CUGL Central U.P. Gas Limited

CENTRAL UP GAS LIMITED (CITY GAS PROJECT IN KANPUR, UNNAO, BAREILLY & JHANSI)

TENDER FOR

TENDER FOR SUPPLY OF 3LPE COATED LINE PIPEFOR CITY GAS DISTRIBUTION PROJECT OF M/S.CENTRAL U. P. GAS LIMITED, FOR THE PERIOD OF 01 YEAR.

TENDER NO. CUGL/REPL/SUPPLY/2026/16

VOLUME II OF II

TECHNICAL VOLUME

OPEN DOMESTIC COMPETITIVE BIDDING (THROUGH E-TENDERING MODE)

	PROJECT NUMBER:	
MATERIAL REQUISITION FOR 3LPE COATED LINE PIPES	TOTAL SHEETS	12
DOCUMENT NO		

CENTRAL U.P. GAS LIMITED

CITY GAS DISTRIBUTION PROJECT

SUPPLY OF 3LPE COATED LINE PIPE

C1	29.05.2026	ISSUED FOR CLIENT REVIEW	HT	AS	GSJ
REV	**DATE**	**DESCRIPTION**	**PREP**	**CHK**	**APPR**

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1.0 PURPOSE

This document is for Procurement, Manufacturing, Testing & Inspection, Packing & Forwarding, Transportation, Unloading and Stacking of 3LPE coated Carbon Steel Pipe at CUGL Site / store basis at different locations in Kanpur, Unnao, Bareilly & Jhansi cities in the State of UP as per the tender terms & conditions.

2.0 DEFINITIONS

Where used in this document, the following terms shall have the meanings indicated below, unless clearly indicated by the context to this order

PROJECT	City Gas Distribution
OWNER	Central U.P. Gas Limited (CUGL)
CONSULTANT	Resonance Energy Private Limited the party to act for and on behalf of OWNER for the EPMC Services.
MANUFACTURER	The party, which manufactures and supplies equipment and services to the OWNER or to Contractor
MR	Material Requisition

3.0 DOCUMENT PRECEDENCE

It shall be the responsibility of the MANUFACTURER/ VENDOR to inform the PURCHASER of any errors, ambiguities, inconsistencies, discrepancies or conflict of information that may be found to exist in any document, specification or drawing submitted by the PURCHASER.
In case of conflict, the order of precedence shall be as follows:

a. MR
b. Basic Documents (Specifications)
c. Codes and Standards

As a general rule in the event of any discrepancy between technical matter and local laws/ regulations (and documents above listed) the most stringent shall be applied.
MANUFACTURER/ VENDOR shall notify PURCHASER of any apparent conflicts between MR, specifications, related datasheets, any code and standards and any other specifications noted herein. (Resolution and/ or interpretation precedence shall be obtained from PURCHASER in writing before proceeding with the design/ manufacturer or completion of services.)

4.0 SCOPE OF SUPPLY

Sl. No.	DESCRIPTION	QTY	REMARKS
1.1	Pipes	As per Bill of Material Clause 5.0 of this document	
1.2	Painting and Coating	1 LOT	As per specification
1.3	Inspection and Testing	1 LOT	As per specification
1.4	Inspection and Test Plan	1 LOT	To be submitted by vendor
1.5	Certification accordance with EN10204, 3.2 certificates.	1 LOT	As per specification
1.6	Vendor Documentation	1 LOT	As per specification
1.7	Marking, Packaging & Transportation	1 LOT	As per specification
1.8	Preparation for Shipment	1 LOT	As per specification
1.9	Delivery Point	Delivery locations shall be as defined Tender Documents	
1.10	Delivery Schedule	Delivery within 20 weeks.	

5.0 BILL OF MATERIAL

Manufacturing, Inspection, testing and supply Coated line pipe as per specifications REPL-SS-PP-1001, REPL-SS-PP-1004, API 5L PSL 2 (46TH Edition) including 3LPE coating as per specification REPL-SS-PP-1003, packing, transportations, handling delivery of coated pipe as per tender conditions, including supply of documentation/ drawings as per the enclosed specifications, and other codes and standards enclosed or referred.

S. No.	SIZE (Inch/ mm)	THK. (mm)	MATERIAL	EXTERNAL COATING	METHOD OF MANUFACTURE	QTY (Mtr)
COATED LINE PIPE						
1	4" (114.3)	6.4	API 5L, X-42 PSL2	3LPE, 2.7 mm thk	SMLS/ HFW	27800
2	6" (168.3)	6.4		3LPE, 2.7 mm thk		6800

Abbreviations

1) HFW – High Frequency Welding
2) SMLS - Seamless

6.0 DESIGN DATA

Description	Value
Product	Natural Gas
Design Pressure (Maximum)	49 Kg/cm2
Material Specification	API 5L X-42 PSL2
Corrosion Protection	3 Layer PE coated and Cathodic Protection

NOTES:

1.0 Negative tolerance on Pipe wall thickness is not acceptable. Negative Tolerance if specified in Standard Specification shall not be considered and shall be superseded by this MR.

2.0 Overall length tolerance shall be (-) Zero and (+) One pipe length to complete the ordered quantity.

3.0 Pipe Manufacturer shall furnish valid license to use API monogram on API 5L Line pipes – Product Specification Level 2 (PSL-2) quality for the proposed pipe mill(s) along with the offer. The submitted API license shall be valid throughout the manufacturing period till completion of order.

4.0 Steel shall be procured from approved steel mill only

5.0 Charpy impact test shall be carried out at (-) 29°C.

6.0 Quantity may vary ± 10% for any item number. Final quantity will be informed to successful bidder during placement of order.

7.0 Mill Hydrotest shall be carried out 95% of SMYS.

8.0 Pipes length shall be as per Clause 9.11.3.3 of line Pipe Specification

9.0 **External Coating:**

- Supply of all coating material as per specification (REPL-SS-PP-1003) for carrying out 3LPE.
- Coating thickness shall be as per below table.

Minimum Thickness of External 3LPE Coating System				
Pipe size (OD)	**Thickness of Epoxy Layer (mm)**	**Thickness of Adhesive Layer (mm)**	**Thickness of HDPE Layer (mm)**	**Total Thickness of 3LPE coating (mm)**
4.5" to 10.75"	0.2	0.2	2.3	2.7

- The bidder's proposed coating raw material supplier(s) shall be manufacturer of the materials meant for the three-layer side extruded polyethylene coating of pipes. They must have manufactured and supplied the offered grades of materials within the last five years reckoned from the bid due date. These manufacturer(s) shall be evaluated at the bid stage and the bidder shall submit necessary letter of authorization and confirmation (as applicable) from such proposed manufacturer(s). Bidder offer shall be unconditional irrespective of the finally qualified raw material manufacturer(s).

- Cleaning and surface preparation of pipes, application of 3-layer side extruded polyethylene coating on line pipes, 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 no REPL-SS-PP-1003. Application shall also include coating of pipes of non-standard lengths obtained in case of cutting of bare pipes necessitated for removal of dents/defects.

10.0 Steel manufacturers indicated in 'Annexure-A' are acceptable for the supply of steel plates/ coils /billets to be used in the manufacture of quoted line pipes. The pipe manufacturer shall furnish specific confirmation for compliance to attached line pipe specification as applicable from any of the proposed steel plate/ coil manufacturer(s).

- In case pipe supplier proposes any steel manufacturer other than those listed at Annexure-A, such steel manufacturer must meet the following criteria:

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

  b. Steel plate/ coil manufacturer must have manufactured plate/ coil/Billets for production of line pipe 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.

  c. Confirmation regarding compliance to Line pipe specification nos. (REPL-SS-PP-1001, REPL-SS-PP-1004), Material requisition of this documents, as applicable from the proposed steel manufacturer shall be furnished.

d. A letter of commitment from proposed steel plate/coil/Billets manufacturer for supply of steel plates/coils/Billets required from manufacturer for the manufacture of line pipes under present bid.

- Pipe manufacturer shall submit the track record, along with the bid, in duly filled-up "Form-D" with documentary evidence (of Steel plate/ coil /Billets manufacturer) to establish the above qualification criteria indicated at (a), (b), (c) & (d) such as purchase order/ work order, inspection release note/ completion certificates of relevant previous supplies, as per bid requirement.

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

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

9 For previous track record in case of equivalent code, bidder shall submit the following:

- English translated copy of relevant code duly certified by Chamber of Commerce highlighting details of SMYS, Fracture Toughness and Cold Expansion & Weld Seam NDT to establish equivalence.

- Tabulated comparison for properties & test requirement etc. of API 5L vis-à-vis equivalent code.

10 Handling, loading, transportation, unloading, Stacking/Storing of coated pipes to designated storage yards, any material requirement for stacking, all necessary arrangement shall be in bidder scope.

11 Bidder shall inspect of all coated line pipes in presence of Owner representative while handing over of pipes. Holiday inspection for visually damaged, coating damaged pipes etc. shall be carried out by bidder while handing over of pipes. 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 coated pipes. All handling, lifting tools etc. required for inspection of coated pipes at Storage Yards shall be carried out by the bidder.

12 Pipe Internal Diameter inspection by Pull through (95% of ID) shall be carried out by bidder during handling over pipes to owner.

13 Pipe roughness shall be 40 Micron.

14 For butt weld end, bevel shall be in accordance with API specification 5L.

15 Both pipe ends of each pipe shall be provided with metallic or high impact plastic bevel protectors/end cap as per Manufacturer's standard. Bevel protectors/end shall be of a design such that they can be re-used by coating applicator for providing on externally anticorrosion coated pipes subsequent to coating of line pipe. The details of the bevel protector/end caps shall be furnished for approval prior to start of the production

16 All major damage to pipe ends/ bevels, including dents or gauges, shall be repaired by removal of damaged pipe material and rebevelling. No welding on the pipe surface shall be allowed.

17 Inspection of Field Test and Warranty

Purchaser shall be reimbursed by Manufacturer for any pipe furnished on this order that fails under field hydrostatic test if such failure is caused by a material/manufacturing defect in the pipe. The reimbursement cost shall include pipe, labor and equipment rental for finding, excavating, cutting out, installation of replaced pipe in position, all incidental expenses and administrative costs. 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

18 Bidder shall furnish quotation only in case he can supply material strictly as per this MR and specification forming part of MR.

19 Indicative ITP for line pipe & Coating is enclosed with MR/Tender. Minimum inspection and testing requirement of the line pipes shall be governed by attached ITP with Tender. Vendor shall submit their ITP after award for approval covering the requirement specified in tender ITP.

20 All items shall be provided with EN 10204, 3.2 Certification. Inspection of Steel Plate/Coil/Billet required for manufacturing of Line Pipe shall also be 3.2 certified as per EN 10204. To carrying out inspection as per EN 10204, 3.2 certification, Vendor shall appoint TPIA from the attached TPIA list at bidder`s own cost.

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

22 White Band marking inside for all the items.

23 Bidder shall submit Forms for Check List (FORM-A), Reference list for Supply of line pipe (FORM-B), Compliance statement (FORM-C), Reference list for Supply of steel (FORM-D), Deviation Sheet, duly filled, signed and stamped along with the bid. Bidder to note that previous track record shall be filled up in Form of reference list only, with all details as required in attached format. Track records in the other formats are not acceptable.

24 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 CONSULTANT/ COMPANY prior approval.

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

26 If the offer contains any technical deviations or clarifications or stipulates any technical specifications (even if in line with MR requirements) and does not include complete scope & technical/ performance data required to be submitted with the offer, the offer shall be liable for rejection.

27 The submission of prices by the Bidder shall be construed to mean that he has confirmed compliance with all technical specifications of the corresponding item(s).

28 Inspection and tests performed/witnessed by purchaser`s inspector shall in no way relieve the manufacturer`s obligation to perform the required inspection and test.

29 Bidder must submit all documents/ drawings/ calculations as specified in relevant specification along with his offer and after award of order.

30 Purchaser`s inspector reserves the right to perform stage wise inspection and witness tests, as indicated in specification at manufacture`s works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and facilities require for inspection to the purchaser`s inspector. Inspection and tests performed/witnessed by purchaser`s inspector shall in no way relieve the manufacturer`s obligation to perform the required inspection and test.

7.0 DOCUMENTS & DATA REQUIREMENTS

The table hereunder specifies the quantities and the nature of the documents to be submitted by the Manufacturer to the PMC.

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 PMC 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 Manufacturer. It shall bear the PMC 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	A	B		C	
		Number of copies	Number of copies	Required date	Number of copies	Required date
1.	Drawing/data submittal list and schedule	3	4	1 week + monthly	4	2 weeks after approval

Item	Documents and Data	A	B		C	
		Number of copies	Number of copies	Required date	Number of copies	Required date
2.	Production, test and delivery schedule (per item)	--	4	1 week + monthly	4	2 weeks
3.	Progress report	- -	4	Daily + weekly + monthly	- -	- -
4.	Catalogues / References	3	- -	- -	- -	- -
5.	Description of application and quality with technical data of 3LPE for external coating	3	4	3 weeks	4	2 weeks after approval + with final techn. File
6.	Code compliance certificate (Quality manual, ISO certificate, API License)	3	4	3 weeks	4	2 weeks after approval
7.	QA/QC program (First Day Production + Regular production separately)	--	4	2 weeks	4	2 weeks after approval
8.	Inspection and test procedures	--	4	3 weeks	3	2 weeks after approval + with final techn. file
9.	A description with calculation for handling, storage, transportation procedure during total manufacturing cycle and long storage procedure		4	4 weeks	- -	- -
10.	Duly filled & signed Technical Questionnaire & documents.	3	- -	- -	- -	- -

Item	Documents and Data	A	B		C	
		Number of copies	Number of copies	Required date	Number of copies	Required date
11.	List of fabrication and control operations (LOFC)	- -	4	2 weeks	4	2 weeks after approval
12.	NDE reports & Procedure	- -	4	When available	4	2 weeks after approval + with final techn. file
13.	Heat treatment reports (When available)	- -	4	When available	4	2 weeks after approval + with final techn. file
14.	Hydrotest and air test report (When available)	- -	4	When available	4	2 weeks after approval + with final techn. file
15.	Material certificate	- -	4	1 week after test	4	With final techn. file
16.	List of subcontractors with their scope	- -	4	2 weeks	- -	With final techn. file
17.	Copy of purchase orders to subcontractors	- -	4	2 weeks	- -	With final techn. file
18.	Copy of purchase order	- -	- -	- -	- -	With final techn. file
19.	Packing/shipping list w/weights and dimensions	- -	4	4 weeks	4	2 weeks before shipping
20.	Final technical file	- -	- -	- -	6	With shipping

NOTES

1) Durations in column B (Required date) are weeks after Purchase Order date.
Durations in column C (Required date) are weeks after document approval.
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 as indicated, and in electronic format (PDF Acrobat files) on two (2) CD-ROMs

8.0 LIST OF ATTACHMENTS

1. Specification for High Frequency Welded Line Pipe-Doc. No. REPL-SS-PP-1001
2. Specification for Seamless (SMLS) Line Pipe (Onshore) – Doc. No. REPL-SS-PP-1004
3. Specification for 3 Layer Polyethylene Coating of Line Pipes- Doc. No. REPL-SS-PP-1003.
4. ITP for HR Coils- Doc. No. REPL-ITP-PP-102.
5. ITP for Seamless Pipe – Doc. No. REPL-ITP-PP-104.
6. ITP for HFW Pipe- Doc. No. REPL-ITP-PP-101.
7. ITP for 3-layer PE coating of line pipes- Doc. No. REPL-ITP-PP-103.
8. Checklist- Doc. (Form-A)
9. Reference List for Supply of Pipe (FORM-B).
10. Compliance Statement – (FORM-C)
11. Reference List for Supply of Steel (FORM-D).
12. Deviation Sheet – Doc. No. REPL-SD-DS-001.
13. Instruction to Bidder – Doc. No. REPL-SD-ITB-001.
14. Vendor drawings document schedule. – Doc. No. REPL-SD-VS-001.

Resonance Energy

RESONANCE ENERGY PVT. LTD.

STANDARD SPECIFICATION

FOR

HIGH FREQUENCY WELDED LINE PIPE

REPL-SS-PP-1001

		Ajay Kumar			
00	04.02.2025	AK	AS	GS	AN
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

UNCONTROLLED COPY	:	If printed
CONTROLLED COPY	:	If in soft and signed

REVISION RECORD						
Rev.	**Revision Date**	**Prepared by**	**Checked by**	**Approved by**	**Authorized by**	**Revision Description**
00	04.02.2025	AK	AS	GS	AN	Issued as Standard Specification

CONTENTS

1. SCOPE

1.1 Coverage

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-Sixth Edition, April 2018 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".

1.2 Application of The API Monogram

The Manufacturer shall have a valid license to use API Monogram and line pipes supplied as per this specification shall bear API monogram in accordance with the requirements of Annex A of API Specification 5L, Forty—Sixth Edition, April 2018 for Product Specification Level PSL 2.

1.3 (New) Pipe Size

This Specification shall be applied to line pipe of size 4.5" (114.3 mm) OD thru 20" (508.0 mm) OD (both sizes included).

2. NORMATIVE REFERENCES

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

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

6. PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

6.1 Pipe Grade and Steel Grade

6.1.2 Line pipe supplied to this specification shall conform to Product Specification Level 2 (PSL2) as given in Table 1 of this specification and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (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	Thermomechanical rolled	BM, X42M, X46M, X52M, X56M, X60M, X65M & X70M
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	Thermomechanical-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 and cast by continuous casting only.

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

8.8 **Treatment of Weld Seams In EW And LW Pipes**

8.8.2 **LW pipe and PSL 2 HFW pipe**

The weld seam and the entire Heat Affected Zone (HAZ) shall be heat treated so as to simulate a normalizing heat treatment in order to control the grain structure so that no untampered 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 (%)	
C [b]	0.16	max. (For Grade BM to X56M)
	0.12[f]	max. (For Grade X60M to X70M)
Si	0.15 [m(new)]	min.
	0.45	max.
Mn [b]	1.20	max. (For Grade BM to X46M)
	1.40	max. (For Grade X52M & X56M)
	1.60	max. (For Grade X60M & X65M)
	1.70	max. (For Grade X70M)
P	0.020	max.
S	0.015	max.
V	0.05	max. (For Grade BM to X46M)
	[d]	max. (For Grade X52M to X70M)
Nb	0.05	max. (For Grade BM to X46M)
	[d]	max. (For Grade X52M to X70M)
Ti	0.04	max. (For Grade BM to X46M)
	[d]	max. (For Grade X52M to X70M)
Al [n (new)]	0.02 [o(new)]	min.
	0.07	max.
Cr	0.20	max.
Mo	0.10	max. (For Grade BM to X65M)
	0.20	max. (For Grade X70M)
Cu	0.35	max.
Ni	0.20	max.
N [n (new)]	0.012	max.
B	0.0005	max.
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} =< 0.20 %

CE_{IIW} =< 0.40%

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.

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

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

9.3 **TENSILE PROPERTIES**

9.3.2 The finished pipe (after all heat treatment & sizing operations) shall conform to the requirements of Table 7 of API Spec 5L and as modified herein.

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

API Spec 5L Grade	Permissible in excess of SMYS, MPa (psi)
Up to and including X46M	131 (19,000)
X52M to X60M	125 (18,000)
X65M to X70M	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 ≥ X60 and t ≥ 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 2 Pipe**

9.8.1 **General**

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

9.8.2 **Pipe body tests**

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

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

Table 8 - CVN absorbed energy requirements

for pipe body, weld and HAZ of PSL 2 pipe

Pipe Grade	Full-size CVN absorbed energy (KvT) [a.b] [J]	
	Average	Minimum
BM	40	32
X42M	40	32
X46M	40	32
X52M	40	32
X56M	40	32
X60M	42	34
X65M	45	36
X70M	50	40
a. The required KvL (longitudinal direction test pieces) values shall be 50% higher than the required KvT values. b. Testing shall be performed at a test temperature of 0° C (32°F) or at a lower temperature as specified in the Purchase Order /Material Requisition/Data sheets..		

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 ^{0}F) or at a lower test temperature as specified in the Purchase Order/ Material Requisition/Data sheets.

9.8.3 **Pipe weld and HAZ tests**

The average (set of three test pieces) absorbed energy value (Kv1) 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/ Material Requisition/Data sheets

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) of API Spec 5L.

9.10.3 **Arc burns**

9.10.3.2 Arc bums shall be treated in accordance with clause C.3 b) or c) of API Spec 5L. 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 per sulfate or a 5% solution of nital.

However, arc bums can be considered for acceptance, in case the same is re-crystallized by seam heat treatment. In such case, the Manufacturer shall demonstrate the re-crystallization 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 b) or c) of API Spec 5L.

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 clause C.3 b) or c) of API Spec 5L. Acceptable cold-formed dents with sharp-bottom gouges shall be treated in accordance with clause C.2 of API Spec 5L & as modified in this specification.

9.10.6 **Hard Spots**

Any hard spot larger than 50 mm (2.0 in) in any direction and hardness greater than 248HV_{10} shall be classified as defect and treated in accordance with clause C.3 b) or C.3 c) of API Spec 5L.

9.10.7 **Other surface imperfection**

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

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

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

c) Imperfections that encroach on the minimum specified wall thickness shall be classified as defects and treated in accordance with clause C.3 b) or c) 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 (inch)	Diameter tolerances [d]		Out-of-roundness [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 + 1.6mm	0.020D	0.015 D up to a maximum of2.0mm
168.3 (6 5/8) < D ≤ 273.1 (10 3/4)	± 0.0075 D	±0.005 D	0.020D	2.0mm
D > 273.1 (10 3/4)	± 0.0075 D up to a maximum of ±3.0mm	± 1.6mm	0.020D	3.0mm

a The pipe end includes a length of 100 mm at each of the pipe extremities.
b Deleted
c The diameter tolerance and out-of-roundness tolerance shall apply on inside diameter. The inside diameter, based on circumferential measurement, shall be calculated as ID = (D – 2t).
d For determining compliance to the diameter tolerances, the pipe diameter is defined as the circumference of the pipe in any circumferential plane divided by Pi (π).
e (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 0' clock, 3 0' clock, 6

0' clock and 9 0' clock positions. The tolerances for wall thickness shall be as given in Table 11 of this specification.

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

Table 11- Tolerances for wall thickness

Wall thickness (mm)	Tolerances c, d (mm)
t < 15.0 mm	+0.20 t -0.0t
t ≥ 15.0 mm	+3.0 mm -0.0 mm
a Deleted b Deleted c The + ve tolerance for wall thickness does not apply to the weld area. d See 9.13.2 of API Spec 5L and as modified herein for additional restrictions.	

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

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, as depicted in Figure 1 of API Spec 5L shall not exceed 12 mm.

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

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 follows:

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 and Inspection Documents

10.1.3 Inspection documents for PSL 2 pipes

10.1.3.1 Inspection certificate 3.2 in accordance with EN 10204 shall be issued for each dispatched pipe by Purchaser's authorized representative.

10.2 Specific Inspection

10.2.1 Inspection frequency

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

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

Table 18 - Inspection frequency of pipe

Sl. no.	Type of inspection	Frequency of inspection
1	Heat analysis [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 100 pipes per heat
5	CVN impact testing of the pipe body	Once per test unit of not more than 50 pipes
6	CVN impact testing of the weld and HAZ of pipe	Once per test unit of not more than 50 pipes
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 3.1.60 of API Spec 5L.

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

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806. Samples used for product analysis shall be taken from finished pipes only.

Samples for product analysis from coil may be used provided the traceability of samples is guaranteed.

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 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>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">Type of test</th><th colspan="2">Number, Orientation and location of test pieces per sample [a]</th></tr>
<tr><th colspan="2">Specified outside diameter, D mm (in)
< 219.1 mm (8.625 in) ≥219.1 mm (8.625 in)</th></tr>
<tr><td rowspan="2">Pipe body</td><td>Tensile</td><td>1 L90</td><td>1T180</td></tr>
<tr><td>CVN</td><td>3T90</td><td>3T90</td></tr>
<tr><td rowspan="3">Seam Weld</td><td>Tensile</td><td>---</td><td>IW[b]</td></tr>
<tr><td>CVN</td><td>3W and 3HAZ</td><td>3W and 3HAZ</td></tr>
<tr><td>Hardness</td><td colspan="2">1W
(As shown in figure 10.2.5.3 of this specification)</td></tr>
<tr><td rowspan="2">Pipe body and weld</td><td>Flattening</td><td colspan="2">As shown in figure 6 a) of API Spec 5L</td></tr>
<tr><td>Reverse Bend</td><td colspan="2">As shown in figure 10.2.4.9.1 of this specification</td></tr>
<tr><td colspan="4">a See figure 5 (b) of API Spec 5L for an explanation of the symbols used to designate orientation and location.

b Test specimen shall be tested for ultimate tensile strength only.</td></tr>
</table>

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.

Longitudinal tensile tests for pipe body with specified outside diameter, D < 219.1 mm (8.625 inch) shall be carried out on a strip specimen representing full wall thickness of the pipe prepared according to ASTM A370.

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

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.

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

10.2.3.7 **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 **Test pieces for Macro graphic and metallographic tests**

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

(New) 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 A370.

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 **Reverse bend test**

(New) 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:

Table 23 — Strain Values for Guided-bend Test

Pipe grade	Strain value *'e'*
Gr. B	0.1375
X42	0.1375
X46	0.1325
X52	0.1250
X56	0.1175
X60	0.1125
X65	0.1100
X70	0.1025

10.2.5 **Macro graphic 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}. 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**

10.2.7.1 Each pipe shall be visually examined for entire external surface and internal surface to the extent feasible and shall be free of defects in finished condition. Visual examination shall be carried out in a sufficiently illuminated area; minimum 1000 1x. If required additional lights shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

10.2.8 **Dimensional testing**

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

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

10.2.10 **Non-destructive inspection**

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

10.2.11 **Reprocessing**

This clause of API Spec 5L stands cancelled.

10.2.12 **Retesting**

10.2.12.1 Recheck analyses

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.

10.2.12.9 **Reverse bend retests**

(New) Reverse bend retest provisions shall be same as specified for flattening retests in clause 10.2.12.3 of API Spec 5L.

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 Purchase Order number, item number, pipe number and heat number.

11.2 Pipe markings

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

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

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

11.2.8 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.

15 PRODUCTION REPORT

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

- Pipe number
- Heat number from which pipe is produced
- Pipe length and weight
- Pipe grade

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

- All test certificates as per clause 10.1.3 of API Spec 5L and as modified herein.
- 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.

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.

16 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 (i.e. less than 50 numbers) ordered against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the manufacturing procedure qualification test as per clause B.5.1 of this specification shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION

Before pipe production commences, Manufacturing Procedure Specification (MPS) for manufacturing of pipes and Statistical process control charts shall be prepared by pipe manufacturer (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 MANUFACTURING PROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

a. **Visual Examination**

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

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

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, one from each pipe

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 (KvT) 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.

Annex C

Treatment of surface imperfections and defects

C.1 TREATMENT OF SURFACE IMPERFECTIONS

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

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

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

Annex E

Non-destructive inspection for Pipe

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

E.1 QUALIFICATION OF PERSONNEL

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

E.3 METHODS OF INSPECTION

E.3.1 **General**

E.3.1.1 The electric weld 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 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 SO mm (2.0 in) wide zone at each pipe end is free of any laminar imperfections in the circumferential direction.

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

E.5 **ULTRASONIC AND ELECTROMAGNETIC INSPECTION**

E.5.1.1 In addition to the API Spec 5L requirements, all automatic ultrasonic equipment shall have an alarm device, which continuously monitors the effectiveness of the coupling. The equipment for the automatic inspection shall allow the localization of both longitudinal and transverse defects corresponding to the signals exceeding the acceptance limits of the reference standard. The equipment shall be fitted with a paint spray or automatic marking device and alarm device for areas giving unacceptable ultrasonic indications. All ultrasonic testing equipment shall be provided with recording device. 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 and heat treatment as the pipe being inspected.

E.5.2.3 **Reference standards**

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

(New) 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 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.

E.5.2.3.2 Reference standards for coil/ pipe body 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 1< d < 0.5 t, where 't' 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 5L 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, SAW AND COW PIPE

E.8.1 The coil, except the longitudinal coil edges (area adjoining 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 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 LAMIMAR IMPERFECTIONS ALONG THE STRIP/ PLATE EDGES OR PIPE WELD SEAM OF EW, SAW AND COW PIPES

The longitudinal edges of the coil (area adjoining weld seam) shall be 100% ultrasonically inspected in accordance with ISO 10893-9 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[a]
	Area mm^2	Length[b] mm	Area mm^2	Length[b] mm	Width[c] mm	
Coil, except the longitudinal	1000	100[d]	300	35	8	10 (per 1.0 m

edges						x 1.0m)
Longitudinal edges of the coil	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**

a) 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 (c) or (d) of clause E.10 of API Spec 5L.

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

(New) 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 G

PSL 2 Pipe with Resistance to Ductile Fracture Propagation

G.1 INTRODUCTION

G.1.1 This annex specifies additional provision that apply for pipes ordered as per this specification.

G.2 ADDITIONAL INFORMATION TO BE SUPPLIED BY THE PURCHASER

G.2.1 CVN minimum average absorbed energy value (based on full-sized test pieces) for each test as per G.3.2 shall be as per table G of this specification for BM, weld and HAZ.

Table G.1, G.2 & G.3 of API specification 5L stands replaced by Table G of this specification.

Table G-CVN Absorbed Energy Requirements for Pipe Body, Weld and HAZ of PSL2 Pipe.

Pipe Grade	Full size CVN Absorbed Energy (K_vT)[a.b {J}]	
	Average	Minimum
BM	40	32
X42M	40	32
X46M	40	32
X52M	40	32
X56M	40	32
X60M	42	34
X65M	45	36
X70M	50	40

a. The required K_VL (Longitudinal direction test pieces) value shall be 50% higher than the required K_VT 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.

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.

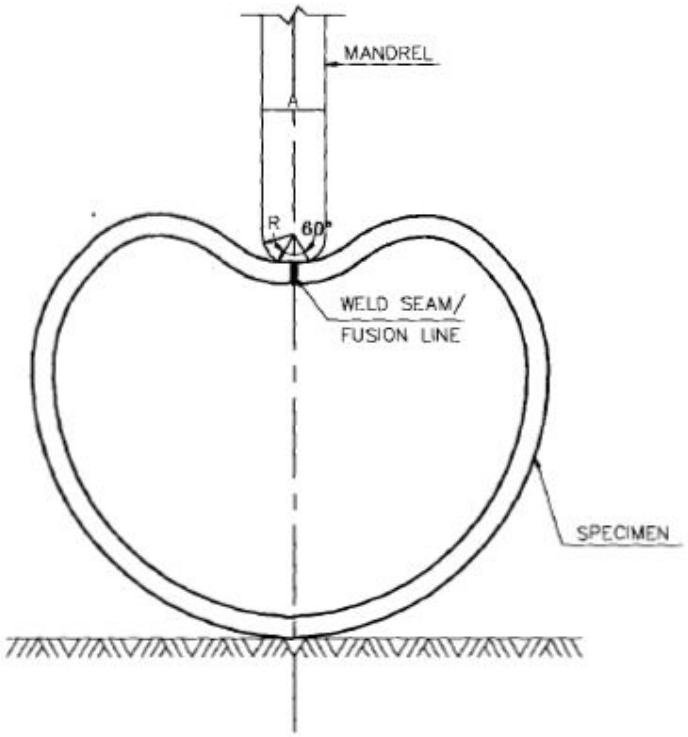


FIGURE: 10.2.4.9.1

REVERSE BEND TEST

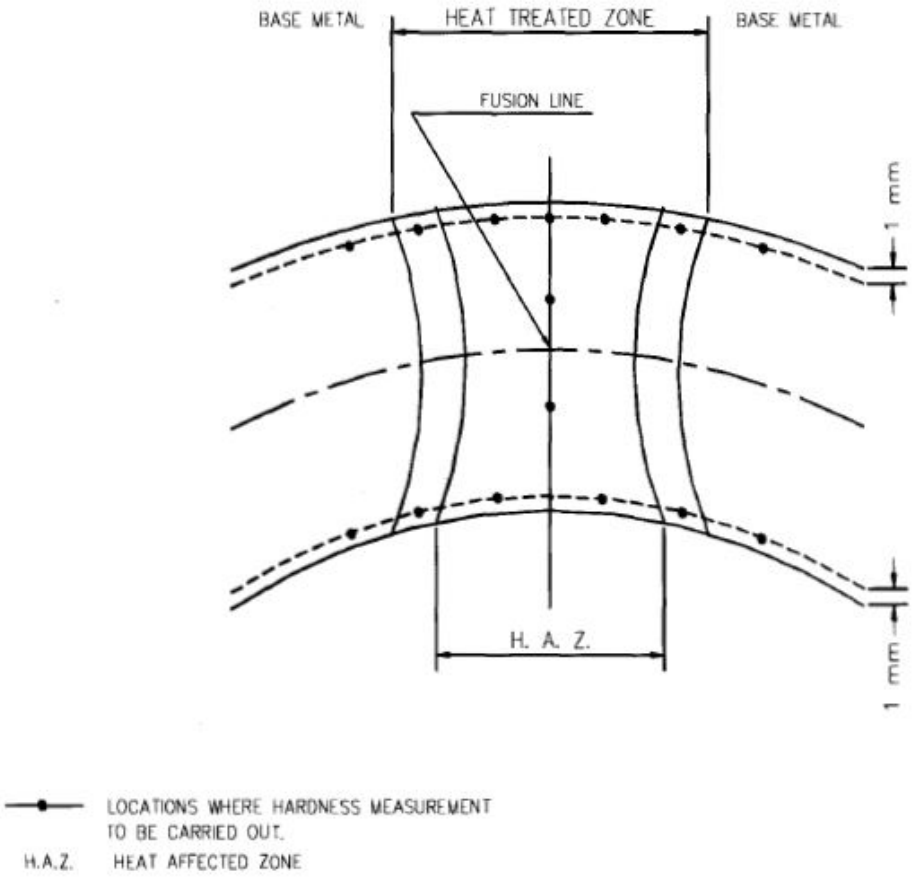
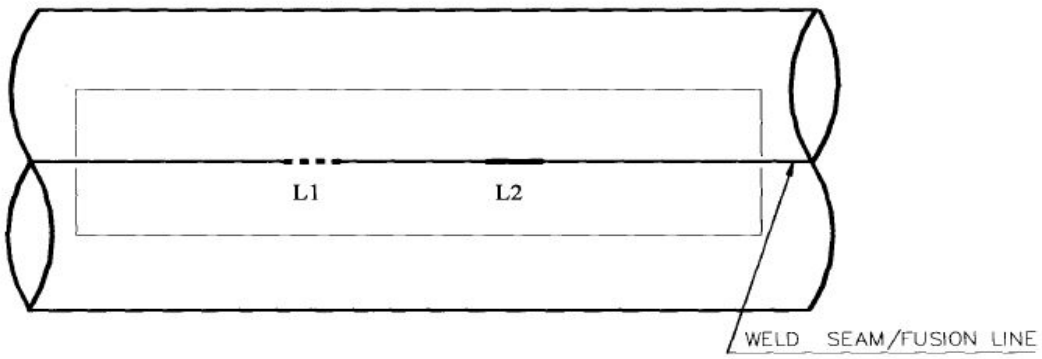


FIGURE: 10.2.5.3

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

Resonance Energy

RESONANCE ENERGY PVT.LTD.

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

REPL-SS-PP-1004

		Ajay kumar			
00	04.02.2025	AK	AS	GS	AN
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

UNCONTROLLED COPY	:	If printed
CONTROLLED COPY	:	If in soft and signed

REVISION RECORD						
Rev.	**Revision Date**	**Prepared by**	**Checked by**	**Approved by**	**Authorized by**	**Revision Description**
00	04.02.2025	AK	AS	GS	AN	Issued as Standard Specification

CONTENTS

1. SCOPE

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

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

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

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

1.1 Pipe Size

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

3. NORMATIVE REFERENCES

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

ASTM

ASTM E112: Standard Test Methods for Determining Average Grain size

6. PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

6.1 PIPE GRADE AND STEEL GRADE

6.1.2 Line pipe supplied to this specification shall conform to Product Specification Level 2 (PSL2) as given in Table 1 of this specification and consists of an alpha or alphanumeric designation that identifies the strength level of the pipe. The steel name (designating a steel grade), linked to the chemical composition of the steel, additionally includes a suffix that consists of a single letter (N or Q) that identifies the delivery condition as per Table 3 of this specification.

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

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

PSL	Delivery Condition	Pipe grade! steel grade [a,b]
PSL -2	Normalized	BN, X42N, X46N, X52N
	Quenched and tempered	BQ, X42Q, X46Q, X52Q, X56Q, X60Q, X65Q & X70Q
a Deleted b The suffix (N or Q) for PSL 2 grades belongs to steel grade		

6.2 DELIVERY CONDITION

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

8 MANUFACTURING

8.1 PROCESS OF MANUFACTURE

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

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

Table 3 - Acceptable manufacturing routes for PSL 2 pipe

Type of Pipe	Starting Material	Pipe forming	Pipe heat treatment	Delivery condition
SMLS	Ingots, Bloom or billet	Normalising forming	Heat treating [a] of weld area only	N
		Hot forming	Normalising or Quenched & Tempered	N or Q
		Hot forming and cold finishing		N or Q

8.3 STARTING MATERIAL

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

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

8.9 COLD SIZING AND COLD EXPANSION

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

8.11 JOINTERS

8.11.1 Jointers on pipes are not permitted.

9 ACCEPTANCE CRITERIA

9.2 CHEMICAL COMPOSITION

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

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

Table 5 - Chemical composition for pipe

Element	Mass fraction based upon heat and product analyses (%)	
C [b]	0.16	max.
Si	0.15 [m(new)]	min.
	0.40	max. (For Grade B to X46)
	0.45	max. (For Grade X52 to X70)
Mn [b]	1.20	max. (For Grade B to X42)
	1.40	max. (For Grade X46 & X70) for delivery condition N
	1.50	max. (For Grade X60 & X65) for delivery condition Q
	1.60	max. (For Grade X70) for delivery condition Q
P	0.020	max.
S	0.010	max.
V	[c]	(For Grade B)
	0.05	max. (For Grade X42 to X52)
	0.07[g]	max. (For Grade X56)
	0.08[g]	max. (For Grade X60 to X70)
Nb	[c]	(For Grade B)
	0.05[g]	max. (For Grade X42 to X70)
Ti	0.04[g]	max. (For Grade B to X60)
	0.06[g]	max. (For Grade X65 & X70)
Al [a (new)]	0.07	max.
Cr	020	
Mo	0.10	
Cu	0.35	
Ni	0.20	
N [n (new)]	0.012	
B	0.0005	

a Based upon product analysis as per clause 9.2.4 and 9.2.5 of API Spec 5L, the CE_{Pcm} limits apply if C =< 0.12% and CE_{nw} 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} =< 0.20 %

CE_{nw} =< 0.40%

Boron content shall be considered in CE_{Pcm} formula even if it is less than 0.0005%.

b Deleted

c Nb + V = < 0.06%

d Deleted

e Deleted

f Deleted

g Nb + V + Ti = < 0.15%

h Deleted.

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

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

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

9.3 TENSILE PROPERTIES

9.3.2 The finished pipe (after all heat treatment & sizing operations) shall conform to the requirements of Table 7 of API Spec 5L and as modified herein.

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

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

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

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

8 CVN IMPACT TEST FOR PSL 2 PIPE

9.8.1 General

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

9.8.2 Pipe body tests

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

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

Table 8 - CVN absorbed energy requirements

for pipe body, weld and HAZ of PSL 2 pipe

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

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

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

9.10 SURFACE CONDITIONS, IMPERFECTIONS AND DEFECTS

9.10.1 General

9.10.1.2 All pipes shall be free from cracks, sweats, leaks and slivers. Pipe containing such defects shall be treated in accordance with clause C.3 b) or C.3 c) of API Spec 5L.

9.10.4 Laminations

Any lamination or inclusion either extending into the face or bevel of the pipe or present within 50 mm from pipe ends shall be classified as defect. Pipes that contain such defects shall be rejected or cut back until no lamination or inclusion is present at the pipe ends and shall be treated in accordance with clause C.3 b) or C.3 c) of API Spec 5L.

9.10.5 Geometric deviations

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

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

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

9.10.6 Hard Spots

Any hard spot larger than 50 mm (2.0 in) in any direction and hardness greater than 248HV 10 shall be classified as defect and treated in accordance with clause C.3 of API Spec 5L.

9.10.7 Other surface imperfection

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

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

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

c) Imperfections that have a depth > 0.05 t and encroach on the minimum specified wall thickness shall be classified as defects and treated in accordance with clause C.3 of API Spec 5L.

9.11 DIMENSIONS, MASS AND TOLERANCES

9.11.3 Tolerances for diameter, wall thickness, length and straightness

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

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

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

Specified outside Diameter (D) mm (inch)	Diameter tolerances [d]		Out-of-roundness	
	Pipe except the end [a]	Pipe end [a,c]	Pipe except the end [a]	Pipe end [a,c]
114.3 (4 1/2) =< D = < 168.3 (6 3/8)	± 0.0075 D	-0.4 mm to + 1.6mm	0.020D	2.0mm
168.3 (6 3/8) < D = < 273.1 (10 3/4)		±0.005 D, but maximum of ± 1.6mm	0.020D	2.0mm
273.1 (10 ¾) < D > 406.4 (16)			0.020D	3.0mm
a The pipe end includes a length of 100 mm at each of the pipe extremities. b Deleted c The diameter tolerance and out-of-roundness tolerance shall apply on inside diameter. The inside diameter, based on circumferential measurement, shall be calculated as ID = (D – 2t). d For determining compliance to the diameter tolerances, the pipe diameter is defined as the circumference of the pipe in any circumferential plane divided by Pi (π). e Out-of-roundness tolerances apply to maximum and minimum diameters as (New) measured with bar gage, caliper, or device measuring actual, maximum and minimum diameters.				

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

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

Table 11- Tolerances for wall thickness

Wall thickness (mm)	Tolerances c, d (mm)
t < 10.0	+0.225 t -0.05 t
10.0 = < t < 15.0	+0.20 t -0.05 t
t ≥ 25.0	+5.00 -1.25
a Deleted b Deleted c The + ve tolerance for wall thickness does not apply to the weld area. d See 9.13.2 of API Spec 5L and as modified herein for additional restrictions.	

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

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 I 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.

10 INSPECTION

10.1 TYPES OF INSPECTION AND INSPECTION DOCUMENTS

10.1.3 Inspection documents for PSL 2 pipes

10.1.3.1 Inspection certificate 3.2 in accordance with EN 10204 shall be issued for each dispatched pipe by Purchaser's authorized representative.

10.2 SPECIFIC INSPECTION

10.2.1 Inspection frequency

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

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

Table 18 - Inspection frequency of pipe

Sl. no.	Type of inspection	Frequency of inspection
1	Heat analysis [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	CVN impact testing of the pipe	Once per test unit of not more than 100

	body	pipes
5	Vickers hardness testing of Pipe body	Once per test unit of not more than 50 pipes
6	Hydrostatic testing	Each pipe
7	Visual inspection	Each pipe
8	Pipe diameter and out-of roundness [d]	Each pipe
9	Wall thickness measurement [d]	Each pipe
10	Straightness [d]	At least 3 times per operating shift (12 hours maximum)
11	Other dimensional testing	Random testing, with the details left to the discretion of the manufacturer
12	Weighing of pipe	Each pipe shall be measured and recorded
13	Non-destructive inspection	In accordance with Annex E of API Spec 5L and as modified herein
14	Length	Each length of pipe shall be measured and recorded
a Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of pipe production. b Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented. c Deleted. d Measurement shall be recorded at least 3 times per operating shift (12 hrs maximum). e "Test unit" is as defined in clause 4.62 of API Spec 5L.		

10.2.2 Samples and test pieces for product analysis

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806. Samples used for product analysis shall be taken from finished pipes only.

10.2.3 Samples and test pieces for mechanical tests

10.2.3.1 General

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

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

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

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

10.2.3.2 Test pieces for the tensile test

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

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

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

10.2.3.3 Test pieces for the CVN impact test

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

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

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

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

10.2.3.8 Samples for hardness tests

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

10.2.4 Test methods

10.2.4.3 CVN impact test

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

10.2.4.8 Hardness test

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

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

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

10.2.6 Hydrostatic test

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

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

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

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

10.2.7 Visual inspection

10.2.7.1 Each pipe shall be visually examined for entire external surface and internal surface to the extent feasible and shall be free of defects in finished condition. Visual examination shall be carried out in a sufficiently illuminated area; minimum 1000 1x. If required additional lights shall be used to obtain good contrast and relief effect between imperfections and backgrounds.

10.2.8 Dimensional testing

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

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

10.2.10 Non-destructive inspection

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

10.2.11 Reprocessing

This clause of API Spec 5L stands cancelled.

10.2.12 Retesting

10.2.12.1 Recheck analyses

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

11 MARKING

11.1 GENERAL

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

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

11.2 Pipe markings

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

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

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

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

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

12 COATINGS AND THREAD PROTECTORS

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

13 RETENTION OF RECORDS

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

14 PRODUCTION REPORT

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

- Pipe number
- Heat number from which pipe is produced

- Pipe length and weight
- Pipe grade

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

- All test certificates as per clause 10.1.3 of API Spec 5L and as modified herein.
- Certified reports of dimensional inspection, surface imperfections & defects.
- Data on test failures, rejected heats/lots, etc.
- Information on production and shipping
- All other reports and results required as per this specification.

The certificates shall be valid only when signed by the Purchaser's Representative. Only those pipes, which have been certified by the Purchaser's Representative, shall be dispatched from the pipe mill.

In the event of small quantities of pipes supplied against this specification, the production report may consist of only test certificates required as per clause 10.1.3 of API Spec 5L and as modified herein and other test reports/results required as per this specification.

15 INSPECTION OF FIELD TESTS & WARRANTY

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

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

Annex B

Manufacturing Procedure Qualification for PSL 2 Pipe

B.1 INTRODUCTION

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

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

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

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

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

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE SPECIFICATION

Before pipe production commences, Manufacturing Procedure Specification (MPS) for manufacturing of pipes and Statistical process control charts shall be prepared by pipe manufacturer and submitted for approval of the Purchaser.

B.5 MANUFACTURING PROCEDURE QUALIFICATION TESTS (MPQT)

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

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

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

a. **Visual Examination**

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

b. **Ultrasonic Examination**

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

c. **Mechanical Properties**

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

The following tests shall be conducted:

i. Tensile test

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

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

- Two (2) longitudinal test pieces

ii. CVN impact testing

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

iii. Hardness test

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

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

Annex C

Treatment of surface imperfections and defects

C.1 TREATMENT OF SURFACE IMPERFECTIONS

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

C.2 TREATMENT OF DRESSABLE SURFACE DEFECTS

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

Annex E

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

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

E.1 QUALIFICATION OF PERSONNEL

E.1.1 All personnel performing NOT activities shall be qualified in the technique applied, in accordance with latest edition of ISO 9712, ISO 11484 or ASNT No. ASNT-TC-IA or equivalent

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

Inspector Qualification

Acceptable qualification for NOT inspectors shall be as specified below:

(i) For UT

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

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

(ii) For all other NDT methods

Evaluation of indications: Level II & Level III inspector

E.3 METHODS OF INSPECTION

E.3.1 General

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

E.3.3 Pipe End Inspection - Welded Pipe

E.3.3.1 Pipe ends including weld at the pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment, or, such non-inspected pipe end shall be cut-off. Records in accordance with E.5.4 of API Spec 5L shall be maintained.

E.3.3.2 Ultrasonic inspection in accordance with the method described in ISO 10893-8 shall be used to verify that the 50 mm (2.0 in) wide zone at each pipe end is free of any laminar imperfections in the circumferential direction.

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

E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION

E.5.1 Equipment

E.5.1.1 In addition to the API Spec 5L requirements, all automatic ultrasonic equipment shall have an alarm device, which continuously monitors the effectiveness of the coupling. The equipment for the automatic inspection shall allow the localization of both longitudinal and transverse defects corresponding to the signals exceeding the acceptance limits of the reference standard. The equipment shall be fitted with a paint spray or automatic marking device and alarm device for areas giving unacceptable ultrasonic indications. All ultrasonic testing equipment shall be provided with recording device.

E.5.2. Ultrasonic and electromagnetic inspection reference standards

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

E.5.2.3 Reference standards

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

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

Flat Bottomed Holes (FBH) for lamination detection shall have 6.4 mm (V4inch) diameter and depth 0.5 t, where 't' is the specified wall thickness.

E.5.3 Instrument standardization

E.5.3.2 The instrument shall be calibrated with appropriate reference standard (refer E.5.2 of API Spec 5L and as modified herein) under the same inspection conditions of pipes of normal production at following intervals::

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

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

E.5.5 Acceptance limits

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

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

a) Greater than or equal to 12.0 mm in the minor dimension.

b) Greater than or equal to 5000 mm^2 in area.

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

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

E.5.8 LAMINAR IMPERFECTIONS IN THE PIPE BODY

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

Compliance with such requirements shall be verified by ultrasonic inspection in accordance with ISO IO893-8 amended as follows:

- The distance between adjacent scanning tracks shall be sufficiently small to ensure detection of minimum allowed imperfection size.

The minimum coverage during automatic inspection shall be >= 25 %of the pipe surface.

E.5.9 Suspect pipe

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

E.7 RESIDUAL MAGNETISM

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

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

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

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

E.10 DISPOSITION OF PIPES CONTAINING DEFECTS

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

E.11 SUPPLEMENTARY NON-DESTRUCTIVE INSPECTION

(New)

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

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

Annex Q (New)

Purchaser Inspection

Q.1 INSPECTION NOTICE

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

Q.2 PLANT ACCESS

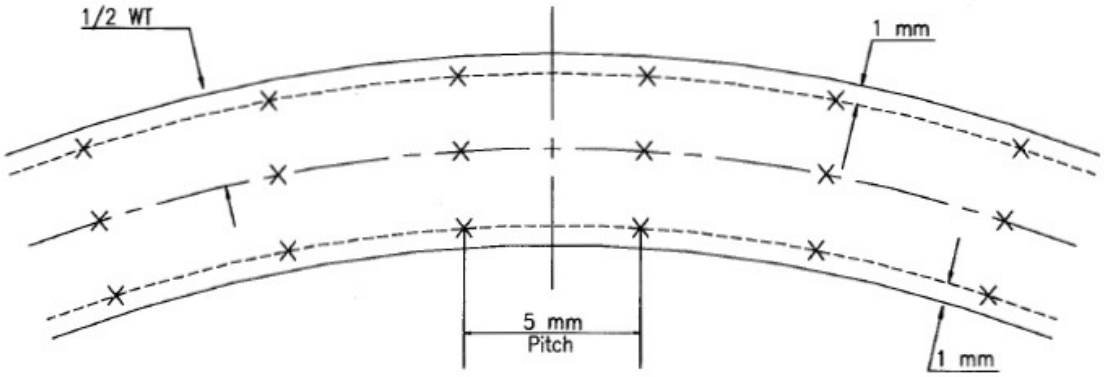
The inspector representing the purchaser shall have unrestricted access, at all times while work of the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable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

Q.3 COMPLIANCE

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

Q.4 REJECTION

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



Notes:

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

FIGURE: 10.2.4.8.1

LOCATIONS FOR HARDNESS MEASUREMENT

RESONANCE ENERGY PVT. LTD.

STANDARD SPECIFICATION
FOR
REPAIR OF POLYTHYLENE COATING

REPL – SS – PP -1002

Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By
00	04.02.2025	AK	AS	GS	AN

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REVISION RECORD						
Rev.	**Revision Date**	**Prepared by**	**Checked by**	**Approved by**	**Authorized by**	**Revision Description**
00	04.02.2025	AK	AS	GS	AN	Issued as Standard Specification

ABBREVIATIONS:

DC	:	Direct Current
EN	:	European Standard
KV	:	Kilo Volt

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for materials and equipment, application procedure and inspection of repair of damaged Polyethylene coatings on steel pipes. This specification is applicable for repairing damages less than 100mm x 100 mm for pipe sizes less than 10", 150mm x 150mm for pipe sizes between 12" to 28" and 300mm x 300mm for pipe sizes more than 28".

If damaged area of coating of the pipeline is larger than above, heat shrinkable sleeve is recommended.

The repair shall be carried out using repair patch made of radiation cross-linked polyolefin backing, coated on the inside with semi-crystalline thermoplastic adhesive and filler mastic.

The repair patch shall have thermal indicators to ensure correct heat is being applied during application.

2.0 MATERIAL AND EQUIPMENT

2.1 The repair material shall be as under:

a) Repair Patch: radiation cross-linked HDPE (Unexpanded High density polyethylene) with semi-crystalline thermoplastic adhesive.

b) Mastic Filler

c) Melt stick shall be Co-Polymer based and same shall be heat sensitive.

d) Liquid Epoxy Primer (two pack)

2.2 The repair material shall be certified by DIN to meet the requirements of EN12068 Stress Class CHT 80

2.3 The material shall not be older than their period of validity at the time of application by the Contractor. Deteriorated/decomposed materials shall not be used.

2.4 Materials shall be stored in sheltered storages in the manufacturer's original packing away from direct sunlight and in accordance with manufacturer's instructions.

2.5 Contractor shall supply all equipment and manpower required for a skilful application in the field in accordance with the specification.

3.0 APPLICATION PROCEDURE

3.1 The application procedure to be followed for holiday type of damage shall be in accordance with manufacturer's instruction and minimum requirement specified below whichever are the more stringent.

3.1.1 Preparation

Remove coating from damaged area with knife, scraper or power brush. Scrap off the damaged area and adjacent coating to remove oil, grease, rust, dirt and moisture. Pipe surface shall be prepared to SA 2½.

3.1.2 Preheating

Preheat the exposed bare metal surface to approx. 80° C and adjacent pipe coating to approx. 60° C with a torch moved back and forth over the surface. Upon preheating, the

pipe surface shall be applied with the two pack epoxy primer to ensure a minimum wet film thickness of not less than 200 microns to cover the exposed base metal.

3.1.3 Application of the Filler

Plastic filler shall be cut to size and applied to all exposed metal surface. The mastic shall be heated and smoothed down with a paint scraper to cover all bare metal in a manner such that all entrapped air is removed and mill applied coating thickness of the pipe is restored.

3.1.4 Application of repair tape

A patch shall be cut from the tape in a manner such that it extends 50 mm (2 inch) beyond the damaged area on all sides. The patch shall be positioned over the damaged area and heated until the temperature sensitive paint on the outside of the patch changes colour or dimples on the backing vanish. It shall be smoothed down to confirm with the contour of lap, and shall be freed of any air bubbles or wrinkles.

3.2 For cosmetic type of defects such as minor gouging, tearing, and/or scratches, which do not indicate holiday during holiday inspection, following procedure shall be adopted.

3.2.1 The defective area shall be roughened to remove loose polyethylene coating, oil, grease, dirt, etc.

3.2.2 This shall be followed by application of patch as detailed in clause 3.1.4.

4.0 INSPECTION AND TEST

4.1 A visual inspection shall be carried out for the following:

- Mastic extrusion on ends of the patch shall be examined.
- There shall be no sign of punctures or pinholes or bend failure. The external appearance of the patch shall be smooth, free from dimples, air entrapment or void formation.
- The entire closure patch shall have changed colour uniformly.

4.2 Holiday Inspection

The holiday detector used shall be checked and calibrated daily with an accurate D.C. Voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

The entire surface of the repaired section shall be inspected by means of a full circle holiday detector approved by Owner set to a D.C. Voltage of at least 25 KV. Inspection of repaired patch shall be conducted only after it has cooled below 50° C.

4.3 Procedure qualification shall be carried out for repair patch. The value for peel strength to pipe surface and to factory coating carried out as per EN 12068 shall be 0.5 N/mm minimum at 60°C.

4.4 All repaired joint shall be approved by the Owner.

5.0 DOCUMENTATION

5.1 Prior to procurement of coating repair materials, Contractor shall furnish four copies of,

but not limited to, the following for qualification of the Manufacturer and material:

i) Complete descriptive technical catalogs describing the materials offered along with samples of repair coating materials, its properties and installation instruction as applicable specifically to the project.

ii) Test certificate and results of previously conducted tests from independent inspection agency, for properties listed in Para 4.3 of this specification.

iii) Reference list of previous supplies of the similar material indicating the project details such as diameter, quantity, service conditions, year of supply, project name, contact person and feedback on performance.

Once the Company's approval has been given, any change in material or Manufacturer shall be notified to Company, whose approval in writing of all changes shall be obtained before the materials are manufactured.

5.2 Prior to shipment of materials from the Manufacturer's works, Contractor shall furnish six hard copies and an electronic copy of the following:

i) Test certificates for each batch of materials.
ii) Specific installation instruction with pictorial illustrations.
iii) Specific storage and handling instructions.

5.3 All documents shall be in English Language only.

RESONANCE ENERGY PVT.LTD.

STANDARD SPECIFICATION
FOR
3LPE COATING OF LINE PIPES

REPL-SS-PP-1003

		Ajay kumar			
00	04.02.2025	AK	AS	GS	AN
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD						
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ABBREVIATION

APS	Application Procedure Specification
ASTM	American Society for Testing and Materials
CD	Cathodic Disbondment
DIN	Deutsches Institut für Normung
DSC	Differential Scanning Calorimetry
ESCR	Environmental Stress Cracking Resistance
FBE	Fusion Bonded Epoxy
ISO	The International Organization for Standardization
HDPE	High-Density Polyethylene
PQT	Procedure Qualification Trial (Test)
QAP	Quality Assurance Plan
ITP	Inspection and Testing Plan
OWNER	Company (companies) that own(s) and /or operate(s) pipeline(s).
APPLICATOR	Company that undertakes the coating application in accordance with the provisions of this document.
CONTRACTOR	A party contractually appointed by the Owner to fulfill all, or any of the activities associated with design, construction and operation.
CONSULTANT	Professionals, who provide technical support, perform trouble-shooting functions and customer issues.
MANUFACTURER	Company responsible for the manufacture of coating materials, chemicals and consumables.
SSPC	The Society for Protective Coatings

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1.0 SCOPE

1.1 This specification covers the minimum requirements for supply/arrangement of all materials, plant, equipment, plant sites, consumables, utilities and application including all labor, supervision, inspection and tests, transportation, handling, coating integrity etc. for application of external anti-corrosion coating of pipes by using 3 Layer Side Extruded Polyethylene coating conforming to ISO 21809- 'Petroleum and Natural Gas Industries-External Coatings for buried and submerged pipeline transportation systems- Part 1:Polyolefin Coatings', and the requirements of this specification.

In case, Applicator/ Contractor feels more stringent testing shall be followed to meet all testing requirements of this specification, then Applicator / Contractor is free to do such stringent testing including equipment calibration etc.

The three-layer coating as per this specification shall belong to coating Class B of ISO 21809- 1: 2018 and shall be suitable for design temperature range of (-) 40 °C to (+) 80 °C.

External 3LPE coating of line pipe consists of:

a) 1st Layer: Electrostatically sprayed primed layer of epoxy powder;

b) 2nd Layer: Application of grafted co-polymer adhesive by side extrusion process

c) 3rd Layer: Application of medium / high density polyethylene by side extrusion process in order to obtain plant-applied, integrated, anti-corrosion 3LPE coating.

All the above coating layers are applied with specified individual thickness, conforming the requirements relevant applicable codes, specifications & standards and also meeting the expected design life for intended uses.

2.0 REFERENCE DOCUMENT

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

ISO 21809-1 :2018	Petroleum and Natural Gas Industries-External Coatings for buried and submerged pipelines used in pipeline transportation systems – Part 1: Polyolefin coatings (3-layer PE and 3-layer PP).

ISO 21809-2 :2014	Petroleum and Natural Gas Industries-External Coatings for buried and submerged pipelines used in pipeline transportation systems – Part 2: Single Fusion-bonded Epoxy Coatings.
ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Frequencies.
ASTM D257	Standard Test Methods for DC Resistance or Conductance of Insulating Materials.
ASTM D792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D1238	Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics.
ASTM D1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
ASTM D4940	Standard Test Method Conductometric Analysis of Water-Soluble Ionic Contamination of Blast Cleaning Abrasives.
API RP 5L1	Recommended Practice for Railroad Transportation of Line pipe
API RP 5LW	Recommended Practice for Transportation of Line pipe on Barges and Marine Vessels.
API RP 5LT	Recommended Practice for Truck Transportation of Line Pipe
DIN EN 30670:2012	Polyethylene Coating on Steel Pipes and Fittings-Requirements and Testing.
BS EN 10204	Metallic Products – Types of Inspection Documents
ISO 306	Plastics-Thermoplastic materials- Determination of Vicat softening temperature (VST)

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
ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
ISO 1133-1	Plastics –Determination of the melt mass- flow rate (MFR) and melt volume –flow rate (MVR) of thermoplastics-Part 1: Standard method.
ISO 1183	Plastics – Methods for determining the density of non-cellular plastics.
ISO 2808	Paints and varnishes - Determination of film thickness
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 and 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 – Tests for assessment of Surface Cleanliness – Part 3 –Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape method).
ISO 8503-4	Preparation of Steel Substrates before Application of Paints and Related Products– Surface roughness characteristics of blast-cleaned steel substrate - Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile – Stylus instrument procedure.
ISO / TS 9002	Quality Management Systems: Guidelines for the application of ISO 9001.
ISO 11124 (all parts)	Preparation of Steel Substrates Before Application of Paints and Related Products – Specification for metallic blast-cleaning abrasives.

ISO 11357-6	Plastics - Differential scanning calorimetry (DSC) - Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT).
ISO 15512	Plastics - Determination of water content
SSPC AB3	Ferrous metallic abrasives.
SSPC- SP1	Solvent cleaning
SSPC Guide15	Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates
API 5L	Specification for Line Pipe
ASME B31.4	Pipeline Transportation Systems for Liquids and Slurries
ASME B31.8	Gas Transmission and Distribution Piping Systems.
AWWA Spec	Standard Methods for the Examination of Water and Wastewater

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

3.0 PLANT SCALE AND INSTALLATION:

3.1 Applicator/ Contractor shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), both new 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/ Contractor shall ensure non-stop work execution owing to prohibitive adverse weather conditions and install requisite equipment and plant in roofed and adequately weather-protected areas.

3.2 Plant equipment, machinery for abrasive blasting, induction heating, chemical pre-treatment, spray of FBE powder, extrusion of adhesive and polyethylene, quenching, cut back preparation 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. The Contractor has to select the Applicator from the Vendor list specified elsewhere in the Tender document.

3.3 The epoxy booth shall be sized to accommodate number of spray guns (virgin & re-cycled) required for application of required quantity of fusion bond epoxy powder to be electrostatically sprayed on to the pipe to achieve required thickness as specified.

3.4 Plant shall have fusion bond epoxy powder storage room with power back up for air conditioning or de-humidifier equipment capable of storing epoxy powder as per temperature & humidity conditions as per manufacturer's recommendation. Conveying of epoxy powder from storage room to fluidized bed shall be thru a suitably designed conveying system. Manual powder feeding shall not be permitted. Proper sieving system shall be available for both virgin and re-cycled powder. System for ratio control of virgin & re-cycled powder should be available.

3.5 HDPE & Adhesive granules shall be separately stored in identified shed area, protected from direct sunlight, heat and water as per manufacturer's recommendations.

3.6 The air used for fluidization of epoxy powder shall be free from f. For this purpose, dehumidifiers and / or air dryer as necessary shall be provided along with necessary

monitoring and control systems. Fluidized bed shall have magnets adequate to remove iron and steel shaving contaminant from recycled powder.

3.7 The conductivity of DI (De-Ionized) water (if used) shall be less than 5 micro-siemens/cm and rinse water pressure shall be minimum 1500 psi.

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

3.9 The Applicator/ Contractor shall at its own responsibility and cost, provide for water and power supply and other utilities and consumables and obtain authorization regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing Authorities.

3.10 The Applicator/ Contractor shall at its own expense provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and regular production. Material manufacturer shall conduct the tests for each grade of material in Approved external independent laboratory (preferably ISO 17025 certified or equivalent having good track records of pipe coating testing) and provide complete test report (not older than 3 years) prior conducting Procedure Qualification Trail (PQT).

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

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

4.0 COATING MATERIALS:

4.1 The three-layer coating system shall comprise of a fusion bond epoxy layer, co-polymeric or grafted adhesive and 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 (FBE), adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified and approved by Owner/ Consultant in accordance with provisions of Annexure I of this specification. Applicator / Contractor shall obtain prior approval from Owner for the coating system and coating materials.

4.2 The coating material manufacturers shall carry out tests for all properties specified in clause 5.4.1, 5.4.2 & 5.4.3 and Table 2, 3 & 4 respectively for each batch of epoxy, adhesive and polyethylene compound. The coating materials manufacturer shall issue test certificates as per BS EN 10204, 3.1 for each batch of materials supplied to

Applicator/ Contractor indicating all contents/ parameters required for batch

certification as per clause 9.3, Table 6 of ISO 21809-1:2018 and the same shall be submitted to Owner for approval prior to their use.

4.3 In addition to Manufacturer's certificate, the Applicator/ Contractor shall draw two samples per batch of epoxy, adhesive and polyethylene in the presence of Owner Representative and test for the following properties at the coating laboratory prior to its use in order to establish compliance with the manufacturer's test certificates.

4.3.1 **Epoxy Powder:**

- Density
- Gel Time
- Particle size
- Moisture content
- Thermal characteristics (Tg1, Tg2 & ΔH)

4.3.2 **Adhesive:**

- Density
- Melt Flow Rate
- Vicat Softening Temperature
- Water Content

4.3.3 **Polyethylene:**

- Melt Flow Rate
- Density
- Vicat Softening Temperature
- Water Content
- Oxidation Induction Time

In case of failure of any of the above tests in any batch, that batch of material shall be tested for all other tests required as per clause 5.4.1, 5.4.2 & 5.4.3 and Table 2, 3 & 4 respectively, including the tests which failed. If all tests pass, the batch shall be

accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

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

- Name of the Manufacturer
- Grade or Trade name
- Health, safety and environmental Instructions
- Type of Material
- Batch Number
- Place of Manufacture
- Manufacturing Date / Shelf Life/Expiry Date (if applicable)
- Quantity

All materials noted to be without above identification shall be deemed suspect and shall be rejected by Owner. Such materials shall not be used for coating and shall be removed from plant/ factory and replaced by Applicator/ Contractor at his expense.

4.5 Applicator/ Contractor shall ensure that all coating materials are properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use. Documentary evidence for the same shall be provided for verification by Owner/ Consultant.

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

5.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING:

5.1 The coating shall be able to withstand a maximum in service operating temperature up to +80°C and shall conform to "Class B" as per ISO 21809-1:2018.

5.2 The topcoat polyethylene used shall be a black readymade compound, fully stabilized against influence of ultraviolet radiation (i.e., sunlight), oxygen in air and heat (due to environmental temperature up to +80°C). No appreciable changes shall occur during exposure to such environments up to at least a period of 8500 hours. The Applicator / Contractor shall submit certificate from Manufacturer in this regard.

5.3 Thickness of the Coating System:

Minimum thickness of each layer and total thickness of finished 3LPE coating system shall be as under:

Table 1: Minimum Thickness of Coating System				
Pipe size (OD)	**Thickness of Epoxy Layer (mm)**	**Thickness of Adhesive Layer mm**	**Thickness of HDPE Layer mm**	**Total Thickness of 3LPE coating mm**
4.5" to 10.75"	0.2	0.2	2.3	2.7
12.75" to 20"	0.2	0.2	2.7	3.1

For SAW pipes, 10% reduction on total thickness of applied coating measured on the apex of the weld seam shall be acceptable.

5.4 Properties

Properties of coating material and coating system shall comply with the requirements indicated in subsequent paragraphs. Applicator/ Contractor shall choose brand of epoxy powder, adhesive & HDPE as per approved vendor list (refer Annexure I) that shall achieve the functional requirements and properties of coating system as specified in clause no. 5.1, 5.2 and 5.4 of this specification respectively.

The acceptable combinations of coating material shall be as per Annexure-I.

5.4.1 Properties of Epoxy Powder (FBE):

Table 2 – Epoxy (FBE) Properties:				
Sl. No.	**Properties**	**Unit**	**Requirements**	**Test Method**
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	%	3.0% retained on 150µm sieve ≤0.2% retained on 250µm sieve and within manufacturer's specification	ISO 21809-2
4	Moisture Content	% mass	≤ 0.6	ISO 21809-1 Annex K
5	Thermal Characteristics (Tg1, Tg2, ΔH) Minimum Glass Transition Temperature (Tg2)	°C	Within manufacture's Specification. ≥ 95 and within manufacturer's specification	ISO 21809-1 Annex D

The colour of epoxy powder shall be either green or dark red or any other colour approved by Owner except grey colour.

5.4.2 Co-polymeric or Grafted Adhesive:

Table 3 – Co-polymeric or Grafted Adhesive Material Properties:				
Sl. No.	**Properties**	**Unit**	**Requirements**	**Test Method**
1	Density	kg/m3	≥930 and within manufacturer's specification	ISO 1183
2	Melt Flow Rate (MFR)	g/10 min	≥1.0 and within manufacturer's specification	ISO 1133-1
3	Water Content	%	≤0.05	ISO 15512
4	Strain at Break at 23°C ± 3°C	%	≥600	ISO 527-2
5	Stress at yield 23°C ± 3°C	MPa	≥8	ISO 527-2
6	Vicat Softening Temperature (A/50, 9.8 N)	°C	≥100	ISO 306

5.4.3 Properties of Polyethylene (HDPE) Compound:

Table 4 - HDPE (Top coat) Material Properties:				
Sl. No.	**Properties**	**Unit**	**Requirements**	**Test Method**
1	Density of black compound	g/cm3	≥0.940	ISO 1183
2	Melt flow rate (MFR)	g/10 minutes	≥0.25 and within manufacturer's specification	ISO 1133-1
3	Water Content	%	≤0.05	ISO 15512
4	Carbon Black Content	%	2-3	ISO 6964
5	Carbon Black Dispersion		Max Grade 3	ISO 18553
6	Hardness	Shore D	≥55	ISO 868
7	Strain at break at 23°C ± 3°C	%	≥600	ISO 527-2
8	Stress at Yield at 23°C ± 3°C	MPa	≥17	ISO 527-2

9	Vicat Softening Temperature (A/50, 9.8 N)	°C	≥110	ISO 306
10	Environmental Stress Cracking Resistance (ESCR) (50°C, F50)	h	≥ 1000 Cond.B, 10% Igepal CO630 or If density of black compound >0.955 g/cm3 ≥ 300 Cond.B, 100% Igepal CO630	ASTM D 1693
11	Oxidation Induction Time (Intercept in the tangent method)	min	≥30 at 2100C	ISO 11357-6
12	UV Resistance and Thermal Ageing	%	Δ MFR ≤35	ISO 21809-1 Annex G
13	Volume resistivity @ 23°C ± 2°C	Ohm-cm	$\geq 10^{16}$	ASTM D 257
14	Dielectric Withstand, 1000 Volts/second rise @ 23°C ± 2°C	V/mm	≥30,000	ASTM D 149

5.4.4 Properties of Applied 3LPE Coating:

Table 5 - On Cured Epoxy (FBE) film of 3LPE Coating

Sl. No.	Properties	Unit	Requirements	Test Method
1	Minimum Epoxy Layer Thickness	mm	0.2	ISO 2808
2	Degree of Cure % Cure ΔTg	 % °C	 Minimum 95 -3°C ≤ΔTg≤ + 3°C	ISO 21809-1 Annex D
3	Holiday Detection (Test Voltage set to 5V per µm of minimum specified epoxy coating thickness)	V	No holidays	ISO 21809-2 Clause 10.3.2
4	Dry Adhesion	-	Rating 1 or 2	ISO 21809-2 Clause A.4
5	Hot Water Adhesion 24 h at 75°C+/3°C	-	Rating 1 to 2	ISO 21809-2 Clause A.16
6	Hot Water Adhesion 28 days at 75°C+/-3°C	-	Rating 1 to 3	ISO 21809-2 Clause A.16
7	Cross-Section Porosity	-	≤compared with Fig. A.11 of ISO 21809-2	ISO 21809-2 Clause A.12
8	Interface Porosity	-	≤compared with Fig. A.12 of ISO 21809-2	ISO 21809-2 Clause A.12

9	Flexibility at 0°C	Degree per ppd	No cracking, tear, disbondment or delamination at 2° ppd length	ISO 21809-2 Clause A.13
10	Impact Resistance at 0 °C	J	> 1.5	ISO 21809-2, Clause A.14

Table 6 - On Extruded Adhesive film of 3LPE coating

Sl. No.	Properties	Unit	Requirements	Test Method
1	Minimum Adhesive Layer Thickness	mm	0.20	ISO 2808
2	Strain at Break at 23°C ± 3°C	%	≥600	ISO 527-2
3	Stress at Yield at 23°C ± 3°C	MPa	≥8	ISO 527-2
4	Vicat Softening Temperature (A/50, 9.8 N)	°C	≥100	ISO 306

Table 7 - On HDPE Top Coat layer and 3LPE coating

Sl. No.	Properties	Unit	Requirements	Test Method
1	Continuity or Holiday of 3LPE coating @ 25 kV	---	Free of defects and discontinuities, delaminations, separations and holidays	ISO 21809-1 Annex B
2	Peel Strength of 3LPE Coating at 23°C +/-3°C at 80°C+/-3°C	N/mm	≥18 ≥5 No disbonding between steel & epoxy	ISO 21809-1 Annex C2
3	Impact strength of 3LPE Coating at 23°C +/-3°C	J/mm	>7	ISO 21809-1 Annex E
4	Indentation of PE top coat @ 230C+/-20C @800C+/-20C	Mm	≤0.2 ≤0 4	ISO 21809-1 Annex F
5	Strain at Break of PE Top Coat at 230C +/-30C	%	≥400	ISO 527-2

6	Product Stability during Application of PE Top Layer process	%	Δ MFR ≤20 (Variation between virgin compound granulate before application and coating after application of the same batch tested by applicator)	ISO 1133-1
7	Cathodic Disbondment of 3LPE Coating at 23°C+/-3°C/28d/-1.38V at 65°C+/-3°C/24h/-3.38V at 80°C+/-3°C/28d/-1.38V	mm	 ≤5 ≤4 ≤15	ISO 21809-1 Annex H
8	Flexibility of 3LPE Coating (-2°C to 0°C, cool for minimum1 h)	Degrees per pipe length diameter	No cracking at an angle 2°per pipe diameter length	ISO 21809-1 Annex I
9	Resistance to Hot Water Immersion of 3LPE Coating (80±3°C, 48 h)	mm	Average ≤2.0 and Maximum 3.0 mm	ISO 21809-1 Annex L
10	Specific Electrical Coating Resistance (23 °C ± 2 °C)	Ωm^2	$\geq 10^8$	DIN 30670 Annex J
11	Hardness of 3LPE Coating	Shore D	≥ 55	ISO 868
12	ΔTg	°C	-3°C ≤ΔTg≤ + 3°C	ISO 21809-1 Annex D

6.0 COATING DOCUMENTATION TO BE SUBMITTED:

6.1 Upon award of the CONTRACT, the Applicator / Contractor shall submit within two (2) weeks, for Owner approval, a detailed report in the form of bound manual outlining, but not limited to, the following:

6.1.1 Details of plant(s), location(s), layout, capacity and production rate(s).

6.1.2 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.

6.1.3 Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.

6.1.4 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.

6.1.5 Plant Organization Chart and availability of manpower including coating specialist.

6.1.6 Details of utilities/facilities such as water, power, fuel, access roads and communication etc.

6.1.7 Details of chemical pre-treatment facilities including process control, inspection equipment for phosphoric acid wash, de-ionized water wash, chromate treatment (if specified), drying system, etc.

6.1.8 Solid/ liquid waste management system procedure and facility details for safe disposal of chemical and organic substances.

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

6.2 At least six (6) weeks prior to the commencement of production coating, a detailed procedure of the Applicator / Contractor's methods, material proposed, etc., shall be formulated by the Applicator/ Contractor and submitted for Owner approval in

the form of a bound manual. The procedure shall include, but not limited to, the following information and proposals:

6.2.1 Incoming inspection and pipe tracking;

6.2.2 Pipe inspection at the time of bare pipe receipt;

6.2.3 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;

6.2.4 Pipe heating, temperatures and its control prior to epoxy application;

6.2.5 Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendations from manufacturer(s);

6.2.6 Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.

6.2.7 Quenching and cooling, including time and temperature;

6.2.8 Quality Assurance System, Quality Plan, Inspection and Testing Plan and reporting formats, including instrument and equipment types, makes and uses, etc.

6.2.9 Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repair thereof including coating stripping technique;

6.2.10 Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates;

6.2.11 Complete details and inventory of laboratory and equipment for procedure qualification (PQT) and regular production;

6.2.12 Pipe handling and stock piling procedures, pipe end protection and protection against adverse ambient conditions during storage;

6.2.13 Sample of recording and reporting formats, including laboratory reports, certificates;

6.2.14 Complete details of test certificates for raw materials including test methods and standards used;

6.2.15 Test certificates from PE compound manufacturer for long term tests UV resistance / Thermal aging & Specific electrical coating resistance or coating resistivity. These test certificates shall not be older than three years;

6.2.16 Health, Safety and Environment Plans;

6.2.17 Storage details of coating materials and chemicals;

6.2.18 Continuous temperature monitoring at various stages of coating.

The APS (Application Procedure Specification) shall cover all items associated with quality control as defined in purchase specification & in this specification and mutually agreed.

The APS, including any revisions, shall be approved by the owner prior to the start of qualification and production.

7.0 APPICATION OF COATING:

7.1 Pipe Surface Preparation:

7.1.1 Unless specified otherwise, the pipes supplied shall be free from mill applied oil, grease, paints, or other visible contaminant but may be subjected to contamination occurring during transit.

7.1.2 Prior to cleaning operation, Applicator / Contractor shall visually examine the pipes and shall ensure that all defects and irregularities (lamination, sliver and scratches), flats and other damages have been repaired or removed as per applicable specification. The Applicator / Contractor 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.

7.1.3 Any dirt, deleterious matter, salt and contaminants (like oil, grease, etc.) 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 like acetone, xylol, etc. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvent cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.

7.1.4 All pipes shall be preheated to a temperature of 65°C to 85°C prior to abrasive blast cleaning using induction heating or radiant heating. The external surface of the pipe shall be cleaned using two dry abrasive blast cleaning units (each having two centrifugal wheels) to achieve the specified surface cleanliness and profile. If specified, Chemical pre-treatment with phosphoric acid solution as per Clause 7.2 of this specification shall be carried out after the second abrasive blaster.

7.1.5 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The Applicator / Contractor shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point. The blast cleaned surface shall neither 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. 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, scratches, etc. shall be removed / rectified, inspected and then pipes shall be re-blasted.

7.1.6 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 dust, fines, corrosion products and other contaminants. The quality of abrasive working mix shall be checked at every four hours.

7.1.7 Abrasives used for blast cleaning shall comply ISO 11124. Hardness, size and ratio of shot and grit to be used in abrasive Blaster #1 & #2 shall be specified in the Inspection and Testing Plan (ITP) test plan to meet the required surface profile and other surface preparation criteria.

7.1.8 Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification.

7.1.9 The blast cleaned surface of the pipe shall conform to near white metal finish (Sa 2½) of ISO 8501-1.

7.1.10 Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 75 to 100 microns (RZ/ Ry5). This shall be measured for each pipe by portable digital surface roughness tester (Stylus Method) as per ISO 8503-4 and it shall be verified twice /shift. For retaining records, surface profile may be checked with Press-O-Film (Replica Tape Method) as per ISO 8503-5.

7.1.11 In addition to checking of degree of cleanliness (Sa 2 ½), blast cleaned pipe surface shall be also checked for degree of dust (dust level) and shape of profile. Degree of dust shall comply the requirements of ISO 8502-3.

7.1.12 After final abrasive blast cleaning, all pipes shall be tested for presence of soluble salts. One test shall be carried out on each pipe. The acceptance criteria shall be 20 mg/m2 or 2 □ g/cm² (max). An approved salt meter (SCM 400 or equivalent) shall be used to carry out using salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations.

Any pipe having salt contamination exceeding 2µg/cm² shall be de-ionized water washed and then re-checked for salt contamination.

In case, salt level is still greater than 2 µg/cm², chemical pre-treatment of steel pipes after abrasive blasting using phosphoric acid wash, followed by high pressure water wash (>1500 psi) shall be carried out as per clause 7.2. The applicator shall specify the method of chemical pre-treatment in coating documentation, namely ITP and APS.

In case, chemical pre-treatment of all steel pipes after abrasive blasting with phosphoric acid wash is a mandatory requirement, the same shall be specified by the Owner.

7.1.13 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 after first blast cleaning shall be reported to the Owner Representative and on permission from Owner Representative, such defects shall be removed by filing or grinding. After any grinding or rectification, the remaining wall

as per the instructions of Owner /Owner's Representative. The method employed to

thickness shall be checked and compared with specified thickness. Any pipes having thickness less than minimum specified thickness shall be kept aside and disposed off

remove surface defects may burnish or destroy the 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, it shall be ensured that anchor pattern shall be restored during second abrasive blasting. Pipes having rectification by grinding and ground areas more than 50 mm shall be re-blasted thru using both the abrasive blasters.

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

7.1.15 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 another end. Any foreign material or shots/grit present in the pipe shall be completely removed by mechanical brush, high pressure air jets or by tilting of pipe, etc.

7.1.16 The maximum allowable elapsed time between completion of the final blasting operations and commencement of the chemical pre-treatment or coating process shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half an hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below:

Table 8

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. The dew point shall be 3°c less than the pipe temp. & RH shall be less than 85%.

7.2 Chemical pre-treatment with phosphoric acid solution (if specified):

7.2.1 All pipes shall be provided chemical pre-treatment with phosphoric acid solution having concentration of 10% (+2%). Oakite 31 / 33 or equivalent shall be used to

remove all soluble salts and other soluble contaminants.

7.2.2 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 pipe prior to the application of the specific fusion bonded epoxy powder and the final coating will meet fully the requirements of this specification.

7.2.3 The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 70°c.

7.2.4 The dwell time of the phosphoric acid wash on the pipe surface shall be minimum 20 s or as recommended by the manufacturer.

7.2.5 The ph of the pipe surface shall be determined after dwell time at a frequency of once per hour. The measured ph shall be as follows:

After phosphoric acid wash: 1 to 2

7.2.6 Phosphoric acid treatment shall be followed immediately by washing with de-ionized (di) water. De-ionized water used shall conform to the following requirements:

Table 9

Sl. No.	Properties	Unit	Requirements
a.	Turbidity	NTU	1 max.
b.	Conductivity	µS/cm	5 max.
c.	Hardness	-	Nil
d.	Total Alkalinity as CaCO3	mg/l	2 to 3
e.	Chloride as Cl-	mg/l	1 max.
f.	Sulphate as SO4=	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 de-ionized water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of de-ionized water w.r.t. the above requirements shall cause stoppage of the operations.

High pressure water rinse (>1500 psi) after phosphoric acid wash shall be used to remove any trace of treatment residue. A minimum 1 liter of de-ionized water

per square meter of pipe surface area shall be used and correct rinsing volume shall

be established in order to ensure that pH of pipe surface shall be in the range of 6 to 7.

7.2.7 The pH of the pipe surface after the de-ionized water rinse shall be checked at a frequency of once in every hour. pH value shall be as follows:

After de-ionized water wash: 6 to 7

7.2.8 After the de-ionized water wash, the pipe shall be dried with dry air, pre-heated to a temperature of 75°C to 85°C.

7.2.9 The salt tests shall be carried out after de-ionized water rinse at one end of each pipe at the blasting inspection bed. The acceptance criteria shall be 2µg/cm2. 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 recommendations.

7.3 Chemical Pre-treatment with Chromate Solution (If specified):

7.3.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically pre-treated with chromate solution having concentration of 10% (+2%), Gardobond 4504 PC or equivalent.

7.3.2 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.

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

7.3.4 The applicator shall check that the concentration of the chemical pre-treatment solution remains within the above range or as recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at start of shift, every 4 h thereafter and every make-up of each fresh solution batch, using a method recommend by the chemical manufacturer. The applicator shall also ensure that the chemical pretreatment solution remains free from contamination at all times. Recycling of chemical pre-treatment solution is not permitted.

7.3.5 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.

7.3.6 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.

7.4 Coating Application:

The external surface of the abrasive blasted cleaned pipe conforming to clause 7.1, 7.2 and 7.3 of this specification shall be immediately coated with 3-Layer Polyethylene (3LPE) coating in accordance with the procedures approved by Owner,

relevant standards and this specification. In general, the procedure shall be as follows:

7.4.1 Pipe Heating:

- Immediately prior to heating of pipe, all dust and grit shall be removed from inside 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.

- 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. Appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. 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.

- External surface of the pipe shall be heated to about 225°C to 240 °C. The targeted temperature shall be selected to achieve proper wettability of steel surface. The pre-heating temperature tolerance above and below the selected target temperature should also be specified during PQT and cure time / line speed window setting should be done for the specified range. Required pipe temperature shall be maintained as it enters the FBE powder coating chamber.

  The required pipe target temperature can be selected outside the 225°C to 240°C range in case of specific epoxy manufacturer's recommendation, however in no case will the target temperature be selected below 200°C or exceed 250°C

- Temperature of the pipe surface shall be continuously monitored & recorded by using optical pyrometers and checked with contact thermometers. 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 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, re-cleaned and recoated.

  - Temperature measuring & monitoring equipment shall be calibrated twice every shift and/or as per Owner Representative's instruction.

  - Applicator shall ensure that pipe surface emissivity variations

are minimized 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.

7.4.2 Pipe Coating:

- Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe:

7.4.2.1 Electrostatic application of epoxy powder of minimum dry film thickness 0.20 mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.

7.4.2.2 Co-polymeric or grafted adhesive application by side extrusion, having minimum thickness 0.20 mm;

7.4.2.3 HDPE application by side extrusion to minimum thickness as specified based on minimum 3LPE coating thickness on pipe body and weld seam as per Table1.

The coated pipe shall be subsequently quenched and cooled in water for a period that shall sufficiently lower the temperature of pipe coating (< 80°C) to permit handling and inspection.

- Only those coating material which are pre-qualified and approved by Owner / Consultant in accordance with provisions of Annexure I of this specification and qualified in accordance with requirements of clause 5.4.1, 5.4.2, 5.4.3, 5.4.4 and Table 2, 3, 4 & 5 of this specification shall be utilized for coating.

- All production coating application shall be carried out as per application parameters recommend by coating material manufacturers and procedure qualification tests (PQT) shall be carried out as per Clause 10.5 and Table 10, 11 &12 of this specification.

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

- Throughout the production, the blasting line speed, pre-heating temperature and coating line speed shall be monitored continuously and data recorded as per Table

10 & 11. Values during production run shall be within a range of +/-10% of the values and verified during PQT.

Variation of the recorded temperature values versus the set pre-heating temperature shall be within range of 5% along the pipe length with the exception of the cut back lengths.

During production, if the above parameters (i.e., blasting speed, pre-heating temperature and the coating line speed, etc.) require modification from the approved PQT, a new PQT shall be performed.

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 subject to:

7.4.2.4 Satisfactory qualification of the reclaimed system during PQT stage;

7.4.2.5 The proportion of the reclaimed powder in the working mix does not exceed 20%at any one time;

7.4.2.5.1 The quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at per Clause para 5.4.1 and Table 2.

7.4.2.5.2 Dry compressed air (free of oil and moisture) shall be used in the coating chamber and FBE spraying system. Filters, dehumidifier / dryer as required along with control and monitoring system shall be provided for this purpose. Dew point of compressed air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-) 40°C and this shall be shall be monitored and checked during PQT and regular production at frequency of start of each shift, then once in a shift and at any breakdown.

7.4.2.6 Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm / activate audio system (hooter) in the event of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.

Thickness of cured FBE layer shall be minimum 0.2 mm as specified in Table1.

7.4.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed and within the gel time window recommended by FBE manufacturer. Applicator shall establish, to the satisfaction of the Owner's Representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. Applicator shall state the minimum and

maximum time interval between epoxy and adhesive application at the proposed pre-

heat temperature and line speed. The extrusion temperature of the adhesive film shall be continuously recorded.

7.4.2.7.1 Thickness of extruded adhesive layer shall be minimum 0.20 mm as specified in Table 1.

7.4.3 Adhesive layer shall be continuous and free of void, air entrapment. Under no circumstances polyethylene top layer can be in contact FBE layer.

- 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 temperature of polyethylene film 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. The applied coating shall be cooled to a temperature (<80°C) that prevents handling damage during finishing and final inspection.

7.4.3.1 Thickness of extruded polyethylene layer and 3LPE coating shall be as specified in Table 1.

- 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 methods to avoid air entrapment. The methods used shall be witnessed and approved by Owner.

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

- 3LPE coating shall terminate 150 mm (+) 20/ (-) 0 mm from pipe ends.

  Applicator shall adopt mechanical brushing and / or tooling device for termination of 3LPE coating at pipe ends. Edge of the polyethylene layer shall be shaped to form a bevel angle not exceeding 30° in the direction of pipe axis.

  FBE layer at the cut back shall protrude 20+/-5mm from the edge of the toe of the polyethylene layer. Damaged FBE toe shall be repaired aesthetically using compatible liquid epoxy, recommended by FBE manufacturer.

8 COATING PROCEDURE QUALIFICATION:

8.1 Procedure Qualification Tests (PQT):

Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedures and Inspection and Testing Plan (ITP) from the Owner. No change in the procedure shall be made after the Owner has given approval.

At the start of the project, the Applicator shall, at his expense, carry out a coating Procedure Qualification Tests (PQT). During PQT, the following shall be carried out by the Applicator:

8.1.1 Qualify various procedures forming a part of coating operations mentioned above and as detailed subsequently;

8.1.2 Carry out raw material testing on the batches of all coating materials to be used for PQT viz. FBE epoxy powder, adhesive granules, PE top coat granules, confirming compliance to properties as per clauses 5.4.1, 5.4.2 and 5.4.3 respectively;

8.1.3 3LPE coating application to prove that plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in Clause 5.3, 5.4.4 and

Table 10, 11 and 12 of this specification, relevant standards, specifications and material manufacturer's recommendations;

8.2 PQT's shall be carried for the following scenarios:

8.2.1 For each pipe diameter on maximum wall thickness (wall thickness to be decided by the Owner);

8.2.2 For each type of pipe (LSAW / HSAW / ERW);

8.2.3 For each coating material combination

8.2.4 For each plant.

Applicator shall give seven (7) working days' notice to witness all procedures and tests.

A batch representing a normal production run, typically 15 pipes, shall be coated in accordance with the approved coating procedure and the coating operations shall be witnessed by Owner or it's Representative. Out of these pipes, at least one pipe at the start & one pipe at the end of PQT shall be coated partly with epoxy layer (approx. 3-4 m), partly with both epoxy & adhesive layers (approx. 3-4) and rest portion with all the three layers. Remaining pipes shall have all the three layers.

At least 7 (seven) test pipes shall be selected by Owner or its Representative for coating procedure qualification tests and shall be subjected to procedure qualification testing as described hereinafter. Owner or its Representative shall witness all tests. Out of 7 (seven) test pipes, 2 (two) pipes partly coated with epoxy layers and partly coated with both epoxy & adhesive layers shall be included. Remaining 5 (five) test pipes shall have all the three layers.

On successful completion of PQT, coating of all seven pipes shall be removed completely and recoated as per approved coating procedure at Applicator's expense. Remaining 8 (eight) pipes will be accepted by Owner provided they meet the requirements of this specification and need not be stripped and re-cycled.

8.3 Qualification of Procedures:

8.3.1 Epoxy Powder Application & Recycling:

During procedure qualification, number of guns for electrostatic spray of FBE powder (virgin and reclaimed), air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed v/s coating thickness, etc. shall be established.

Dew point of compressed air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT.

Also, Applicator shall remove 2 samples of reclaimed powder from the reclamation system. These samples of reclaimed powder shall be subjected to detailed visual examination, laboratory testing (gel time, density, thermal analysis, particle size, and moisture content, etc.). 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.

8.3.2 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 Owner Representative.

8.3.3 Surface Preparation

The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. Blasting speed, ratio of shot to grit 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 salt contamination & dust on the abrasive blast cleaned pipe surface.

8.3.4 **Chemical Pre-treatment**:

8.3.4.1 Phosphoric Acid Wash followed by De-ionized Water Wash (If specified):

The procedure to apply the chemical pre-treatment viz. phosphoric acid wash followed by de-ionized water wash shall be in accordance with the recommendations 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. Pipe pre-heat temperature vs line speed vs dwell time, rinsing procedure including pressure of the rinse water, testing & control, rectification measures, drying procedure etc. shall be clearly established during PQT. Also, the quality of the de-ionized water shall be established during PQT.

8.3.4.2 Chromate Treatment (if specified):

The procedure to apply the chromate treatment shall be in accordance with the recommendations of the manufacturer. Working solution preparation, maintaining concentration, pipe temperature before application, chromate solution temperature, application procedure including method of spreading, drying times, etc. depending upon the temperature of the incoming pipe and the line speed shall be established. Pipe temperature vs. line speed, testing & control, rectification measures shall be clearly established during PQT.

8.3.5 Coating Application:

The Owner 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 gel / 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.

8.4 Qualification of Coating Repair:

During PQT, Coating repair qualification shall be carried out using approved repair materials and approved procedure by competent Repair personnel or Insulator under supervision of QC Inspector or Engineer.

Type of Repair	No. of Location / Test	Detailed Inspection
Cosmetic Repair (By heating & rolling)	1 Pipe (2 Locations)	Visual
Repair with Melt Stick	1 Pipe (2 Locations)	Visual, Thickness and Holiday Inspection
Patch Repair	1 Pipe (2 Patches)	Visual, Thickness, Holiday Inspection @25 kV Peel Test: ≥ 2.5 N/mm @23±3°C; ≥ 0.2 N/mm @80±3°C; No separation of epoxy layer from the steel surface.
Heat- shrinkable Sleeve (HSS) Repair (System 14-B of ISO 21809-3	1 Pipes (2 HSS)	Visual, Thickness, Holiday Inspection @25 kV Peel Test (Table 17 of ISO 21809-3): ≥ 5 N/mm @23±3°C; ≥ 0.3 N/mm @80±3°C; No separation of epoxy layer from the steel surface.

On successful completion of coating repair qualification activities and its inspection & testing, Repair Materials, Repair Personnel or Insulator and Repair Procedure are qualified for the entire project.

8.5 Qualification of Applied Coating during PQT:

Procedure Qualification tests shall be carried out on partly coated epoxy, adhesive and fully 3LPE coated pipes, as detailed here under in accordance with Table 12 of this specification.

8.5.1 Tests on pipe coated partly with Epoxy (FBE) and partly with Epoxy & Adhesive Layers:

8.5.1.1 Degree of Cure:

Epoxy film samples (minimum 4 nos./pipe) shall be scrapped from the coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure mentioned in Annexure D of ISO 21809-1. Care shall be taken to

remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (☐Tg) and % cure (☐ H1) shall comply with the requirements as specified in Clause 5.4.4 and Table 5.

8.5.1.2 Epoxy Layer Thickness:

Epoxy layer thickness shall be checked on two pipes at every one meter spacing at 3, 6, 9 and 12 o'clock positions using calibrated digital thickness gauge as per ISO 2808. The thickness shall comply with the requirement as specified in Table 1.

Digital thickness gauge shall be verified at the start of each shift using standard foil or shim within 5% tolerance.

8.5.1.3 Adhesive Layer Thickness:

Adhesive layer thickness shall be checked two pipes at every one meter spacing at 3, 6, 9 and 12 o'clock positions using calibrated digital thickness gauge as per ISO 2808. The thickness shall comply with the requirement as specified in Table 1.

Digital thickness gauge shall be verified at the start of each shift using standard foil or shim within 5% tolerance.

8.5.1.4 Holiday Inspection:

Epoxy coated portion of two pipes shall be subjected to holiday inspection as per Clause 10.3.2 of ISO 21809-2 and the test voltage shall set to 5V per µm of minimum specified epoxy coating thickness. There shall be no holiday on epoxy coated portion (Refer Clause 5.4.4 and Table 5).

8.5.1.5 Dry Adhesion:

Dry adhesion test on epoxy coated pipe section of two pipes shall be carried out as Clause A.4 of ISO 21809-2. The adhesion rating obtained shall be either 1 or 2 (Refer Clause 5.4.4 and Table 5).

8.5.1.6 Hot Water Adhesion:

24 h Hot Water Adhesion Test @75±3°C on epoxy coated pipe section of two pipes shall be carried out as per clause A.16 of ISO 21809-2. The rating obtained shall be from 1 to 2 (Refer Clause 5.4.4 and Table 5).

8.5.1.7 Porosity:

Cross-Section Porosity and Interface Porosity tests shall be carried out on the epoxy coated pipe section of two pipes. Test method shall be as per clause A.12 of ISO 21809-2. Acceptance shall be less than or equal to Figures A.11 & A.12 of ISO 21809-2 (Refer Clause 5.4.4 and Table 5).

8.5.1.8 Flexibility:

2° Flexibility test at 00C shall be conducted on ring specimen obtained from epoxy

coated pipe section of two pipes as per clause A.13 of ISO 21809-2. No cracking,

tear disbondment or delamination shall be observed (Refer Clause 5.4.4 and Table 5).

8.5.1.9 Impact Test:

1.5 J Impact test at 00C shall be conducted on ring specimen obtained from epoxy coated pipe section of two pipes as per clause A.14 of ISO 21809-2. There shall be no holiday on impact area (Refer Clause 5.4.4 and Table 5).

8.5.2 Tests on Pipes Coated with all Three Layers:

8.5.2.1 Visual Inspection:

Immediately following the coating, 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 inclusions. The coating shall not show any defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts, swellings, disbonded zones, air inclusions, tears, voids or any other irregularities. Special attention shall be paid to the areas adjacent to the longitudinal weld (if applicable), adjacent to the cut-back at each end 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 focused at the middle of the pipe at one end while inspection is carried out visually from another end.

8.5.2.2 Coating Thickness Measurement:

All 3LPE coated pipes shall be subject to coating thickness measurement using digital thickness gauge in accordance with ISO 2808. Digital thickness gauge shall be verified at the start of each shift using standard foil or shim within 5% tolerance.

The coating thickness shall be determined by taking at least 12 measurements at locations uniformly distributed over the length and periphery of each pipe. If any of these 12 readings is below the minimum coating thickness, carry out additional four readings around this area. The average of the additional four readings and the initial reading shall be higher than the minimum thickness.

Take the measurements at points distributed along four equally spaced longitudinal lines at pipe length with three equally circumferential lines on the middle of the pipe and at a distance of 300 mm from the end of the coating cutback.

In case of welded pipes, 6 of these readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All readings must meet the minimum requirements. Acceptance criteria shall be as per Clause 5.3

and Table 1.

8.5.2.3 Holiday Detection:

High voltage pulse DC full circle electronic holiday detector (with audible alarm and precise voltage control) shall be used to check continuity of applied finished coating.

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.

Holiday detector shall be set to test voltage min. 25 kV and testing speed shall not exceed 300 mm / s. Holiday detection shall be carried out in accordance with Annex B of ISO 21809-1. The finished coating shall be free of holiday (Refer Clause 5.4.4 and Table 7).

Any pipe coating shall be rejected if no. of holiday and size of defect/ damage/ holiday exceed as detailed in Clause 13 of this specification.

8.5.2.4 Peel (Adhesion) Strength:

Five test pipes shall be selected for Peel strength tests as per Annex C (C2) of ISO21809 -1. On each of the selected pipes, three peel tests shall be performed for each specified temperature (23±3°C& 80±3°C), one at each end and one in the middle of the pipe. Specified peel strength requirement at each temperature shall be complied with and there shall be no disbonding between steel & epoxy (Refer Clause 5.4.4 and Table 7). Length of peel shall be minimum 140 mm. None of test pipes shall fail.

8.5.2.5 Impact Strength:

Three test pipes shall be selected for impact strength test as per Annex E of ISO 21809-1 at 23±3°C. Minimum thirty (30) impacts (with impact energy min. 7J/mm) located equidistant (>50 mm) along the length of the pipe shall be performed. Immediately after testing, the test area shall be subjected to holiday detection @25 kV. There shall be no holiday on impact area (Refer Clause 5.4.4 and Table 7).

8.5.2.6 Indentation Resistance:

Five test pipes shall be selected for indentation resistance test and two samples from each pipe at each temperature shall be taken and tested as per Annex F of ISO 21809-1 for temperatures 23±2°C and 80±2°C. The test shall comply with the specified requirement (Refer Clause 5.4.4 and Table 7) and none of the test samples shall fail.

8.5.2.7 Air Entrapment:

One sample each from pipe body and on weld (if applicable) shall be taken from all 3LPE coated pipes. Strips from adhesive strength tests or coated pipes shall be used

to determine the porosity of the finished coating. Strip shall be cut from longitudinal / spiral weld (if applicable) and examined for presence of voids.

Peel strength test strip shall be viewed from the side and at the failure interface. At the peel strength test location, utility knife shall be used to cut the edge of the coating to a 45° angle and viewed under microscope. Similar examination shall be done in the coating cut back area.

One sample each either on the peel 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.

All examination shall do 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.

8.5.2.8 Degree of Cure:

Epoxy film samples (minimum 4 no., equally spaced) shall be scrapped from one 3LPE (PQT) coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Silicon coated sulphite paper or other equivalent shall be placed between the epoxy layer and adhesive layer immediately after epoxy application, to ensure physical separation of epoxy & adhesive as well as to prevent contamination of epoxy with adhesive layer, at a location from where the epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition

temperature differential (ΔTg) and % Cure shall comply with the specified requirements (Refer Clause 5.4.4 and Table 7).

8.5.2.9 Cathodic Disbondment:

The following CD tests shall be carried out on samples selected from 1 PQT test pipe in accordance with Annex H of ISO 21809-1:

- 65±3°C/24h/-3.38V;
- 23±3°C/28d/-1.38V;
- 80 ±3°C/28d/-1.38 V.

The maximum disbondment acceptance criteria shall be as per Clause 5.4.4 and Table 7 of this specification.

8.5.2.10 Strain at Failure:

Six samples each from three selected coated pipes i.e., total 18 samples in all shall be tested in accordance with ISO 527-2 and the test shall comply with the specified requirement (refer Clause 5.4.4 and Table 7). None of the test samples shall fail.

8.5.2.11 Stress at Yield:

Six samples from one selected coated pipe shall be tested in accordance with ISO 527-2 and the test shall comply with the specified requirement (refer Clause 5.4.4 and Table 7). None of the test samples shall fail.

8.5.2.12 Resistance to Hot Water Immersion:

One test pipe shall be selected for hot water immersion test previously subjected to holiday test. Three samples shall be prepared from the selected test pipe and shall be placed in vessel filled with tap water already pre-heated to 80±3°C for 48 hours. The test method shall be as per Annexure L of ISO 21809-1.

Loss of adhesion shall be average ≤2.0 and maximum 3.0 mm beyond 5mm on each side of the corner. All samples shall pass the test (refer Clause 5.4.4 and Table 7).

8.5.2.13 Flexibility:

One test pipe shall be selected for Flexibility test. The test method shall be as per Annexure I of ISO 21809 Part 1. Three samples shall be prepared from the test pipe. The samples shall be placed in freezer and cooled between -2°C and 0°C and hold at that temperature for 1 hour and then bent at 2°ppd over fixed radius mandrel.

No cracking, tear, disbondment or delamination shall observe in any of the samples (refer Clause 5.4.4 and Table 7).

8.5.2.14 Product Stability during Application of HDPE Top Layer:

Three test pipes shall be selected for product stability test of PE top layer. The test

method shall be as per ISO 1133-1. One sample shall be prepared from each test pipe. The measured MFR value of the applied PE layer shall be within ±20% of the

measured MFR value of the virgin compound granulate PE of the same batch (refer Clause 5.4.4 and Table 7).

8.5.2.15 Specific Electrical Coating Resistance:

The long term Specific Electrical Coating Resistance test of 3LPE coated pipes section shall be conducted for 100 days @ 23°C in accordance with Annex J of DIN 30670. Tested value shall be ≥108 Ωm² (refer Clause 5.4.4 and Table 7).

The test certificate (not older than 3 years) submitted by the PE manufacturer shall be of recognized independent test laboratory with a track record of 3LPE coating testing. The test laboratory should be NABL / ISO 17025 accredited and shall have approval for conducting the above specific test as per DIN 30670.

Owner may decide to get the test conducted for 3LPE coating applied during PQT and get tested for the above long-term test at the cost of the coating applicator at an accredited independent laboratory as per above requirement.

8.5.2.16 UV Resistance and Thermal Ageing:

The followings long term tests for extruded PE top material shall be conducted in accordance with Annex G of ISO 21809-1:

8.5.2.16.1 UV Ageing Test:

Continuous irradiation of UV xenon lamp;

Black standard Temperature: 65±3°C;

Relative Humidity: 65±5%;

Test Duration: 2210 h.

8.5.2.16.2 Thermal Ageing Test:

Test Temperature: 100±3°C;

Test Duration: 4800 h (200 d).

Tested values shall meet the requirements as specified in Clause 5.4.4 and Table 7.

The test certificate (not older than 3 years) submitted by the PE manufacturer shall be of recognized independent test laboratory with a track record of 3LPE coating testing. The test laboratory should be NABL / ISO 17025 accredited and shall have approval for conducting the above specific tests as per ISO 21809-1.

Owner may decide to get the test conducted for PE top coat material 3LPE coating applied during PQT and get tested for the above long-term tests at the cost of the

coating applicator at an accredited independent laboratory as per above requirements.

8.5.2.17 Hardness:

One PQT pipe shall be subjected to shore D hardness checking for PE top coat surface using calibrated Durometer in accordance with ISO 868. Minimum 5 measurements shall be taken on entire coated pipe surface. All measured hardness values shall be ≥ 55 Shore D (refer Clause 5.4.4 and Table 7).

8.5.2.18 Residual Magnetism:

One PQT pipe shall be subjected to residual magnetism checking at both pipe ends at 4 locations (circumferentially at 0°, 90°, 180°& 270° positions) using calibrated Gauss meter. All measured values shall meet the requirement of Table 12.

After completion of the qualification procedures and PQT as per above, the Applicator shall prepare and issue to Owner for approval a detailed report of the coating procedures, methods, equipment and tools used and document above tests and inspection including test reports/certificates of all materials and coatings tested. This document will be termed as Application Procedure Specification (APS) and shall be referred during subsequent application of coating of production pipes.

On successful completion of PQT, coating of all seven test pipes shall be removed and completely recoated as per approved coating procedure at Applicator's

expense. Remaining eight pipes will be accepted by Owner, provided they meet the requirements of this specification and need not be stripped and re-cycled.

Only upon written approval from Owner, Applicator/ Contractor shall commence production coating.

9 RE-QUALIFICATION OF PROCEDURE QUALIFICATION:

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

9.1.1 Every time there is a change in the previously qualified procedure;

9.1.2 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;

9.1.3 Every time the coating yard is shifted from one location to the other or every time the critical coating equipment (induction heater, epoxy spray system, extruder, etc.) are shifted;

9.1.4 Any change in line speed during coating application;

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

Owner 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 Owner's opinion, the results are deemed suspect. Owner's decision shall be the final.

10 COATING PROCEDURE TESTS DURING PRODUCTION:

Production tests shall be carried out on partly coated epoxy, adhesive and 3LPE coated pipes as detailed here under and Table 10, 11 & 12 of this specification

10.1 Raw Material Testing:

Raw material testing shall be conducted on all the batches of all coating materials to be used for production viz. FBE epoxy powder, co-polymeric melt adhesive granules, PE top coat granules to confirm compliance as per clause 5.4 sub clauses 5.4.1,

10.2 External Pipe Surface Preparation:

Prior to coating application, the pipe steel surface shall be abrasive blasted as per Clause 7.1, followed by inspected and tested after 2nd abrasive blasting as per Table 10 to ensure compliance to required surface cleanliness, surface roughness, residual dust level, salt contamination, etc.

10.3 Chemical Pre-treatment with Phosphoric Acid Solution and / or Chromate

Treatment (If specified by the Owner):

Depending on requirements, each pipe shall be subjected to Chemical Pre-treatment with Phosphoric Acid Solution followed by high pressure water rinse and / or Chromate

Treatment in accordance with Clauses 7.2 & 7.3 of this specification. Treated pipe surface shall be inspected and tested in accordance with Table 11 in order to ensure characteristics of pipe surface prior to induction heating.

10.4 Pre-heating of Pipe Surface:

Pre-heating of the pipe surface shall be carried using suitable rated induction coils. The temperature and other application parameters, set during procedure qualification testing will be maintained during production and the pr-heat temperature of the pipe before entering the FBE booth shall be recorded and monitored continuously as per Table 12 of this specification.

10.5 3LPE Coating Application:

10.5.1 3LPE coating application shall be carried out as per Application Procedure Specification (APS) approved by the Owner. After successful completion of coating procedure qualification as per Clause 8, various stages of coating application shall be measured, monitored and inspected in accordance with Table 12 of this specification.

Table 10 — Requirements for inspection of surface preparation of pipe

SI. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production
1	Surface condition of pipe before blasting	Visual Inspection	Free of contaminations and surface defects	Each pipe	Each pipe
2	Relative humidity	Measurement/ as required	Record (relative humidity shall be < 85%)	Every ½ h	Every ½ h
3	Pipe temperature before blasting	Thermocouple	min. 3°C above dew point	Each pipe	Every 1 h
4	Size, shape and properties of virgin abrasive	Visual + Certification as per ISO 11124-3	Conformity to certificate and compliance with manufacturing/ working procedure	Every batch	Every batch

SI. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production

5	Water soluble contamination abrasives	ASTM D4940	Conductivity ≤ 60 µS/cm	Once	1/shift
6	Abrasive blasting line speed	Stop watch	As per approved Qualification procedure	Each pipe	1/shift
7	Soluble salt after blasting (at one end)	ISO 8502-6 or ISO 8502-9 or SSPC Guide 15	Salt (Chloride) content as (NaCl) max. 20 mg/m2 (2 µg/cm2)	Each pipe	Each pipe
8	Surface roughness of blasted surface	ISO 8503-4 or ISO 8503-5	Rz / Ry5: 75µm to 100 µm	Each pipe	Each Pipe
9	Visual inspection of blasted surface	ISO 8501-1	Grade Sa 2½	Each pipe	Each pipe
10	Presence of dust after dust removal	ISO 8502-3	max. class 2 (for both size and quantity)	Each pipe	Every 1 h

Table 11 — Requirements for Inspection of Chemical Pre-treatment (If specified):

SI. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production
A: Chemical-pretreatment with Phosphoric Acid Solution (Oakite 31/ Oakite 33 or Equivalent)					
1	Concentration of phosphoric acid solution	Titration	10(+2) %	Prior to start of PQT	Start of shift, every 4 h thereafter and every make-up of each fresh solution batch
2	Pipe Temperature before acid wash	Thermocouple	45°C to 750C	Each pipe	Every 1 h
3	Dwell time	Stop watch	Minimum 20 s or as per manufacturers recommendation No drying out of acid solution on surface	Each pipe	Every 1 h
4	pH of pipe surface after acid wash	Litmus paper	1 to 2	Each pipe	Every 1 h

SI. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production
5	Pressure of water rinse after acid wash	Pressure Gauge	Min. 1500 psi (*)	Each pipe	Every 1 h
	(*A minimum of 1 liter of DI water per m2 shall be used to be established during PQT)				
6	pH of pipe surface after high pressure water rinse	Litmus paper	6 to 7	Each pipe	Every 1 h
7	Temperature of hot air used for pipe drying after water rinse	Monitor and record	75°C to 850C	Once	Every 1 h
8	Quality of de-ionized water	As per Clause 7.2.6	As per Table 9	One Sample (Prior to start of PQT)	At start of shift and then Every 4 h
B: Chemical-pretreatment with Chromate Solution (Gardobond 4504 PC or Equivalent (If specified):					
9	Concentration of chromate solution	Titration	10(+2) %	Prior to start of PQT	At start of shift, every 4 h thereafter and every make-up of each fresh solution batch
10	Chromate solution temperature	Thermocouple or Glass Thermometer	<60°C or as recommended by the manufacturer	Once	Every 1 h
11	Pipe Temperature before application of chromate solution	Thermocouple	40°C to 800C or as recommended by the manufacturer	Each pipe	Every 1 h
12	Coverage	Visual	100% coverage of pipe surface	Each pipe	Each pipe

Table 12 — Requirements for Inspection of Plant Applied Coating (PQT & Production)

Sl. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production

1	Dew Point of compressed air	ASTM D4285	No indication of oil, water, Dew Point: at least -40°C	Prior to start of PQT	Start of shift & then 1/shift and at breakdown
2.0	Epoxy (FBE) Layer				
2.1	Visual inspection of pipes prior to introduction to coating line	Visual	No rust	Each pipe (100% surface area)	Each pipe (100% surface area)
2.2	Induction Coil Setting	As per APS and Clause 7.4.1.3 of this specification	As per approved APS	Each pipe	Continuous monitoring
2.3	Pipe temperature	As per APS & Clause 7.3.1.3 of this specification	225 to 2400C	Continuous monitoring & recording	Continuous monitoring & recording
2.4	Recording of application parameters (Coating line speed. No. of epoxy guns, epoxy gun pressure, inter-coat time, % of)	As per Clause 7.4	As per Approved APS	Each pipe	Start of shift & then 1/shift and each breakdown / restart (partly coated)
2.5	Air pressure in epoxy spray guns	As per Clause 7.3.2.7 of this specification	As per APS	Each pipe	Continuous monitoring & recording
2.6	Testing of reclaim FBE powder (If used) (Gel time, density, thermal analysis, particle size, moisture content)	As per APS & Clause 4.3 a, 5.4.1 & 8.4.1 of this specification	As per Clause 5.4.1 & 7.4.2.5, Table 2	Once in PQT	Once / shift
2.7	Minimum Epoxy Layer Thickness (DFT)	ISO 2808, Clause 8.6.1 b.	≥ 0.200 mm	2 Pipes	Start of shift & at breakdown / restart (partly coated)

Sl				Frequency

No.	Properties	Test Method	Requirements	During PQT	During Production
2.8	Degree of Cure % Cure ΔTg	ISO 21809-1 Annex D, Clause 8.6.1.1.	Min. 95% -3°C ≤ΔTg≤ + 3°C	4 Samples x 2 Pipes	1/shift (1sample)
2.9	Holiday Detection (Test Voltage set to 5V per µm of minimum specified epoxy coating thickness)	ISO 21809-2 Clause 10.3.2, Clause 8.6.1.4.	No holidays	2 Pipes	Not required
2.10	Dry Adhesion	ISO 21809-2 Clause A.4, Clause 8.6.1.5.	Rating 1 or 2	2 Pipes	Not required
2.11	Hot Water Adhesion 24 h at 75°C+/3°C	ISO 21809-2 Clause A.16, Clause 8.6.1.6.	Rating 1 to 2	2 Pipes	1/shift (1 sample)
2.12	Cross-Section Porosity	ISO 21809-2 Clause A.12, Clause 8.6.1.7.	≤compared with Fig. A.11 of ISO 21809-2	2 Pipes	1/shift (2 samples)
2.13	Interface Porosity	ISO 21809-2 Clause A.12, Clause 8.6.1.7.	≤compared with Fig. A.12 of ISO 21809-2	2 Pipes	1/shift (2 samples)
2.14	Flexibility at 0°C	ISO 21809-2 Clause A.13, Clause 8.6.1.8.	No cracking, tear, disbondment or delamination at 2° ppd length	2 Pipes	Not required
2.15	Impact Resistance at 0 °C	ISO 21809-2, Clause A.14, Clause 8.6.1.9.	> 1.5 J	2 Pipes	Not required
3.0	Adhesive Layer:				
3.1	Minimum Adhesive Layer Thickness	ISO 2808, Clause 8.6.1.3.	≥ 0.200 mm	2 Pipes	Start of shift & at breakdown / restart (partly coated)
3.2	Extrusion temperature of adhesive	As per APS & Clause 7.4.2.8 of this specification	As per APS or recommended by manufacturer	Continuous monitoring & recording	Continuous monitoring & recording

Sl				Frequency

No.	Properties	Test Method	Requirements	During PQT	During Production
4.0	HDPE Layer and 3LPE Coating:				
4.1	PE Extrusion temperature	As per APS & Clause 7.4.2.9 of this specification	As per APS or recommended by manufacturer	Continuous monitoring & recording	Continuous monitoring & recording
4.2	Coating temperature after water quenching	As per APS and Clause 7.4.2.1 & 7.4.2.9 of this specification	< 80°C	Each pipe	Every 1 h
4.3	Visual Inspection	Visual, Clause 8.6.2.1.	As per Clause 8.6.2.a. of this specification	Each pipe 100% surface area	Each pipe 100% surface area
4.4	Coating Thickness	ISO 2808,	Table 1 of this specification	Each pipe	Each pipe
		Clause 8.6.2.2.			
4.5	Holiday Detection (test voltage shall be min. 25 kV & travel speed shall not exceed 300 mm/s)	ISO 21809-1, Annex B, Clause 8.6.2.3.	No holiday in finished coating	Each pipe 100% surface area	Each pipe 100% surface area
4.6	Peel Strength of 3LPE Coating at 23°C +/-3°C at 80°C+/-3°C	ISO 21809-1 Annex C2, Clause 8.6.2.4.	≥18 N/mm 23±3°C, ≥5 N/mm 80±3°C, (No disbonding between steel & epoxy)	5 pipes x 3 tests (@ both ends & middle)	2 h for pipe ends (cutback portion) & 4 h for middle of pipe
4.7	Impact Strength @ 23±3°C, 30 impacts	ISO 21809-1 Annex E, Clause 8.6.2.5.	>7J/mm. No holiday on impact area	3 Pipes	2 Pipes/shift
4.8	Indentation resistance @ 23 ± 2°C @ 80 ± 2°C	ISO 21809-1 Annex F, Clause 8.6.2.6.	≤ 0.2 mm @ 23±2 °C, ≤ 0.4 mm @ 80±2 °C.	5 Pipes X 2 Samples at each temp.	2 pipes/ shift
4.9	Air Entrapment	Clause 8.6.2.7. of this specification	≤ 10% & as per clause 8.6.2.g. of this specification	5 pipes x 1 sample from body & 1 sample from weld (if applicable)	1Pipe/shift 1 sample from body & 1 sample from weld (if applicable)

4.10	Degree of Cure	ISO 21809-1 Annex D, Clause 8.6.2.8.	-3°C ≤ΔTg≤ + 3°C, Cure: Min 95%.	1 Pipes x 4 Samples	1st Pipe and 2 Pipes /shift (1sample/pipe)

Sl. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production
4.11	Cathodic Disbondment		Average Disbondment Radius)	---	---
	@65 °C/ 24 h; -3.38 V	ISO 21809-1 Annex H, Clause 8.6.2.9.	≤ 4 mm	1 Pipe	1 Pipe / day
	@23 °C/ 28 d; -1.38 V		≤ 5 mm	1 Pipe	Not required
	@80 °C/ 28 d; -1.38 V		≤ 15 mm	1 Pipe	Not required
4.12	Strain at Break @23±3°C	ISO 527-2, Clause 8.6.2.10.	≥ 400%	3 Pipes x 6 Samples	Once per PE batch
4.13	Stress at Yield at 23°C ± 3°C	ISO 527-2, Clause 8.6.2.11.	≥17 MPa	1 Pipe x 6 Samples	Not required
4.14	Resistance to Hot Water Immersion (80±3°C, 48 h)	ISO 21809-1 Annex L, Clause 8.6.2.12.	Avg. ≤ 2 mm & Max. ≤ 3 mm,	1 Pipe	Once/ day
4.15	Flexibility (@0°C, 2°ppd)	ISO 21809-1 Annex I, Clause 8.6.2.13.	No cracking, tear, disbondment or delamination	1 Pipe (3 Samples)	Not required
4.16	Product Stability during Application of PE Top Layer	ISO 1133-1, Clause 8.6.2.14.	Δ MFR: ≤20 % (Variation between virgin compound granulate before application and coating after application of the same batch tested by applicator)	Each pipe	1st Pipe / Shift

4.17	Specific Electrical Coating Resistance (23 °C ± 2 °C)	DIN 30670 Annex J, Clause 8.6.2.15.	≥108 Ωm²	Review of Independent test certificate not older than 3 years as per clause 8.6.2.o	Not required (However, Owner may request to conduct the test for 3LPE coating at an accredited independent laboratory)

Sl. No.	Properties	Test Method	Requirements	Frequency	
				During PQT	During Production
4.18	UV Resistance and Thermal Ageing	ISO 21809-1 Annex G, Clause 8.6.2.16	Δ MFR: ≤35 %	Review of Independent test certificate not older than 3 years as per clause 8.6.2. p	Not required (However, Owner may request to conduct the test for PE top coat material at an accredited independent laboratory)
4.19	Hardness	ISO 868	≥ 55 Shore D	One pipe	Not required
		Clause 8.6.2.17.			
4.20	Cutback of 3LPE coating	Clause 7.4.2.12 of this specification	Length: 150mm (+)20/(-)0mm, Bevel Angle: <30°, FBE Toe: 20+/-5mm	Each pipe	Each pipe
4.21	Residual Magnetism at each pipe end (@ 4 points: 0°, 90°, 180°& 270°)	Hall-Effect Gauss meter, Clause 8.6.2.18.	Avg: ≤ 2.0 mT (20 gauss). No single reading ≥ 2.5 mT (25 gauss)	1 Pipe x 4 readings	1/shift
4.22	Coating Repairs	Visual ISO 21809-1 Annex B	As per Clause 13 of this specification	1 Pipe	Each damage / defect

11 QUALITY ASSURANCE:

11.1 The Applicator shall have established 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 or equivalent.

11.2 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.

11.3 The Applicator shall submit the procedures that comprise the Quality System to the Owner for agreement.

11.4 The Applicator quality system shall pay particular attention to the control of suppliers and sub-contractors and shall ensure that the requirements of this specification are satisfied by the suppliers and sub-contractors operating quality system in their organization.

11.5 The Applicator shall, prior to the commencement of work, prepare and issue a Quality Plan for all of the activities required satisfying the requirements of this specification. The plan shall include any sub-contracted work, for which the sub-contractor's 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.

11.6 The Applicator 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 Owner Representatives who will witness and accept the inspection, testing and associated work required by this specification.

11.7 The coating pipe mill shall have internal tracking system for pipe traceability during regular coating to reduce manual interference. SAP base system is preferred.

12HANDLING, STORAGE AND TRANSPORTATION OF BARE & COATED PIPES:

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

12.2 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 Owner a procedure/calculation generally in compliance with API RP-5L1& API RP 5LT and prevailing guidelines/rules of statutory bodies (Road/ rail) for stacking of pipes of individual sizes, which shall be approved by Owner prior to commencement of work.

12.3 The Applicator/ Contractor shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and, in a manner, to avoid damage to the pipe and coating. The Owner shall approve such procedure prior to commencement of work.

12.4 Coated pipes may be handled by means of slings and belts of proper width (minimum 60 mm) 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 is prohibited. Forklifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber.

12.5 Bare/coated pipes at all times shall be stacked completely clear from the ground, at least 500 mm, so that the bottom row of pipes remains 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 be of dry, germ-free straw covered with 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/ Contractor shall

submit calculations for Owner 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 bevel protector shall be removed and stored for reuse after completion of coating application. The ends of the pipes during handling and stacking shall always be protected with bevel protectors

12.6 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the flat bed type lorry/ trailer. Total width of the supports shall be at least 5% of the pipe length and min. 4 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 suitably padded at the contact points with the pipe

12.7 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/ Contractor's expenses. These materials shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion. When supplied in containers and envelopes, they shall not 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/ Contractor shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials that are susceptible to change in properties and characteristics due to unsuitable storage. If necessary, the Applicator/ Contractor shall provide for a proper conditioning.

12.8 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/ Contractor shall furnish all details pertaining to marine transportation including drawings of cargo barges, storing/stacking, sea fastening of pipes on the barges/marine vessels to the Owner for approval prior to undertaking such transportation works. In addition, Applicator/

Contractor shall also carry out requisite analyses considering the proposed

transportation scheme and establish the same is safe and stable. On-deck overseas shipment shall not be allowed.

13 REPAIR OF COATING:

Applicator shall submit to the Owner, its methods and materials proposed to be used for executing a coating repair and shall receive approval from Owner prior to regular production.

In open storage, the repair coating materials must be compatible with parent 3LPE coating and 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 pipes leaving coating plant shall have sound external coating with no holiday or porosity on 100% of the surface.

13.1 Defects, repairs and acceptability criteria shall be as follows:

13.1.1 Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm2 or linear damage (cut) of less than 3 cm shall be repaired by melt stick using material of same quality;

13.1.2 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 mm and an area not exceeding 10 cm2, shall be rebuild by Repair Patch material only and without exposing to bare metal;

13.1.3 Defects of size exceeding above mentioned area or holidays of length less than 300 mm shall be repaired with heat shrink repair patch by exposing the bare metal surface;

13.1.4 Defects exceeding the above and in number not exceeding 1 per pipe and linear length not exceeding 500 mm shall be repaired using Heat Shrinkable Sleeves (HSS), HTLP 80 or equivalent;

13.1.5 More than two (02) repairs are not allowed in single length of pipe and cumulative area for these repairs shall not exceed 100 cm2 per pipe;

13.1.6 Pipes with bigger damage shall be stripped and recoated.

13.1.7 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 cutback exceeds 150 mm linear length

of pipe then the coating shall be repaired by the use of heat shrink sleeves thereby making up the coating cut back length of 150 mm;

13.1.8 Notwithstanding the above, if defects exceed 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure;

13.1.9 No Circumferential sleeve (full encirclement) repair is permitted within 100 mm length of the coating cut back area;

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

13.2.1 Holiday repair of size ≤ 100 cm2 attributable to process of coating application shall be maximum one number per pipe;

13.2.2 In addition to the above, defects to be repaired by heat shrink patch/sleeve shall be maximum 1 (One) per pipe;

13.2.3 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/ Contractor.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the Owner or its Representative. In any case the Applicator / Contractor shall establish his material, methods and

procedure of repair that result in an acceptable quality of product by testing and shall receive approval from Owner prior to use.

All repairs shall result in a coating thickness no less than the parent coating thickness. Applicator / Contractor shall test repairs to coating as and when required by Owner.

Repair procedures/ process shall be qualified during PQT.

Only qualified Repair personnel or Insulator shall be allowed to conduct the repair work and all repaired pipes shall be identified by indicating alphabet 'R' afte the coating number.

14MARKING:

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

14.1.1 Applicator's Name and Logo;

14.1.2 Pipe number, Heat number;

14.1.3 Pipe diameter, wall thickness, material grade & length;

14.1.4 Coated pipe number;

14.1.5 Colour band (if required);

14.1.6 Any other information considered relevant by Owner;

14.1.7 Inspection Mark/Punch;

14.1.8 Coating Class and Max, design Temp. (If required).

Applicator/ Contractor shall obtain prior approval on marking procedure to be adopted from the Owner.

15INSPECTION, MEASURING AND TEST EQUIPMENT:

All inspection, measuring and test equipment shall be good working condition and have valid calibration certificates traceable to ISO 17025 accredited calibration laboratory or equivalent. In addition to the above, the following measuring devices shall be verified at a regular interval during execution of coating activities.

Device Name	Reference Clause No.	Frequency of in-house Verification	Tolerance

Digital Roughness Gauge	7.1.10	Start of shift	Standard value ± 5 %
Digital Contact Thermometer	7.4.1.5	Twice / shift	Standard value ± 2 %
Optical Pyrometer	7.4.1.5	Twice / shift	Standard value ± 2 %
Digital Thickness Gauge	8.6.1.1, 8.6.1.2, 8.6.2.2	Start of shift	Standard value ± 5 %
Holiday Detector	8.6.2.3.	Every 4 hours	Standard value ± 2 %

16 RELEASE OF FINISHED COATED PIPES:

Upon successful completion of various in-process inspection and testing, Applicator QC department shall prepare all the records (including release documents) of qualification and production stages. Owner and / or its representative shall review all records and documents for endorsement and then finally release the finished product for dispatch or shipment.

ANNEXURE-I

LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

The following combinations of coating materials are considered acceptable. In case any of the combinations listed below are offered, details regarding properties of the offered materials need not be furnished with bid. However, In the event of award of contract, Applicator/ Contractor shall furnish the combination(s) proposed and re-confirmation of compatibility of the proposed combination (s) from the raw materials Manufacturers.

Epoxy Powder (Manufacturer)	**Adhesive (Manufacturer)**	**PE Compound (Manufacturer)**
JOTAPIPE AC 2002 (Formerly, CORRO-COAT EP-F 2002HW) (JOTUN) or SCOTCHKOTE 226N (3M) or PIPECLAD 2000/PIPECLAD 1000 (SHERWIN-WILLIAMS)	LUCALEN G3710E (LYONDELLBASELL)	LUPOLEN 4552 D (LYONDELLBASELL)
JOTAPIPE AC 2001 (Formerly, CORRO-COAT EP-F 2001) / JOTAPIPE AC 2002 (Formerly, CORRO-COAT EP-F 2002HW) / JOTAPIPE AC 1003 (Formerly, CORRO-COAT EP-F -1003HW) (JOTUN) or SCOTCHKOTE 226N (3M) or PIPECLAD 2000/PIPECLAD 1000 (SHERWIN-WILLIAMS)	ME 0420 (BOREALIS)	HE 3450H (BOREALIS / BOROUGE)
JOTAPIPE AC 2001 (Formerly, CORRO-COAT EP-F 2001) (JOTUN) or PIPECLAD 2000/PIPECLAD 1000 (SHERWIN-WILLIAMS)	LE149V (HYUNDAI ENGINEERING PLASTICS)	ET509B (HYUNDAI ENGINEERING PLASTICS)

Although the above combinations would be acceptable to the owner, the responsibility of suitability for application, performance and compliance to the coating system requirements shall unconditionally lie with the applicator / contractor.

Resonance Energy

RESONANCE ENERGY PVT. LTD.

INSPECTION AND TEST PLAN
FOR
SEAMLESS LINE PIPES UP TO 16”

REPL – ITP – PP – 104

Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By
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ABBREVIATIONS:			
CE	Carbon Equivalent	MTC	Material Test Certificate
HT	Heat Treatment	NDT	Non-Destructive Testing
IC	Inspection Certificate	PO	Purchase Order
IGC	Inter Granular Corrosion	PMI	Positive Material Identification
ITP	Inspection and Test Plan	TC	Test Certificate
MPT/MT	Magnetic Particle Testing	TPI or TPIA	Third Party Inspection Agency
MPS	Manufacturing Process Specification	UT	Ultrasonic Testing
MR	Material Requisition	VDR	Vendor Data Requirement

LEGENDS:
H - Hold (Do not proceed without approval)
W - Witness (Give due notice, work may proceed after scheduled date)
P - Perform
R - Review
RW - Random Witness (As specified or 10% [min.1 no. of each size and type of Bulk item])

1.0 SCOPE:

This Inspection and Test Plan covers the minimum testing requirements of Seamless Pipes up to 16" (Including 16")

2.0 REFERENCE DOCUMENTS:

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS:

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
1.0	**Procedure**						
1.1	MPS	Documented Procedures	100%	Procedure Documents	-	H	R
2.0	**Raw Material Procurement**						
2.1	Raw Material Inspection	Chemical & Mechanical Properties, Method of manufacturing, Heat Treatment Condition etc.	100%	Mill Test Certificates (EN 10204-3.2)	H	H (Note-3)	R (Note-3)

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
3.0	**In Process Inspection**						
3.1	First Day Production test	All testing requirement as per PR/ MPS	As per PR/ MPS	Test Report	-	H	H
3.2	Raw material Inspection	Marking & Correlations with Test Certificates	100%	Inspection Reports	-	H	-
3.3	Heat Treatment	Heat Treatment time and temperature	100%	HT Graph / Record	-	H	R
4.0	**Final Inspection**						
4.1	Hydrostatic Testing	Leak & pressure Drop, Calibration of Gauges/ Recorder	100%	Inspection Report	-	H	RW (Min.5%)

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
4.2	Calibration of UT system	Run with calibration pipe	1) Beginning of each shift 2) After Breakdown /Maintenance	Inspection Report	-	H	W
4.3	Pipe UT	Lamination & other defects	100%	Inspection Report	-	H	RW (Min.5%)
4.4	Pipe End UT MPT as applicable	Lamination & other defects	100%	Inspection Report	-	W	RW (Min.1%)
4.5	Final visual and dimension	1. Visual Examination 2. Dimensional Check Surface Condition, Straightness, End Finish, Bevel Angle, Root Face, Outer Dia., Thickness, Length, End Finish, Marking etc.	100%	Inspection Report	-	H	RW (Min.5%)
4.6	Lot Testing	1. Chemical Analysis 2. Tensile Tests 3. Macro & Hardness Tests 4. Impact Tests and	As per MPS/API 5L/Spec.	Inspection Report	-	H	W

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
		other applicable test					
4.7	Non-conforming product/stage	Repair / Retest /Reject	100%	Inspection Report	-	H	W
4.8	Marking/Stenciling	Pipe No, Acceptance No., Heat. No., Size, Weight, Grade, Thickness, Colour Code etc as per MPS	100%	Inspection Report	-	H	RW (Min.5%)
5.0	**PAINTING**						
5.1	Rust Preventive Coating & Colour Coding	Visual & Colour Coding as applicable	100%	Inspection Report	-	H	-

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
6.0	**Documentation & IC**						
6.1	Documentation & Inspection Certificate(IC)	Review of Stage Inspection Reports / Test Reports & Issue of IC	100%	Manufacturer TC & IC (Note-4)	-	H	H
6.2	Final documents as per PR/MR	Verification & compilation of inspection & test records for submission to customer	100%	Final dossier (Note-4)	-	H	H

NOTES (As applicable):

1. ITP shall be submitted including but not limited to the item/activity covered above. Any item/activity identified and required for the completeness shall also be covered in the ITP submitted by the manufacturers.
2. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in /Job Specification /Approved Documents.
3. Raw Material shall be inspected at Mills (Sub vendors works) by TPIA appointed by Vendor.
4. Items shall be EN 10204 Type 3.2 Certified based on this ITP/MR/PR for the Pipe (Final product).

Resonance Energy

RESONANCE ENERGY PVT. LTD.

INSPECTION AND TEST PLAN
FOR
HFW LINE PIPES

REPL – ITP – PP – 101

		Ajay Kumar			
00	04/02/2025	AK	AS	GS	AN
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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ABBREVIATIONS:			
CE	Carbon Equivalent	PO	Purchase Order
HT	Heat Treatment	PQR	Procedure Qualification Record
IC	Inspection Certificate	RT	Radiography Testing
ITP	Inspection and Test Plan	TC	Test Certificate
MPS	Manufacturing Process Specification	TPI or TPIA	Third Party Inspection Agency
MPT/MT	Magnetic Particle Testing	UT	Ultrasonic Testing
MR	Material Requisition	VDR	Vendor Data Requirement
MTC	Material Test Certificate	WPQ	Welders Performance Qualification
NDT	Non Destructive Testing	WPS	Welding Procedure Specification
PMI	Positive Material Identification		

LEGENDS:
H - Hold (Do not proceed without approval)
W - Witness (Give due notice, work may proceed after scheduled date)
P - Perform
R - Review
RW - Random Witness (As specified or 10% [min.1 no. of each size and type of Bulk item])

1.0 SCOPE:

This Inspection and Test Plan covers the minimum testing requirements of Electric Welded Pipes.

2.0 REFERENCE DOCUMENTS:

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS:

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
1.0	**Procedure**						
1.1	MPS	Documented Procedures	100%	Procedure Documents	-	H	R
1.2	WPS, PQR & WPQ	Welding parameters & Qualification Record	100%	WPS, PQR & WPQ	-	H	W- New R- Existing (Qualified under Reputed TPIA)
2.0	**Raw Material Procurement**						

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
2.1	Inspection of Coils at Mills (Sub vendor works)	Chemical & Mechanical Properties, Method of manufacturing, Heat Treatment Condition etc.	100%	Mill Test Certificates (EN 10204-3.2)	H	H (Note-3)	R (Note-3)
3.0	**In Process Inspection**						
3.1	First Day Production test	All testing requirement as per PR/ MPS	As per PR/ MPS	Test Report	-	H	H
3.2	Raw material Inspection	Heat No, Coil /Plate, Visual & Dimension	100%	Inspection Reports	-	H	RW (Min.1%)
		1) Mechanical 2) Chemical 3) Impact	One/Heat	Inspection Report	-	W	W
3.3	Coil /Skelp UT as applicable	1) 25mm (Min) from edges 2) 20 % Min Coverage in Bal. part of Coil/ Plate	100%	Inspection Reports	-	H	RW (Min.1%)

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
3.4	Pipe Forming & Welding	Offset & Welding Parameters	100%	Inspection Reports	-	H	-
3.5	Heat Treatment	Weld Seam Normalising, Stress Relieving, Normalising, Tempering, Solution Annealing, Stabilization Heat Treatment , Heat Treatment temperature etc. as applicable	100%	HT Graph / Record	-	H	R
4.0	**Final Inspection**						
4.1	Hydrostatic Testing	Leak & pressure Drop, Calibration of Gauges/ Recorder	100%	Inspection Report	-	H	RW (Min.5%)
4.2	Calibration of UT system	Run with calibration pipe	1) Beginning of each shift 2) After Breakdown /Maintenance	Inspection Report	-	W	W

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
4.3	Final weld UT & Pipe body UT (If applicable)	Calibration, Seam Tracking. & Examination of Defects	100%	Inspection Report	-	H	RW (Min.5%)
4.4	Manual UT of Pipe end	Welding defects, crack/ lamination of base metal	100%	Inspection Report	-	W	RW (Min.1%)
4.5	Inspection of Pipe ends MPT	1. Examination of Surface Defects after Beveling 2. Demagnetization	100%	Inspection Report	-	H	RW (Min.1%)
4.6	Final visual and dimension	1. Visual Examination 2. Dimensional Check Surface Condition, Straightness, End Finish, Bevel Angle, Root Face, Outer Dia., Thickness, Length, End Finish, Marking etc.	100%	Inspection Report	-	H	RW (Min.5%)

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
4.7	Lot Testing	1. Chemical Analysis 2. Tensile Tests 3. Flattening 4. Reverse Bend Test 5. Macro & Hardness Tests 6. Impact Tests 7. Drop Weight Tear Test, etc. as applicable	As per MPS/API 5L/Spec.	Inspection Report	-	H	W
4.8	Non-conforming product/stage	Repair / Retest /Reject	100%	Inspection Report	-	H	RW
4.9	Marking/Stenciling	Pipe No, Acceptance No., Heat. No., Size, Weight, Grade, Thickness, Colour Code etc	100%	Inspection Report	-	H	RW (Min.5%)
5.0	**PAINTING**						

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB VENDOR	VENDOR	TPIA
5.1	Rust Preventive Coating & Colour Coding	Visual & Colour Coding as applicable	100%	Inspection Report	-	H	-
6.0	**Documentation & IC**						
6.1	Documentation & Inspection Certificate(IC)	Review of Stage Inspection Reports / Test Reports & Issue of IC	100%	Manufacturer TC & IC (Note-4)	-	H	H
6.2	Final documents as per PR/MR	Verification & compilation of inspection & test records for submission to customer	100%	Final dossier	-	H	H

NOTES (As applicable):

1. ITP shall be submitted including but not limited to the item/activity covered above. Any item/activity identified and required for the completeness shall also be covered in the ITP submitted by the manufacturers.
2. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in /Job Specification /Approved Documents.
3. Raw Material (Coils) shall be inspected at Mills (Sub vendors works) by TPIA appointed by Vendor.
4. Items shall be EN 10204 Type 3.2 certified based on this ITP/MR/PR for the Pipe (Final Product).

RESONANCE ENERGY PVT. LTD.

INSPECTION AND TEST PLAN
FOR
RAW MATERIAL (HR COIL/ PLATES)

REPL – ITP – PP – 102

Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By
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ABBREVIATIONS:			
CE	Carbon Equivalent	PO	Purchase Order
HT	Heat Treatment	PQR	Procedure Qualification Record
IC	Inspection Certificate	RT	Radiography Testing
ITP	Inspection and Test Plan	TC	Test Certificate
MPS	Manufacturing Process Specification	TPI or TPIA	Third Party Inspection Agency
MPT/MT	Magnetic Particle Testing	UT	Ultrasonic Testing
MR	Material Requisition	VDR	Vendor Data Requirement
MTC	Material Test Certificate	WPQ	Welders Performance Qualification
NDT	Non Destructive Testing	WPS	Welding Procedure Specification
PMI	Positive Material Identification		

LEGENDS:
H - Hold (Do not proceed without approval)
W - Witness (Give due notice, work may proceed after scheduled date)
P - Perform
R - Review
C - Certify
RW - Random Witness (As specified or 10% [min.1 no. of each size and type of Bulk item])

1.0 SCOPE:

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

2.0 REFERENCE DOCUMENTS:

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS:

NO	Sl. No.	Components & Operations	Characteristics / Type of check	Quantum of check	Reference document and Acceptance norm	Responsibility	Format of records	Steel Manuf.	Scope of Inspection	
									Pipe Manuf.& TPI	CONSULTANT / CLIENT
1	2	3	4	5	6	7	8	9	10	11
2	**Rolling department**	Slab preheating	Heating parameters per zone	1 slab/Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW (20%)	M
3	**Hot rolling department**	Rolling and accelerated cooling of coils	Rolling Parameters and temperature tolerances.	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW (20%)	M

4	**Ultrasonic of plates**	Automatic Ultrasonic machine	Internal imperfections& laminat ion	1 Plate/Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	W	RW
5	**Sampling department**	Sample removal	Check sample position (end or within body)	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	W	RW
6	**Sampling department**	Inspection of coil end surface quality and dimensions	Surface of coil	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format	P	RW	M
7	**Sampling department**	Mechanical, chemical and hardness tests	Chemical analysis, Tensile Test, Bend Test, Impact Test, Hardness Test,	1 coil/Plate per Heat	As per Steel Manuf. control level and acceptance as per Tender Requirement	Quality In-charge	Report as per Steel Mill format & inspections reports	P	W	RW(Minimum 20% of Total Heats)

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

NOTES (As applicable):

1. ITP shall be submitted including but not limited to the item/activity covered above. Any item/activity identified and required for the completeness shall also be covered in the ITP submitted by the manufacturers.
2. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in /Job Specification /Approved Documents.
3. Successful pipe Manufacturer has to submit latest audit report of offered Coil /Plate mill along with Inspection Test plan
4. Raw Material (Coils) shall be inspected at Mills (Sub vendors works) by TPIA appointed by Vendor.
5. Items shall be EN 10204 Type 3.2 certified.
6. In case of conflict between purchase specification, contract documents and ITP, more stringent conditions shall be applicable
7. Wherever W/R is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier

8. Wherever RW is indicated, Inspection engineer shall witness at least 10% quantity (Minimum 1No.) randomly in a specific time interval.

9. The Line Pipe Manufacturer shall be completely responsible for the design, materials, testing, inspection, preparation for shipment, loading of the supplied item strictly in accordance with the Material Requisition and all attachments thereto.

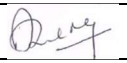
10. Line pipe manufacturer has to give at least 3 weeks advance notice for inspection to CONSULTANT/CLIENT.

11. Scope of inspection for Quantity less than 10,000MT shall be finalized after award of contract.

RESONANCE ENERGY PVT. LTD.

INSPECTION AND TEST PLAN
FOR
3 LAYER PE COATING OF THE PIPE

REPL – ITP – PP – 103

					
00	04/02/2025	AK	AS	GS	AN
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ABBREVIATIONS

CE	Carbon Equivalent	NDT	Non Destructive Testing
DFT	Dry Film Thickness	NPSH	Net Positive Suction Head
DPT	Dye Penetrant Testing	PO	Purchase Order
DHT	De-hydrogen Heat Treatment	PESO	Petroleum Explosive Safety Organization
ERTL	Electronics Regional Test Laboratory	PQR	Procedure Qualification Record
FCRI	Fluid Control Research Institute	MR	Material Requisition
HT	Heat Treatment	PMI	Positive Material Identification
HIC	Hydrogen Induced Cracking	RT	Radiography Testing
ITP	Inspection and Test Plan	SSCC	Sulphide Stress Corrosion Cracking
IP	Ingress Protection	TC	Test Certificate
IHT	Intermediate Heat Treatment	TPI or TPIA	Third Party Inspection Agency
IC	Inspection Certificate	UT	Ultrasonic Testing
IGC	Inter Granular Corrosion	VDR	Vendor Data Requirement
MPT/MT	Magnetic Particle Testing	WPS	Welding Procedure Specification
MTC	Material Test Certificate	WPQ	Welders Performance Qualification
MRT	Mechanical Run Test		

1.0 SCOPE:

This Inspection and Test Plan covers the minimum testing requirements of 3 Layer PE Coating of the pipe.

2.0 REFERENCE DOCUMENTS:

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS:

SL. NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	TPIA
1.0	**Procedure**						
1.1	Coating application, testing and Other Procedures	Documented Procedures	100%	Procedure Documents	-	H	R
2.0	**Material Inspection**						
2.1	Epoxy powder, Adhesive & Polyethylene compound	All the properties as per Material specification	100%	Manufacturer Test Certificates	H	R	R
3.0	**In Process Inspection**						

3.1	Epoxy powder, Adhesive & Polyethylene compound check testing	Properties as per Material specification	100%	Test Reports	-	H	H
3.2	Coating Procedure qualification	All the testing as per Material specification	As per Material Specification	Inspection/Test Report	-	H	H
3.3	Incoming Pipes	Visual inspection, marking verification & correlation with mill TC/Tally sheet	100%	Supplier Data Sheet	-	H	-
3.4	Blast Cleaning	Pre Heating, Elapsed time, Degree of cleaning„ Surface Profile, Contamination of shots/grits, salt level, Degree of dust & roughness	100%	Inspection Reports	-	H	RW (Min.1%)
3.5	Lab test for Chromate, Phosphoric acid & de-ionized water (as applicable)	Properties as per purchase specification / Manufacturer TC	As per Material Specification	Inspection Reports	-	H	RW (Once in a Day)
3.6	Phosphoric acid wash followed by de-ionized water wash (as applicable)	Visual, PH Value, salt level etc.	100%	Inspection Reports	-	H	RW (Once in a Day)

3.7	Chromate Treatment (as applicable)	Uniform application as per Manufacturer's recommendation	100%	Inspection Reports	-	H	RW (Once in a Day)
3.8	Coating application	Preheating temperature, Inter coat time, line speed, Adhesive / PE film temperature, Overlap of layers etc.	100%	Inspection Reports	-	H	RW (Min.1%)
3.9	Epoxy and adhesive Thickness on semi coated pipe	Visual, Thickness, overlap, Adhesion test (St Andrew's Cross Cut method) etc.	As per Material Specification	Inspection Reports	-	H	W
4.0	**Final Inspection**						
4.1	Holiday detection at 25KV	Pin hole, coating damage & Other through thickness defects.	100%	Inspection Report	-	H	RW (Min.1%)
4.2	Visual and Dimensional	Visual, coating thickness, Cut back dimension, Marking , colour coding etc.	100%	Inspection Report	-	H	RW (Min.1%)
4.3	Impact test	No coating damage @ specified Energy	As per Material Specification	Inspection Report	-	H	W

4.4	Peel Test	Bond strength, mode of failure, rate of peeling etc.	As per Material Specification	Inspection Report	-	H	RW (Min.1%)
4.5	Resistance to indentation test	Hardness against indentation	As per Material Specification.	Inspection Report	-	H	W
4.6	Cathodic Disbondment Test	Disbonded area / Equivalent circle radius (ECR)	As per Material Specification	Inspection Report	-	H	W
4.7	Dry Adhesion Test	Epoxy Coating resists Disbondment from the steel (rating 1 or 2)	As per Material Specification	Inspection Report	-	H	W
4.8	Hot water immersion test	Average less than or equal to 2 and maximum less than or equal to 3 as per ISO 21809-1	As per Material Specification	Inspection Report	-	H	W
4.9	Elongation at Break	Minimum 400%	As per Material Specification	Inspection Report	-	H	W
4.10	Visual (Air Entrapment)	Air entrapment between the layers	As per Material Specification	Inspection Report	-	H	W

4.11	Degree of Cure Test	Cure %, Glass Transition Temp(ΔH and ΔTg)	As per Material Specification	Inspection Report	-	H	W
4.12	Calibration of measuring Instruments / Holiday tester	Verify Accuracy	As per Material Specification	Calibration Report	-	H	R
4.13	Handling, Load out & Transportation (Bare & coated pipes)	Pipes stacking & weather protection	As per Material Specification	Inspection Report	-	H	-
5.0	**Documentation & IC**						
5.1	Documentation & Inspection Certificate(IC)	Review of Stage Inspection Reports / Test Reports & Issue of IC	100%	Manufacturer TC & IC	-	H	H
5.1	Final Document submission	Compilation of Inspection / Test reports as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legend: H - Hold (Do not proceed without approval), P - Perform, RW - Random Witness (As specified or 10% [min.1 no. of each size and type of Bulk item]), R - Review, W - Witness (Give due notice, work may proceed after scheduled date).

NOTES (As applicable):

1. This document describes the generic test requirements. Any additional test or Inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon)
2. Acceptance Norms for all the activities shall be as per PO/MR/STANDARDS referred there in /Job Specification /Approved Documents.

FORM - A

CHECK LIST - TECHNICAL

REQUISITION FOR :	**CARBON STEEL COATED/ BARE PIPES**
PROJECT :	

Bidder confirms following, as a minimum, have been enclosed in the offer:

Sl. No.	Requirements	Complied by Bidder
1.0	Total compliance to technical requirements of the Material Requisition, as per Compliance Statement (Form-C), enclosed.	Yes/No
2.0	Bidder has clearly identified the quoted items covered in Material Requisition including location of pipe mill(s) where the quoted items are proposed to be manufactured.	Yes/No
3.0	Type of Line pipe (SAWL/ SAWH/ HFW/SMLS) quoted has been clearly indicated for each quoted item, as applicable.	Yes/No
4.0	Bidder meets Bidder's Evaluation criteria (BEC) and documentary evidence in support of BEC is enclosed in the offer as per following, as a minimum:	Yes/No
	a) Name & Location of Proposed Pipe Mill	Yes/No
	b) Valid API 5L certificate and copy of license to use API monogram on line pipes of PSL 2 quality as per API spec 5L	Yes/No
	c) Proposed Pipe Mills' past track record for supply of line pipes of same or higher in terms of diameter, wall thickness and grade in the last seven years as per Form-B	Yes/No
	d) A certificate from reputed international inspection agency (i.e. CEIL/ Lloyds/ BV/ DNV/ TUV/ ABS/ Moody/ AIB-Vincotte) is enclosed in 'Format-A' for proposed pipe mill, certifying that the proposed mill has the capability to produce linepipes complying technical requirements specified in the bid document.	Yes/No
	e) Documentary evidence in support of BEC [i.e. copies of W.O/ P.O (without price) & Inspection release notes/ completion certificate etc.]	Yes/No
5.0	a) Regarding raw material supplier(s) i.e. steel plate/ coil material, Bidder confirms compliance to relevant notes of General Notes to "Material Requisition for Line Pipe" and Documentary evidence required as per above note are enclosed with the offer along with duly filled-up Form-D.	Yes/No
	b) Compliance to Applicable REPL specification attached with MR / from proposed steel plate/ coil manufacturer(s) is enclosed with the offer.	Yes/No

To be filled, signed and stamped by Bidder.

Bidder's seal **Signature of Bidder**

FORM – B

REFERENCE LIST OF SUPPLY OF LINE PIPES FOR THE LAST SEVEN YEARS

Pipe Manufacturer: _____ Mill Name & Location: _____

Sl. No.	Project	Client (Company name, Address, email ID, contact phone no.)	Diameter NB (inch)	Grade API 5L X-	Wall thickness (mm)	Length (metres)	Process of Manufacture (SAWL/ SAWH/ HFW/SMLS)	Product Specification Level (PSL-2)	Service	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 linepipe manufacturer for each proposed mill.
2. Copy of Purchase/ work order(s) and Inspection Release Note(s)/ Completion Certificate(s) shall be enclosed.

Bidder's seal **Signature of Bidder**

FORM - C

COMPLIANCE STATEMENT

REQUISITION FOR	:	CARBON STEEL COATED LINEPIPES
PROJECT	:	

Sl. No.	Requirement	Bidder's Confirmation
1	Bidder confirms that the offer is in total compliance with technical requirements of the complete Material Requisition including General notes to MR, Data sheet SOW etc. as well as specification and there are no technical deviations. Bidder to note that as this is a **"Zero-Deviation Bid**", deviation expressed or implied anywhere in the offer shall not be considered valid.	
2	Bidder confirms meeting the Bidder's Evaluation Criteria (BEC) with necessary documentary evidence as per BEC.	
3	(a) Bidder confirms meeting the qualification requirements of steel plates/ coil manufacturer as stipulated in relevant notes of Material Requisition for the proposed steel supplier(s).	
	(b) Bidder confirms compliance to applicable REPL specification nos. by steel plate/ coil manufacturer.	
4	Bidder confirms that for the items quoted by the bidder, the entire process of line pipe manufacturing shall be carried out in the proposed pipe mill(s).	
5.	Bidder confirms that all materials proposed by the bidder are same/ superior to those specified in specification/ data sheets enclosed.	

Bidder's Signature with stamp

FORM - D

REFERENCE LIST OF SUPPLY OF STEEL COIL/ PLATE FOR THE LAST SEVEN YEARS

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.)	Coil Width (mm)	Plate Width (mm)	Billet	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-3)	Inspection Release Note/ Completion Certificate No. (Note-3)

To be filled, signed and stamped by Bidder.

Note:

1. This form shall be submitted along with the bid.
2. This form shall be filled separately by line pipe manufacturer for each steel coil/ plate manufacturer proposed by the bidder.
3. Copy of Purchase/ work order(s) and Inspection Release Note(s)/ Completion Certificate(s) shall be enclosed.

Bidder's seal **Signature of Bidder**

Resonance Energy	DEVIATION SHEET	REPL-SD-DS-001

DEVIATION/ EXCEPTION/ CLARIFICATION SHEET

Sr. No.	Contractor's Inquiry Reference	Contractor's Requirement	Proposed Deviation by Supplier, with Technical Justification	Cost Impact, if any	Contractor's Conclusions

NOTES

1- Bidder confirms that apart of from the deviations/exceptions/clarifications listed above, the bid is in full compliance with Inquiry requisition.
2- Bidder shall submit this sheet duly filled up and signed by him along with his bid. In case there is no deviation, then also supplier shall submit this sheet along with his bid indicating NIL deviation.

(Contractor's Name and Signature with Seal)

0	31.01.2025	ISSUED AS STANDARDS	AK	GS	AN
REV	**DATE**	**DESCRIPTION**	**PREP**	**CHK**	**APPR**

INSTRUCTION TO BIDDERS

1. Bidder to note that no correspondence shall be entered into or entertained after the bid submission.
2. Bidder shall furnish quotation only in case he can supply material strictly as per this Material Requisition and specification/data sheet forming part of Material Requisition.
3. If the offer contains any technical deviations or clarifications or stipulates any technical specifications (even if in line with MR requirements) and does not include complete scope & technical / performance data required to be submitted with the offer, the offer shall be liable for rejection.
4. Bidder must submit all documents as listed in checklist with his offer.
5. Supplier must note that stage wise inspection for complete fabrication, testing including the raw material inspected to be carried out.
6. Vendors for bought out items to be restricted to the approved vendor list attached with bid document. Approval of additional vendor if required, for all critical bought out items shall be obtained by the supplier from the purchaser before placement of order. Credentials/PTR of the additional vendor proposed to be submitted by supplier for review and approval of Purchaser/ Purchaser's representative

Resonance Energy	VENDOR DRAWINGS DOCUMENT SCHEDULE	REPL-SD-VS-001

VENDOR DRAWINGS

DOCUMENT SCHEDULE

	Vendor Drawing/ Document Submission Schedule						Status:	
							Date:	
Client	Project		Vendor Name					
Item Description	PO No.		Address					
	Date		Contact Person:				Fax:	
REPL Department		Contact Person(REPL)	Phone:				Email:	

S. No.	Equipment/ Item Number	Drg./Doc. Nomenclature	Vendor Drg./ Doc. Number	Vendor Drg./Doc. Title	Category Review (R) / Records	Scheduled date of 1st submission (Rev.0)	Form Electronic/ Print	Remarks

0	31.01.2025	ISSUED AS STANDARDS	AK	GS	AN
REV	**DATE**	**DESCRIPTION**	**PREP**	**CHK**	**APPR**

	LIST OF ACCEPTABLE STEEL PLATE/COIL/BILLET MANUFACTURER	Resonance Energy

List of acceptable Steel Plate/Coil/Billet 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. Welspun PCMD, India
13. Baoshan Iron & Steel Co. Ltd, Shangai, China
14. Arcelor Mittal Nippon Steel India (earlier Essar Steel, India)
15. Jindal Steel & Power Ltd (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

	LIST OF ACCEPTABLE STEEL PLATE/COIL/BILLET MANUFACTURER	Resonance Energy

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
27. Tata Steel Limited, Jamshedpur (up to API 5L X-60 & WT up to 9.35 mm)
28 Tata Steel Limited, Kalinganagar (WT up to 16.0 mm)
29 Tata Steel BSL Limited, Meramandali (WT up to 12.7 mm)
30 Inner Mongolia Baotou Steel Union Co. Ltd. China (WT up to 12.8 mm)
31 Baosteel Zhanjiang Iron & Steel Co. Ltd., China (WT up to 12.8 mm)
Legend WT: Wall Thickness
32 Baotou Steel, China
33 Lloyd Steel, India (up to X-70, WT-11.7 mm)

FOR Billets

1. Jindal Steel Limited, Vijay Nagar
2. Jindal Steel & power Limited,Raigarg,Chhatisgarh
3. JSW Steel Limited, Salem
4. Kalyani Steel Limited, Hospet

	GAIL (INDIA) LIMITED
LIST OF RECOMMENDED THIRD PARTY INSPECTION AGENCY (TPIA)	
SL. NO	**NAME OF TPI**
1	Lloyd Register of Industrial Services
2	Det Norske Veritas (DNV)-GL/ Germanischer Llyod
3	Bureau Veritas (BV)
4	SGS India
5	ABS
6	Velosi
7	AB-Vincotee
8	CEIL
9	Moody International
10	TUV India
11	TUV Norde
12	Dr. Amin Controller Pvt ltd
13	Meenar Global Consultant
14	VCS Quality Services Pvt Ltd
15	IR CLASS System and Solution Pvt ltd
16	Edlipse Engineering Global Pvt Ltd

Vendor shall proposed 2 agency for approval from given agencies for inspection purpose. Vendor has to intimate the TPIA name from below listed agencies to GAIL/ REPL prior to perform any inspection activity. In addition to the above, owner also reserves the right to inspect and witness any tests during manufacturing at their own or through authorized representative.