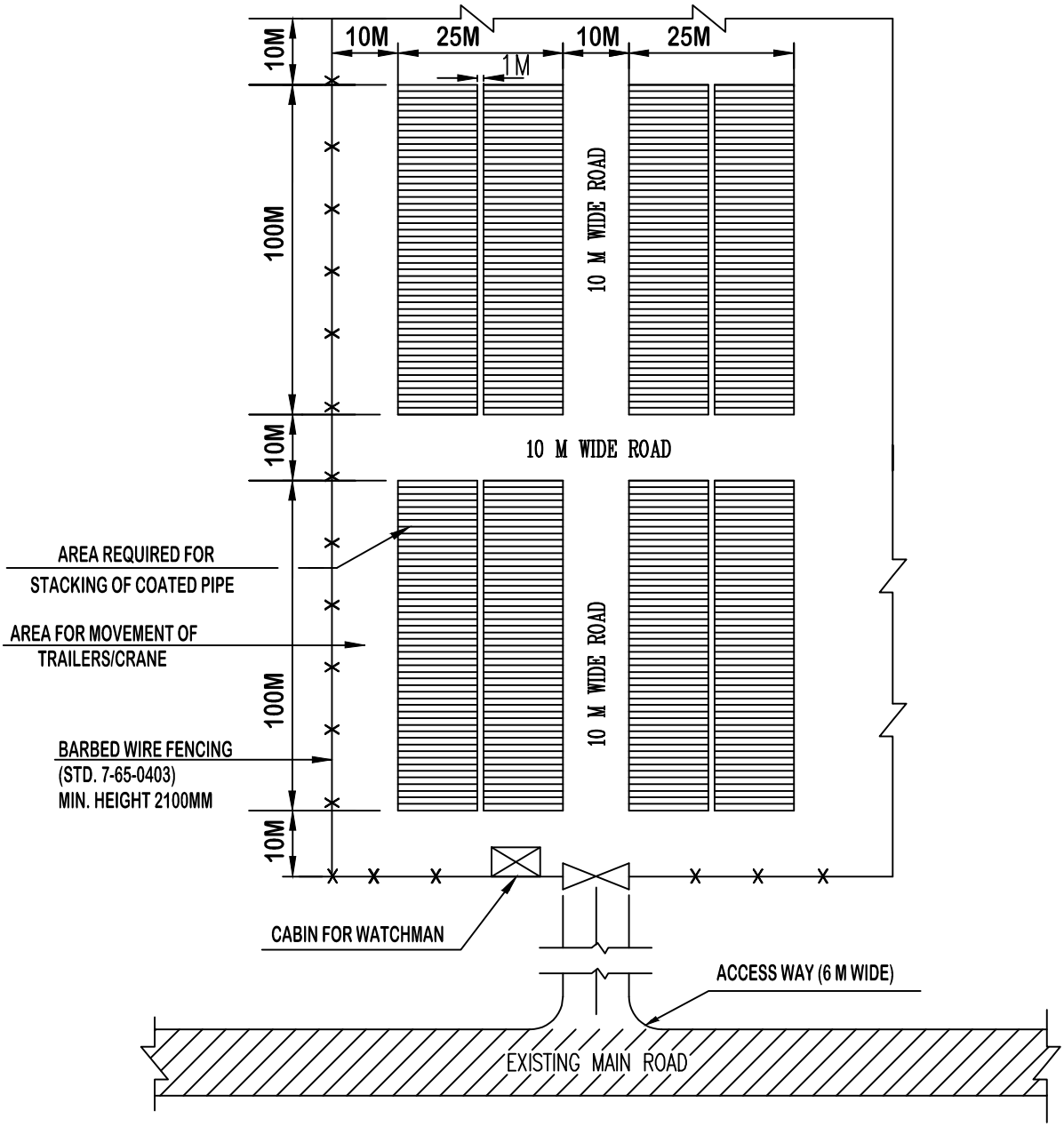
All items shall be provided with EN 10204-3.2 Certificates.

NOTES (As applicable):

1) 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.
2) In case of conflict between purchase specification, contract documents and ITP, more stringent conditions shall be applicable.
3) This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable.
4) Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in / Job Specification / Approved Documents.

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		PROJECT:
REVISIONS						REFERENCES	DRG. NO.

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

APPROVED BY ANIL KUMAR

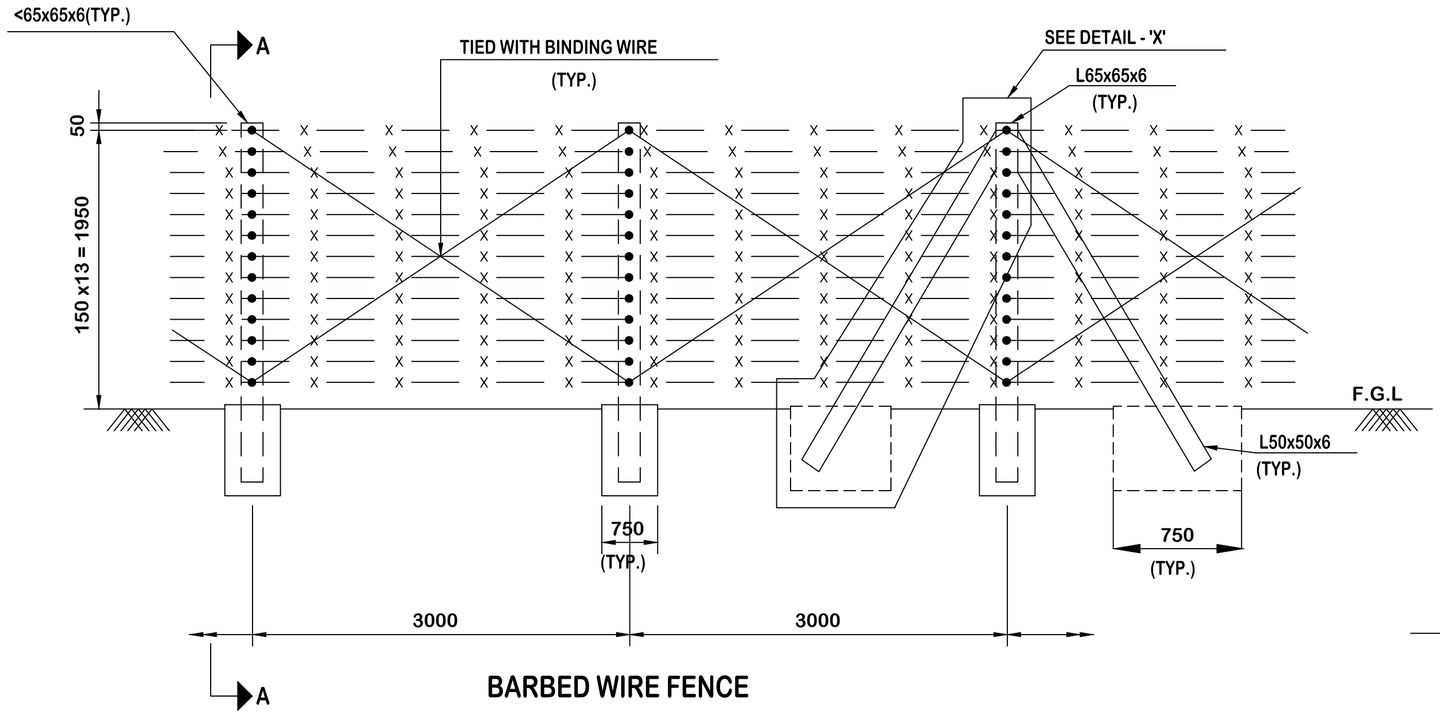
TYPICAL LAYOUT PLAN FOR STORAGE YARD

मेकॉन लिमिटेड
MECON LIMITED

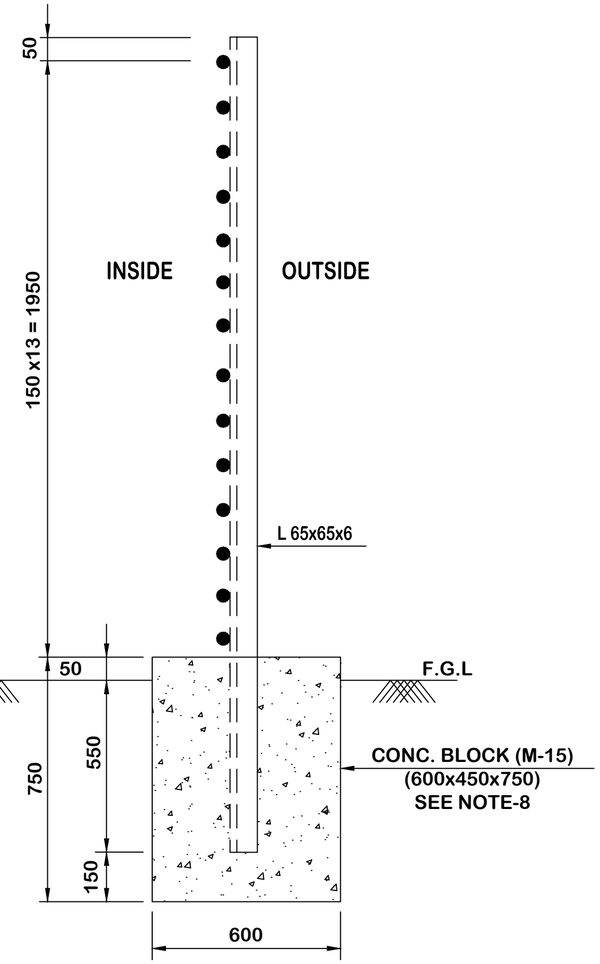
SCALE :

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

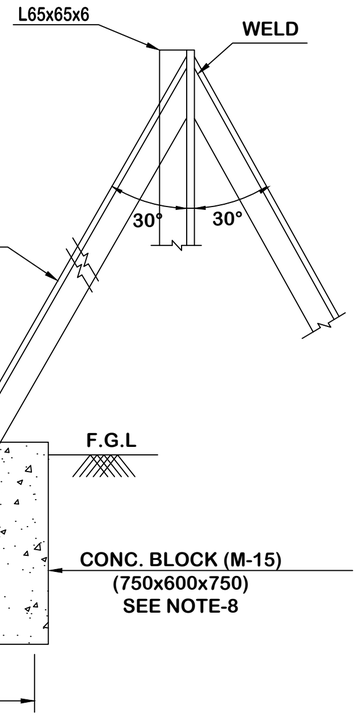
REV A



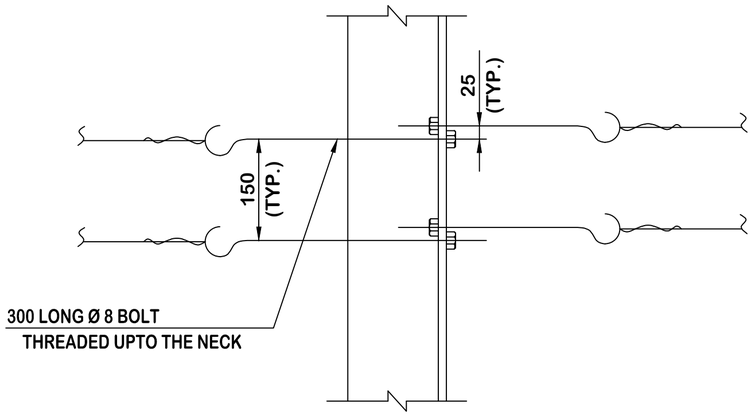
BARBED WIRE FENCE
(OUTSIDE)



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.

SECTION	CIVIL
LOCATION	NEW DELHI
DESIGNED	SACHIN
DRAWN	SUNIL
CHECKED AND VERIFIED	
APPROVED	SIG
	DATE 01.08.201

मेकॉन लिमिटेड
MECON LIMITED

DETAIL OF BARBED WIRE FENCING (WITH ANGLE IRON POST)

SCALE : NTS | SHEET 1 OF 1 | REV 0

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

Tender Ref. No.: 05/51/E0085/IGGL/012

REV / SEC — CONCURRED BY

ANNEXURE-A

REFERENCE LIST FOR SUPPLY OF STEEL PLATE/ COIL FOR THE LAST SEVEN YEARS

(MR No. MEC/E/0085/05/21/M/001/S002/12)

Steel Manufacturer : _____ Mill Name & Location : _____

Sl. No.	Project	Owner (Company name, Address, email ID, contact phone no.)	Pipe Manufacturer (Name, address, contact phone no., email ID etc.)	Plate/ Coil Width (mm)	Grade API 5L X-	Product Specification Level (PSL-2)	Wall thickness (mm)	Quantity (MT) > 5000 MT	Pipe Diameter for which supplied NB (inch)	Year of supply	Purchase/ Work Order No. (Note-2)	Inspection Release Note/ Completion Certificate No. (Note-2)

To be filled, signed and stamped by Bidder. Note:

1. This form shall be filled separately by line pipe manufacturer for each steel plate/ coil manufacturer (Not listed in Annexure-I to MR) proposed by the bidder.
2. Copy of Purchase/ work order(s) and Inspection Release Note(s)/ Completion Certificate(s) shall be enclosed.

Bidder's seal Signature of Bidder