



GODAVARI GAS PRIVATE LIMITED

{A Joint venture of APGDC & HPCL}

CITY GAS DISTRIBUTION PROJECT AT EAST & WEST GADAVARI DISTRICTS BID DOCUMENT FOR SUPPLY OF COATED LINE PIPES

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SECTION -I

MATERIAL REQUISITION

MATERIAL REQUISITION

Project : City Gas Distribution project of East & West Godavari Dist
Client : M/s GGPL
Items : CS coated pipes

The Scope includes supply of following 3 layer PE coated Steel line pipes conforming to specifications and other technical requirements as specified in bid document. The scope of bidder also includes delivery of CS coated pipes at GGPL's storage yard at Rajahmundry/Ravulapalem. The delivery period is three months from the date FOA.

Sl. No.	Description							Manuf. process (Seamless / ERW)	Quantity, KM
	Supply of 3 layer PE coated Steel line pipes ,Double random conforming to GGPL's Technical Specification No. MEC/TS/05/21/012 or 12A & MEC/S/05/21/014 for 3 layer PE coated Steel line pipes of following sizes, grades & specifications as indicated below :								Destination:
	Pipe size (NB), Inch (OD in mm)	W.T. (mm)	Ends	Std./ Code	Grade	Finish	Min.3 LPE Coating thickness (mm)		Rajahmundry/ Ravulapalem
2	4" (114.3)	6.4	BE	API 5L	X-52	Coated	2.0	Bidder to indicate	10

LEGEND

WT = Wall Thickness
BE = Bevelled End

Note:

- i. Bidder has to quote for full quantity, else bidder's offer shall not be considered for evaluation for the corresponding item
- ii. Item nos. 1 shall have External coatings.
- iii. Type of pipe to be supplied to the coating contractor shall be Seamless/ ERW.

No cost implication shall be considered for change of pipe quantity from one to other process.

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

A. REMARKS / COMMENTS

1. GENERAL NOTED

VENDOR'S COMPLIANCE

Vendor must include the following statement in his bid:

We certify that our bid is fully complying with your enquiry dated And referenced

.....

Compliance with this material requisition in any instance shall not relieve the Vendor of his responsibility to meet the specified performance.

2. COMPLIANCE WITH SPECIFICATION

The vendor shall be completely responsible for Design, Manufacture, fabrication, testing, inspection, preparation for shipment, transport, delivery at specified Warehouse at Rajahmundry and the above items strictly in accordance with the Material Requisition and all attachments thereto.

3. INSPECTION

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

- a) Lloyd Register of Industrial services
- b) Technische Ulierwachungs Verein (TUV)
- c) Det Norske Veritas (DNV)
- d) AIB - Vincotte
- e) Bureau Veritas
- f) SGS
- g) ABS Industrial Verification India Ltd.
- h) Velosi Certification Services

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

CERTIFICATION

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

4.0 PROCUREMENT OF STEEL PLATE/COIL

4.1 List of acceptable Steel Coil/Billet Manufacturer

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

For Coils

- (i) Thyssen Krupp, Germany (upto X-70, WT-15.9mm)
- (ii) AHMSA (Altos Hornos De Mexico), Mexico (upto X-70, WT-15.9mm)
- (iii) Bao Steel, China (upto X-70, WT-15.9mm)
- (iv) Wuhan Iron & Steel, China (upto X-80, WT-18.4mm)
- (v) US Steel Kosice, Slovak Republic (upto X-70, WT-15.9mm)
- (vi) Arcelor Mittal, France (upto X-80, WT-21.6mm)
- (vii) Arcelor Mittal, Germany (upto X-70, WT-15.9mm)
- (viii) Erdemir, Turkey (upto X-80, WT-18.4mm)
- (ix) Posco, South Korea (upto X-80, WT-10.85mm)
- (x) TISCO (Group) Co.Ltd, China (upto X-80, WT-18.4mm)
- (xi) Maanshan Iron & Steel Co. Ltd., China (upto X-80, WT-17.5mm)
- (xii) Jinan Iron & Steel Co.Ltd., China (upto X-80, WT-14.3mm)
- (xiii) Benxi Iron & Steel, China (upto X-80, WT-17.5mm)
- (xiv) Shagang (Group), China (upto X-70, WT-15.9mm)
- (xv) Shou-gang Qian Iron & Steel Co. Ltd., China (upto X-80, WT- 18.4mm)
- (xvi) Hyundai Steel, South Korea (upto X-70, WT-14.0mm)
- (xvii) Hadeed Saudi Iron & Steel Co., Saudi Arabia (upto X-70, WT-15.9mm)
- (xviii) Hunan Valin Lianyuan Steel Co.Ltd., China (upto X-80, WT-18.4mm)
- (xix) Anyang Iron & Steel Group Co.Ltd., China (upto X-70, WT-15.9mm)
- (xx) Angang Steel Co.Ltd., China (upto X-80, WT-18.4mm)
- (xxi) HBIS Hebei Iron & Steel Group Co.Ltd., China (upto X-80, WT-12.8mm)
- (xxii) Megasteel, Malaysia (upto X-70, WT-10.3mm)
- (xxiii) Essar Steel, India (upto X-70, WT-15.9mm)
- (xxiv) Ispat Industries, India (upto X-70, WT-11.7mm)
- (xxv) SAIL, Bokaro (upto X-70, WT-15.9mm)
- (xxvi) JSW, India (upto X-70, WT-15.9mm)

FOR Billets

1. Jindal Steel Limited, Vijay Nagar
2. Jindal Steel & power Limited, Raigarh, Chhatisgarh
3. JSW Steel Limited, Salem
4. (Kalyanai Steel Limited, Hospet

4.2 A letter of commitment from two proposed steel coil/billet manufacturer for

supply of steel coils/billets required for the manufacture of line pipes under present bid.

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

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

4.3.2 The steel coil/billet manufacturer have manufactured coils/billets conforming to API5L (PSL-2) of same or higher wall thickness as quoted for in the last seven(07) years from the bid due date.

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

Bidder must submit the track record, along with bid, in duly filled up “Annexure A” with documentary evidence (of steel Coil/Billets manufacturer) to establish the above qualification criteria indicated above at clause No4.3,1 &4.3.2, Such as Purchase order/work order, inspection release note/completion certificate of relevant previous supplies In the absence of such documentary evidence, Owner/ Consultant reserve the right to reject the bid without making any reference to the bidder.

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

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

4.6 Bidder’s offer shall be unconditional irrespective of the finally qualified steel coils/billets manufacturer(s).

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

5. APPLICABLE DOCUMENTS

General descriptions, requirements and information are listed under point C of this Material Requisition.

6.0 VENDOR'S DOCUMENTS

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

All documents shall be supplied in English language.

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

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

Project no.

Item is CS COATED PIPES

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

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

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

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

0000	LPCOAT	QAP	0001	R0
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B. LIST OF ATTACHMENTS

Sl.No.	Title	Specification
1	Specification for Electric Welded Line Pipe (Onshore)	As per technical specification in the bid document
2	Specification For Seamless Line pipe (Onshore)	As per technical specification in the bid document
3	Specification for 3 Layer Polyethylene Coating of Line pipe	As per technical specification in the bid document
4	Quality Assurance Plan (Guideline)	As per bid document
5	Inspection & Test Plan (Seamless)	
6	Inspection & Test Plan (ERW)	
7	Inspection & Test Plan 3 Layer Polyethylene Coating	

C. DOCUMENTS & DATA REQUIREMENTS

The table hereunder specifies the quantities and the nature of the documents to be submitted by the CONTRACTOR to GGPL/GGPL. 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 GGPL/GGPL are listed under column B.

The final and certified documents are listed under column C.

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

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

Item	Documents and Data	Doc. Index No	A	B		C	
			No. Of copies	No. Of copies	Required date	No. Of copies	Required date
1	Drawing/ data Submittal List / schedule	DLS	1	3	2 weeks + weekly	3	2 weeks after approval
2	Fabrication / rolling, test and delivery schedule (per item)	FTD	1	3	2 weeks + weekly	3	1 within weeks
3	Progress report	PRT		3	Daily + weekly		Daily + weekly
4	Catalogues /references	CRS	1				
5	Code compliance certificate	CCC		3	Within 2 weeks		1 week after approval
6	The welding method and welding procedure specification and records WPS/PQR for EW or	WPS/MP S	1	3	Within 2 weeks		1 week after approval + with final technical;

	manufacturing process for seamless						
7	QA / QC program	QAP	1	3	2 weeks	3	
8	Inspection and test procedure	ITP	1	3	2 weeks	3	
9	NDE reports	NDR		3	When available	3	1 week after approval + with final technical file.
10	Hydro-test report	HTR		3	When available	3	2 weeks after approval + with final technical file.
11	List of subcontractors with their scope	LSS		3	2 weeks		With final technical file
12	Copy of purchase orders to subcontractors	CPS		3	2 weeks		With final technical file
13	Copy of purchase order	CPO					With final technical file
14	Packing/shipping list w/weights and dimensions	PSD		3	2 weeks	3	2 weeks before shipping
15	Final technical file	FTF				6	With shipping

NOTES

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

Due date of each document may be proposed.
- 2) Latest submittal time for:
 - ™ Test procedure : 2 weeks before test
 - ™ Test report : 2 week after test
- 3) Final technical file shall be supplied in hard copy as indicated, and in electronic format (.pdf Acrobat files) on six (6) CD-ROMs.

SECTION -II

TECHNICAL SPECIFICATION

Edition : 2

**SPECIFICATION
FOR
ELECTRIC WELDED LINEPIPE
(ONSHORE)**

CONTENTS

<u>Sl.No.</u>	<u>Description</u>
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7	DIMENSIONS, WEIGHTS, LENGTHS, DEFECTS, AND END FINISHES
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13	PIPE LOADING
14	(New) INSPECTIONS OF FIELD TEST AND WARRANTY
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	FIGURE 6.2.7 : REVERSE BEND TEST
	FIGURE 9.8.5.2 : REFERENCE STANDARD FOR UT OF LONGITUDINAL WELD SEAM

AMENDMENT STATUS

1.1 Purpose and Coverage

This specification establishes the minimum requirements for the manufacture of longitudinal seam electric welded steel line pipes in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty Third Edition, 2004 and makes restrictive amendments to API Spec. 5L. Unless modified and or deleted by this Specification, the requirements of API Spec. 5L shall remain applicable.

In addition to this specification, wherever stringent, requirement / provision / amendments of the latest 44th edition of API 5L (effective October 2008) shall apply.

The sections, paragraphs and appendices 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 Manufacturer shall have a valid license to use API Monogram in accordance with the requirements of API Spec. 5L on line pipe as Product Specification Level PSL-2.

1.2 Product Specification Level (PSL)

Line pipes supplied to this specification shall conform to Product Specification Level PSL-2.

1.3 Grades

This specification is applicable to PSL-2 line pipes of grade B through X80.

1.4 Dimensions

This specification shall be applied to line pipes of size 4½" through 24" (both size included).

2 REFERENCES

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

ASTM

ASTM E 92 : Test Method for Vickers Hardness of Metallic Materials.
ASTM E 112 : Standard Test Methods for Determining Average Grain Size.

BS

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

5 PROCESS OF MANUFACTURE AND MATERIAL

5.1 Process of Manufacture

Following paragraphs of API Spec. 5L shall be applicable to the line pipe manufactured as per this Specification:

Welding Process : Electric Welding as per para 5.1.2.1.2
Type of Pipe : Electric Welded Pipe as per para 5.1.3.3 & 5.1.3.3.2
Type of Seam Weld : Electric Weld as per para 5.1.4.1

5.1.3.3.2 PSL 2 Electric Welded Pipe

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

- Time
- Welding Speed
- Current and Voltage
- Heat Treatment Temperature
- Temperature, Heat Input

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

5.2 Cold Expansion

Pipes furnished to this specification shall be non-expanded.

5.3 Material

5.3.3 (New) Line pipe furnished to this specification shall be made from steel produced in basic oxygen or electric arc furnace. The steel used for manufacture of pipe shall be fully killed and fine grained with a grain size of ASTM 7 or finer as per ASTM E 112. Steel shall be made by continuous casting only.

For X-80 Grade pipe, skelp / plate shall be produced by thermo mechanical rolling process and subsequent accelerated cooling. The micro structure of plates / skelp shall be ferritic - bainitic (grain size shall be ASTM 10 and above) as per ASTM E112.

5.4 Heat Treatment

The pipes shall be produced from skelp which shall be quenched and tempered or controlled rolled or combined controlled rolled and accelerated cooled to impart uniformly fine ferritic grain structure to the finished steel. Other types of heat treatment shall be agreed upon between Purchaser and Manufacturer.

6 MATERIAL REQUIREMENTS

6.1 Chemical Properties

6.1.1 Chemical Composition

The chemical composition of each heat of steel on product analysis shall be in accordance with Table-2B and notes given below. Table-2B of API Spec. 5L is cancelled.

Table-2B : PSL 2 - Chemical requirements for Heat and Product Analysis

Element	Maximum Permitted Alloy Content, Wt. %	
	EW (for Grade B to Grade X-70)	EW (for Grade X-80)
C	0.16	0.12
Mn	1.5 (For Gr. B to X-52) 1.6 (For Gr. X-56 to X-70)	1.85
Si	0.15 min. - 0.45 max.	0.45
P	0.02	0.020
S	0.010	0.006
V	0.08	*(Note-1)
Nb	0.10	*(Note-1)
Ti	0.04	*(Note-1)
Cr	0.20	0.40
Mo	0.28	0.30
Ni	0.20	0.50
Cu	0.35	0.50
Al	0.07	*(Note-3)
N	0.012	0.008
B	0.0005	0.0005

Element	Maximum Permitted Alloy Content, Wt. %	
	EW (for Grade B to Grade X-70)	EW (for Grade X-80)
Ca	0.006	-

Note: g(New)

1. V+Nb+Ti shall not exceed 0.15%.
2. Cu+Ni shall not exceed 0.4% (applicable for Grade B to X-70).
Cu+Ni shall not exceed 0.75% (applicable for Grade X-80).
3. The AL/N ratio shall not be less than 2:1

NOTE: h (New)

If alloying elements other than those specified in Table 2B above are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

Note: i (new)

Minimum for Si is not applicable for Al killed steel.

6.1.2 Elements Analysed

For heat analysis and product analysis, all the elements listed in Table-2B of this specification shall be analysed and reported, even if those are not purposely added but are present as residuals only.

6.1.3 Carbon equivalent (PSL 2 Only)

6.1.3.1 Calculations of Carbon Equivalent

Boron content shall be considered in CE (Pcm) formula even if it less than 0.0005%.

6.1.3.2 Maximum Carbon Equivalent

For pipes of all grades,, size and wall thickness, carbon equivalent shall comply the following limits:

CE (Pcm)	≤	0.23%
CE (IIW)	≤	0.43%

6.2 Mechanical Properties

6.2.1 Tensile Properties

The finished pipe (after all heat treatment and expansion or sizing operations) shall conform to the requirements of Table 3B 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 not case it shall exceed the limits specified here under:

<u>API Spec. 5L Grade</u>	<u>Permissible in excess of SMYS, psi (Mpa)</u>
Up to and including X46	19,000 (131)
X52 to X-65	22,000 (152)

X70	20,000 (138)
X80	20,000 (138)

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

The ultimate tensile strength of the weld shall be equal to or better 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 (a) of Table-3B and shall comply with the minimum values of API Spec. 5L Appendix D. However elongation in no case shall be less than 20%. API Spec. 5L Appendix D stands modified accordingly.

6.2.2 Flattening Test Acceptance Criteria

Dye penetrant testing may be used to positively confirm the presence of crack, break or opening.

6.2.5 Fracture Toughness Tests

6.2.5.2 Charpy Impact Tests for PSL 2

(New)

For all pipe sizes and specified wall thickness, additional fracture toughness requirements as per Supplementary Requirements Appendix-F SR 19 of API Spec 5L and as modified in this specification shall be applicable for body, weld and heat affected zone.

6.2.5.3 Supplementary Fracture Toughness Tests

For pipe of all grades and specified wall thickness, the Charpy V-notch Impact Test for determination of Shear Area in accordance with Supplementary Requirement SR 5A of API Spec 5L and as modified herein shall be performed. In addition, whenever line pipes are specified for hydrocarbon service in gaseous phase and Liquefied Petroleum Gas (LPG) service in Purchase Order for pipe size 16 and larger, Drop Weight Tear Test in accordance with Supplementary Requirements SR 6 of API Spec 5L and as modified in this specification shall be also performed for all grades and wall thickness.

6.2.6 Metallographic Examination

6.2.6.1
(New)

A test specimen for Metallographic & hardness examination shall be taken transverse to the longitudinal weld, from one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hours maximum) whichever is occurring more

frequently and whenever changes in grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered. The specimen shall be suitably ground and etched to reveal the macrostructure. The specimen shall be visually examined using a minimum 10X magnification to provide evidence that heat treatment of weld zone is adequate and there is no untempered martensite left. 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.

6.2.6.2 Vickers hardness tests shall be carried out on each specimen taken for metallographic examination in accordance with ASTM E-92, at locations indicated in Fig. 6.2.6.2 of this specification. Indentation in the Heat Affected Zone shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 HV₁₀ for Grade B to Grade X-70 and 285 HV₁₀ for Grade X-80. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80 HV₁₀. Modalities of retest shall be in accordance with para 9.12.2 of API Spec. 5L.

6.2.7 Reverse Bend Test

(New)

6.2.7.1 Reverse bend test shall be executed with the same number of tests and retests specified for flattening tests in para 9.3.2 of API Spec. 5L. Ring Specimen of width 100mm to 115mm shall be taken from the pipe and tested in accordance with the procedure given below and Fig. 6.2.7 of this specification.

(New)

6.2.7.2 Selection of Mandrel

(New)

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.

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

Where

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

Minimum values of 'e' shall be as follows :

<u>Grades of Steel</u>	<u>Min 'e' value</u>
Gr.B	0.1425
X-42	0.1375
X-46	0.1325
X-52	0.1250
X-60	0.1125
X-65	0.1100

X-70	0.1075
X-80	0.0900

6.2.7.3
(New) **Procedure**

The Mandrel shall be plunged into the specimen, with the weld in contact with the mandrel, to such a depth that the angle of engagement between mandrel and specimen reaches 60° (see Fig. 6.2.7 of this specification). If the combination of diameter and wall thickness of pipe, and radius of mandrel is such that the angle of engagement does not reach 60° the mandrel shall be plunged into the specimen until opposite walls of the specimen meet.

6.2.7.4
(New) **Acceptance Criteria**

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

7 **DIMENSIONS, WEIGHTS, LENGTHS, DEFECTS, AND END FINISHES**

7.2 **Diameter**

Pipe Body

The outside diameter of pipe body, as determined by taping the circumference, shall not deviate by more than the value given below from that given in Table E - 6B (for size 4½") and E-6C (for size ≥ 6-5/8"), Appendix E. API Spec. 5L Table-7 stands modified accordingly.

	<u>Pipe Size</u>	<u>Tolerance</u>
smaller	≥ 4½" and ≤ 18"	± 0.75% of specified OD or ± 3mm whichever is
	20"	+ 3mm, -0.25% of specified OD

Pipes Ends

Diameter tolerances for the pipe ends indicated in API Spec. 5L Table-8 shall be applicable on the inside diameter for sizes ≥ 14" and on outside diameter for pipe sizes ≤ 12".

The inside diameter, based on circumferential measurement, over a length of 100mm from the end shall comply with the tolerances specified in API Spec. 5L. Inside diameter is defined as ID=(OD-2WT) where ID, OD & WT are the specified diameter,

specified outside diameter and specified wall thickness respectively.

Out of Roundness

Out of Roundness i.e., the difference between the maximum and minimum diameter (inside for pipe size ≥ 14 and outside for pipe size ≤ 12) at pipe ends shall comply with the following limits.

<u>Pipe Size</u>		<u>Tolerance</u>
$\leq 10\frac{3}{4}$	-	2mm
$\geq 12\frac{3}{4}$	-	3 mm

Out of roundness tolerance apply to maximum and minimum diameters as measured with a bar gauge, caliper or device measuring actual maximum and minimum diameter. Out of roundness tolerance indicated in API 5L Table 8 stands deleted.

Each pipe shall be measured for conformance to above requirements. All dimensions and tolerances shall be measured and recorded at least 3 times per operating shift (12 hrs maximum).

7.3 Wall Thickness

In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerances shall comply with the requirements of this specification.

The tolerances on specified wall thickness shall be (+) 15% and (-) 0%. API Spec. 5L Table 9 stands cancelled.

Wall thickness measurements shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

7.5 Length

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 max. of 5% of the ordered quantity. The minimum average length of the entire ordered quantity in any case shall be 12.0m. API Spec 5L Table 11 shall not be applicable. Overall length tolerance shall be (-) Zero and (+) One pipe length to complete the ordered quantity.

Each pipe shall be measured for conformance to above requirements and all

measurements shall be recorded.

7.6 Straightness

The deviation from a straight line for all pipe sizes shall not exceed 12mm. Each pipe shall be checked for conformance to the requirements. Straightness shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

7.7 Jointers

Jointers on pipes are not permitted.

7.8 Workmanship and defects

7.8.1 Dents

Allowable dent size shall be as per API Spec. 5L. Disposition of dents shall be carried out in accordance with API Spec. 5L para 9.9(c) or (d). Dents on weld and heat affected zone (HAZ) are not acceptable.

7.8.2 Offset of Plate Edges

All pipes shall be checked for offset of skelp plate edges. Offset shall be measured and recorded at least 3 times per operating shift (12 hour maximum).

7.8.5 Height of Flash of Electric Welded Pipe

Each pipe shall be checked for conformance of height of flash. Height of flash shall be measured and recorded at least 3 times per operating shift (12 hours maximum). The inside flash of EW pipe shall not extend above the prolongation of the original inside surface by more than 0.5 mm +5% of normal wall thickness.

7.8.7 Trim of Inside Flash of Electric Welded Pipe and Trim of Inside Weld Reinforcement of Laser Welded Pipe

Each pipe shall be checked for conformance of depth of trim. Depth of trim shall be measured and recorded at least 3 times per operating shift (12 hours maximum). In any case the groove shall not cause the remaining thickness to be less than that allowed by section 7.3.

7.8.8 Hard Spots

Any hard spot having a minimum dimensions greater than 2 inch (50.8 mm) in any

direction and a hardness greater than 248 HV₁₀ shall be rejected. The section of pipe containing the hard spot shall be removed as a cylinder.

7.8.9 Cracks, Sweats and Leaks

Sections of the pipe containing cracks, sweats and leaks shall be cut off as per the requirements of API Spec. 5L para 9.9 (c) or (d).

7.8.10 Laminations

Any lamination or inclusion extending into the face or bevel of the pipe or present within 25 mm from pipe ends is considered defect and pipe containing such defects shall be cut back until such defects are eliminated.

The acceptance limit and disposition of lamination and other type of defects on the skelp/ pipe body shall be as per Para 9.8.5.4 of this specification.

7.8.11 Arc Burns

Arc burns produced during the manufacturing of pipes are injurious defects and shall be disposed off in accordance with the requirements of API Spec. 5L para 9.9 (c) or (d). As a reference method for conforming the existence of an arc burn, the area shall be buffed with wire brush or sanding disc and etched with 5 percent nital solution. However, arc burns can also be considered for acceptance, in case the same is recrystallized by seam heat treatment. In such case, the Manufacturer shall demonstrate the recrystallization to Purchaser by taking a sample as per para 6.2.6.1 (New) of this specification.

7.8.14 Other Defects

Any imperfection (measured from the surface) with a depth greater than 5 percent of the specified thickness of the pipe shall be considered a defect and shall be repaired in accordance with API Spec. 5L para 9.9 and as modified in this specification.

7.9. Pipe Ends

7.9.1 General

Pipes shall be furnished with plain ends.

7.9.3 Plain Ends

Unless specified otherwise, the pipe ends shall be bevelled as per API Spec. 5L.

In removing the inside burrs at the pipe ends, care shall be taken not to remove excess metal and not to form an inside cavity or bevel. Removal of excess metal beyond the minimum wall thickness as indicated in para 7.3 of this specification, shall be a cause for rebeveling. In case root face of bevel is less than that specified, the pipe ends shall be rebevelled and rectification by filing or grinding shall not be done.

7.9.6
(New)

Bevel Protectors

Both pipe ends of all pipes 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 contractor for providing on coated pipes subsequent to coating of line pipes.

9

INSPECTION AND TESTING

9.2.1

Heat Analysis

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 production.

9.2.2

Product Analysis

9.2.2.1

Sampling Frequency

Two pipes per inspection lot shall be analysed. Inspection lot shall be 100 pipes per heat. Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat is also represented.

9.2.2.2

Sampling Method

9.2.2.2.2

Welded Pipe

Samples used for product analysis shall be taken from finished pipes. Samples for product analysis from skelp may be used provided the traceability of samples is guaranteed.

9.3

Testing of Mechanical Properties

9.3.1

Tensile Tests

9.3.1.2

Tensile Testing Frequency

Tensile test shall be made at the frequency of two pipes per inspection lot. Inspection lot shall be 100 pipes per heat. API Spec. Table 13 stands modified accordingly.

9.3.1.3 Longitudinal Tensile Tests

Longitudinal tensile tests shall be carried out on a strip specimen.

9.3.1.4 Transverse Tensile Tests

The transverse tensile tests shall be carried out on flattened rectangular specimen.

9.3.1.5 Weld Tensile Tests

Inside and outside flash of weld in excess of pipe wall thickness shall be removed from the specimen either by grinding or machining. Specimen shall be tested for ultimate tensile strength only.

9.3.5 Fracture Toughness Tests

9.3.5.1 Charpy Test Specimens

In addition to the specimen taken from the body of the pipe, three transverse specimens with weld in middle and three transverse specimens with Heat Affected Zone (HAZ) in the middle shall also be taken. When either full size or sub-size transverse specimen as per API Spec 5L, Table 14 is not possible to obtain, transverse specimen of either 1/3 Size or 1/4 Size, whichever is maximum possible, may be obtained.

When such sub-size specimens are used, the acceptance of the individual/average absorbed energy values shall be established as per API Spec 5L para 9.10.4 and as modified in this specification.

9.3.5.2 Charpy Testing Frequency

The minimum test frequency shall be one test (a set of three specimens each for body, Weld and HAZ) per heat per lot of 100 pipes per combination of pipe size and specified wall thickness.

9.4 Hydrostatic Tests

9.4.1 Hydrostatic Test Requirement

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

9.4.2 Verification of Hydrostatic Test

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 pressure gauge shall be calibrated by means of a "Dead Weight" tester only prior to start of the first day production.

9.4.3 Test Pressure

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 formula mentioned in API Spec 5L para 9.4.3 (Note 2)

9.5 Dimensional Testing

The measuring equipment requiring calibration or verification under the provisions of API 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.

9.8 Non Destructive Inspection

The purchaser reserves the right to depute its Representative(s) to perform inspection and witness tests in all phases of manufacturing and testing starting from steel making to finished line pipe ready for shipment. Manufacturer shall comply with the provisions regarding inspection notice, plant access, compliance and rejection mentioned in Appendix H of API Spec 5L. 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.

9.8.1 Qualification of Personnel

All personnel performing NDT activities shall be qualified in the technique applied, in accordance with latest edition of ISO 9712 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. 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 I, II, III inspector
 - Supervision : Level II or Level III inspector (in case evaluation is by Level I inspector)

9.8.3 Methods of Inspection

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

Plate/Skelp Inspection

The longitudinal edges of the plate/skelp shall be 100% ultrasonically inspected over a width of at least 25 mm from the trimmed plate/skelp edge. Remaining plate/skelp shall be ultrasonically tested for laminations using an oscillating or straight running pattern of probes, so as to provide inspection coverage of at least 25% of the plate/skelp surface uniformly spread over the area.

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

Pipe Ends Inspection

The full circumference of both ends of each pipe after beveling shall be 100% ultrasonically tested for laminations from inside over a circumferential band of at least 25 mm width.

Alternatively the pipe may be tested from outside prior to bevelling, in which case a band of at least 50 mm wide shall be tested to include the eventual bevelled area.

Bevel Inspection

Bevel face of all pipes shall be inspected by magnetic particle method to detect defects.

Weld Inspection

Electric welds shall be inspected by ultrasonic methods (Refer Table 24) using automatic ultrasonic equipment in accordance with API Spec 5L para 9.8.5, API Spec 5L SR 17 (Appendix F) and as modified in this specification. Pipe end welds shall be inspected in accordance with Para 9.8.3.1.

9.8.3.1 Pipe End Weld Inspection

(New)

Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment.

9.8.5 Ultrasonic and Electromagnetic Inspection

9.8.5.1 Equipment

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 localisation 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.

9.8.5.2 Ultrasonic and Electromagnetic Inspection Reference Standards

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

The reference standard for weld UT shall contain machined notches as per Figure 9.8.5.2 of this specification and as given below:

- One longitudinal inside notch of type N10 at the Weld Line.
- One longitudinal outside notch of type N10 at the Weld Line.

The reference standard for skelp/pipe body UT shall contain continuous machined notch of size 8mm width x $\frac{1}{2}$ t depth, where 't' is the specified wall thickness.

The reference standard for skelp edge UT / UT area adjoining weld seam and pipe ends shall have $\frac{1}{4}$ inch dia. FBH x $\frac{1}{2}$ t depth, where 't' is the specified wall thickness.

The calibration shall be performed at following intervals:

- a. At the beginning of each operating shift (12 Hours maximum).
- b. At least once during each operating shift (12 Hours maximum).
- c. 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 Purchase's Representative, all the pipe or skelp already inspected after the previous verification shall be inspected again at Manufacturer's cost.

9.8.5.4 Acceptance Limits

9.8.5.4.1 Skelp Edges/Area on either side of the Longitudinal Weld Seam

(New)

Acceptance limit for material edge examination shall be as per criteria laid down for Acceptance Level E2 of BS:5996 - 1993 which is reproduced hereunder for ready reference.

1. No individual imperfection of length less than 20 mm shall be considered for population density assessment.
2. Maximum length of imperfection in any direction shall not exceed 30 mm.
3. Maximum area of individual imperfection shall not exceed 500 mm².
4. Maximum population density (number of imperfections smaller than the maximum permissible imperfection size and longer than 20 mm per 1m length) shall not exceed 4.

Disposition of any defect shall be as per API Spec 5L para 9.9 (c) or (d).

9.8.5.4.2 Skelp/ Pipe Body

(New)

Acceptance limit for material body examination shall as per criteria laid down for Acceptance level B4 of BS 5996: 1993 which is reproduced hereunder for ready reference :

1. No individual imperfection that does not exceed all of the following dimensions shall be considered for population density assessment:

Area:300 mm², Length: 35mm, Width:8mm
(The length is the dimension at right angles to the scan track and the width is the dimension parallel to the scan track.)
2. Maximum area of any individual discontinuity shall not exceed 1000 mm².
3. Maximum population density of imperfections smaller than the maximum permissible imperfection size and larger than the minimum imperfection size per 1m x 1m square shall not exceed 10.
4. Any imperfection exceeding 100mm in length shall be not be acceptable and any planar imperfection not parallel to the plate surface is not acceptable.

Disposition of any defects shall be as per API Spec 5L para 9.9 (c) or (d).

9.8.7 Residual Magnetism Measurement Requirements

- e. The average of the four readings shall not exceed 20 gauss and no one reading shall exceed 25 gauss when measured with Hall-effect gaussmeter. All residual

magnetism measurements shall be recorded.

9.9 DISPOSITION OF PIPE 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 API Spec 5L Para 9.9 (c) or (d).

9.10 Test Methods

9.10.4 Charpy Test

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

9.12 Retests

9.12.1 Recheck Analysis

Modalities of recheck analysis shall be as per API Spec. 5L as applicable to the lot being tested (refer para 9.2.2.1). However, during individual testing, each pipe shall be fully analysed to meet the requirement of Tables 2B of this specification.

9.12.6 Charpy Retest

In the event that a set of charpy test fails to meet the acceptance criteria, the manufacturer may elect to replace the lot of material involved or alternatively to test two more lengths from that lot. If both the new tests meet the acceptance criteria, then all pipe in that lot with the exception of the original selected length, shall be considered to meet the requirement.

9.13 Reprocessing

This para stands cancelled.

10.0 MARKING

10.1 General

Marking specified in API Paragraphs and otherwise specified in the Purchase Order shall be in English language and international system (SI) of units. Marking shall also include API Monogram, Purchase Order number, item number, heat number, colour bend and weight & length.

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.

10.2 Location of Markings

Marking shall be paint stenciled on length of the pipe at right angles to the pipe axis. Stencil marking shall be placed on the inside surface length except that on pipe size smaller than 16, marking may either be placed on inside or outside.

10.3 Sequence Of Markings

Shall be as specified in Appendix-I of API 5L.

10.3.4 Specified Dimension

Actual pipe weight in kg shall also be marked.

10.3.5 Grades and Class

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

10.5 Length

Actual length shall be marked in metres.

10.7 Die Stamping

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

11 COATING AND PROTECTION

11.1 Coatings

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.

12 DOCUMENTS

12.1.2

PSL 2 Certification requirements

The Manufacturer shall furnish to Purchaser a certificate of compliance including the requirements of (Appendix F, SR15).

The certificate shall comply with ISO 10474 type 3.1.c. For tests witnessed by the Purchaser, type 3.1.c. certificates shall be issued.

12.2

Retention of Records

In addition to the records indicated in APL Spec 5L Table 27, 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/skelp as well as pipe ends.

12.3

(New)

Production Report

The Manufacturer shall provide six 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 six 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 SR 15.1
- Certified reports of dimensional. Workmanship and defect inspection.
- 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 that pipes which have been certified by the Purchase's Representative shall be dispatched from the pipe mill.

In the event of small quantities of pipes supplied this specification like those for bends and other similar applications, as specifically called out in the Purchase Order, the production report may consist of only test certificates required as per SR 15 of API Spec 5L and other test report/results required as per this specification.

12.4

(New)

Line Pipe Traceability Data

The manufacturer shall establish and follow procedures for maintaining heat and lot

identity of all pipes as per Supplementary Requirements SR 15.2 of API Spec. 5L.

The line pipe data shall be provided in MS EXCEL / MS ACCESS format in Compact Disc (CD). The specific data to be recorded shall be agreed between Purchaser and the Manufacturer and shall include, but not limited to, the following :

- All marking information.
- Data of Skelp and Pipe Manufacture
- All Mechanical properties from test results.
- All dimensional records.
- All workmanship and defects inspection records.
- Final inspection and release date.
- Description and disposition of repairs
- Load-out / dispatch date.
- Destination
- Consignment details.

14

(New)

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, 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 week 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.

APPENDIX-F

SUPPLEMENTARY REQUIREMENTS (NORMATIVE)

SR 5 **Fracture Toughness Testing (Charpy V-Notch) for Pipe of Size 4 ½ or Larger**

SR 5.1 The Manufacturer shall perform Charpy V-notch test for determining Shear Area.

SR 5.3 The specimen shall be full sized or largest obtainable sub size in case pipeline diameter and thickness does not permit full size specimen. In case it is not feasible to obtain transverse specimen, a longitudinal specimen may be taken upon approval from Purchaser.

SR 5.4 Flattened specimen shall not be used.

Delete existing section and replace with the following

Impact testing shall be carried out using 10 x 10, 10 x 7.5 or 10 x 5mm cross section specimens. The largest possible specimen shall be used. Where the nominal pipe dimensions are insufficient to extract a 10 x 5mm specimen, impact testing is not required.

For pipes of DN 250 (10 inch) or less, impact test specimens shall be taken parallel to the axis of the pipe (i.e. longitudinal specimens shall be taken).

For pipes greater than DN 250 (10 inch), impact test specimens shall be taken transverse to the axis of the pipe, except where the wall thickness prevents extraction of a 10 x 5mm specimen, in which case longitudinal specimens shall be taken.

For weld centreline and HAZ impact tests, only transverse specimens shall be used.

SR 5.5 This para stands deleted

SR 5A **Shear Area**

SR 5A.1 Three transverse specimen representing one test shall be taken from one length of pipe per heat per lot of 100 pipes per combination of pipe size and specified wall thickness.

SR 5A.2 Unless specified otherwise in the Purchase Order, the specimen shall be tested at +32°F (0°C). The average shear value of the fracture appearance of three specimens shall not be less than 85 percent.

Note: The acceptance criteria of shear area as referred in API Spec. 5L para SR5A.3 SR5A.4 and SR5A.5 stand modified based on above mentioned requirements. Wherever `heat` indicated in API Spec. 5L SR5A.3, SR5A.4, SR5A.5 and SR5A.6

shall be replaced by `lot`. Lot shall be as per SR5A.1 as above.

SR 6 **DROP WEIGHT TEAR TESTING (DWTT) ON WELDED PIPE**

SR 6.1 When required as per para 6.2.5.3 of this specification, fracture toughness shall be determined using Drop Weight Tear Test (DWTT) by the Manufacturer for pipe size 16 and larger. DWTT shall be carried out in accordance with the requirements of API Spec 5L para SR 6.2 thru SR 6.8 and as modified in this specification.

SR 6.2 Two transverse specimen shall be taken from one length of pipe per heat per lot of 100 pipes per combination of pipe size and specified wall thickness. Unless specified otherwise, the test shall be conducted at -32°F (0°C).

SR 6.4 For each test (of a set of two test pieces), the average shear fracture area shall not less than 85%, based upon a test temperature of +32°F (0°C).

Note: Acceptance criteria for retesting indicated in API Spec. 5L para SR6.5 stands modified based on above mentioned requirements. Wherever `heat` indicated in API Spec. SR6.5 shall be replaced by `lot`. Lot shall be as per SR6.2 as above.

SR 17 **NON DESTRUCTIVE INSPECTION OF WELDS IN ELECTRIC WELDED PIPES AND LASER WELDED PIPES**

SR 17.1 **Supplementary Non Destructive Inspection**

The weld in electric welded pipe shall be inspected full length for surface and subsurface defects and laminations by ultrasonic methods using automatic ultrasonic equipment.

SR 17.2 **EQUIPMENT AND REFERENCE STANDARDS**

The equipment for ultrasonic inspection shall meet the requirements of para 9.8.5.1 and 9.8.5.2 of this specification. The detailed procedure shall be approved by Purchaser's Representative.

SR 17.3 **ACCEPTANCE LIMITS**

If during production, repeated ultrasonic indications occur requiring re-inspection by other methods and it appears that the nature of defects causing ultrasonic indications can not be definitely established, the Manufacturer shall prove by other inspection methods (such as making cross-sections as per para 6.2.6.1 of this specification) that these defects are not injurious defects as stipulated in this specification.

SR 17.4 **DISPOSITION**

Disposition of defects shall be in accordance with API Spec 5L para 9.9 (c) or (d).

**SR19
Notch)**

**Additional Fracture Toughness Requirements (Transverse Charpy V-
for PSL 2 Pipe**

SR 19.1 Except as allowed by SR 19.2 of API Spec 5L, fracture toughness testing shall be performed in accordance with the requirements of para 9.3.5.1 and 9.3.5.2 of API Spec 5L and as modified in this specification, with a test temperature of 32°F (0°C) or at a lower temperature as specified in the Purchase Order. The required minimum all heat average full size absorbed energy value (based on a set of three specimens) for transverse body specimen shall be the greater of SR 19.1 (a) and SR 19.1 (b) of API Spec 5L. In case longitudinal specimen is applicable as per Table 14 of API Spec. 5L, the minimum average absorbed energy value shall be 1.5 times that applicable for transverse specimen. The required minimum all heat average full size absorbed energy value for weld and HAZ specimen shall also be the greater of SR 19.1 (a) and SR 19.1 (b) of API Spec 5L. In addition, the lowest individual absorbed energy value of the three specimens shall not be less than 80% of the value specified.

APPENDIX-H

PURCHASER INSPECTION (NORMATIVE)

H 4

Rejection

If 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.

H.5

(New)

Purchaser shall specify if, and to what extent, he will monitor the Manufacturer's production, quality control and inspection.

Sufficient fluorescent lighting both overhead and at pipe ends shall be provided at the inspection area. Facilities shall be provided for rolling each pipe joint for inspection. The Manufacturer shall make ultrasonic or other suitable equipment available for use by the Purchaser to check the remaining wall thickness where any defects have been found out of the pipe.

ANNEXURE-I (NEW)
FIRST DAY PRODUCTION TESTS

Two lengths, each of completely finished pipes of first day's production from two different heats (i.e. a total of four pipe lengths) shall be selected at random for testing 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 first day's production tests shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser's Representative. The first day production tests shall be carried out on pipes for each wall thickness, each diameter and each grade of steel.

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.

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 first day production test shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

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 Annexure.

a. Visual Examination

All pipes shall be examined visually for dimensional tolerance 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 representative will select the places in pipe from where the test specimens shall be removed.

The following tests shall be conducted :

- i. Two (2) flattening test specimens shall be removed : one specimen shall be tested with weld at 0° and other at 90°.
- ii. Two (2) transverse base material specimens and two transverse weld specimen for tensile test shall be tested. In case transverse base metal specimen is not applicable as

per Fig. 3 of API Spec. 5L, longitudinal specimen may be taken.

- iii. Six (6) weld cross-section specimen, three (3) from each end of the pipe joint, shall be taken for metallographic examination. Two of these specimens shall be tested for hardness at room temperature after etching.
- iv. Fracture toughness testing specimen shall be extracted as follows:
 - Four sets of three transverse specimen each from base metal
 - One set of 3 transverse specimen with weld in middle
 - One set of 3 transverse specimen with HAZ in middle

The base metal specimen shall be tested at - 40, -10, 0, + 20° C for shear area and absorbed energy to produce full transition curve. The value at the test temperature specified in SR 5A and SR 19 of API Spec. 5L and duly modified in this specification for shear area and absorbed energy respectively shall be complied with. For other temperatures, the value shall be for information only. The sets of weld and HAZ specimen shall be tested for absorbed energy only at the same test temperature applicable as per SR 19 of API Spec. 5L.

- v. At points selected by Purchaser, twelve (12) DWTT specimens shall be removed from base metal in a transverse direction. The sets of 3 base metal specimen shall be tested at -40, -10, 0, +20°C for shear area to produce full transition curve. The value at the test temperature specified in SR 6 of API Spec 5L duly modified in this specification shall be complied with. For other temperatures, the value shall be for information only.

(Note: This test is to be carried out only when required as per para 6.2.5.3 of this specification)

- vi. Hardness test shall be conducted on selected pipes as per requirement of para 6.2.6 of this specification.

d. Burst Test (New)

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

Burst pressure of the subjected pipe shall not be less than the calculated burst pressure based on the UTS of the subjected pipe.

- e. In addition, all the tests and inspections require to be conducted as per this specification shall be conducted on all the pipes selected for testing during first day production test.

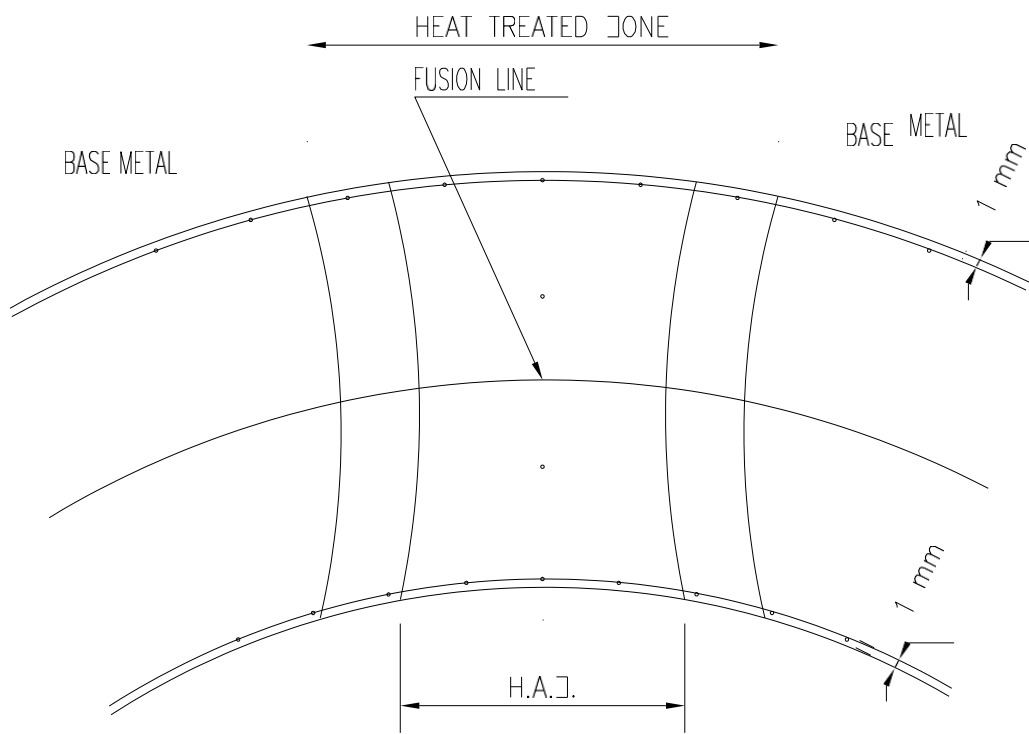


FIGURE 6.2.6.2

—○— LOCATIONS WHERE HARDNES MEASUREMENT TO BE CARIED OUT

H.A.Z. - HEAT AFFECTED ZONE

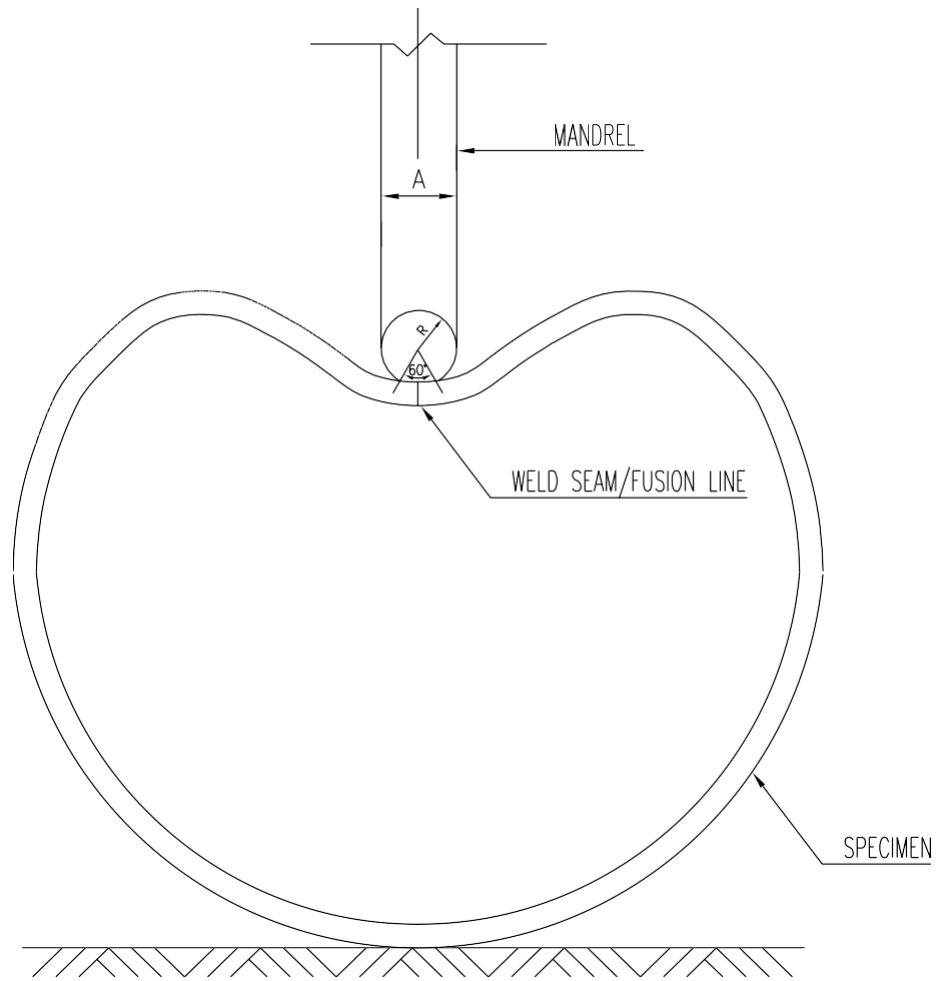
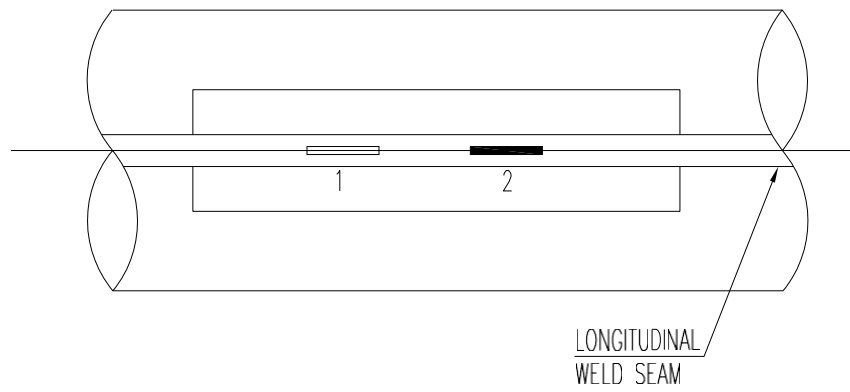


FIGURE 6.2.7
REVERSE BEND TEST



- 1 - LONGITUDINAL INSIDE NOTCH (N10) AT WELD LINE
- 2 - LONGITUDINAL OUTSIDE NOTCH (N10) AT WELD LINE

FIGURE 9.8.5.2
REFERENCE STANDARD FOR U.T. OF LONGITUDINAL WELD SEAM

Edition : 1

**SPECIFICATION
FOR
SEAMLESS LINEPIPE
(ONSHORE)**

CONTENTS

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1 **SCOPE**

1.1 **Purpose and Coverage**

This specification establishes the minimum requirements for the manufacture of Seamless steel line pipes in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty Third Edition, 2004 and makes restrictive amendments to API Spec. 5L. Unless modified and or deleted by this Specification, the requirements of API Spec. 5L shall remain applicable.

In addition to this specification, wherever stringent, requirement / provision /amendments of the latest 44th. Edition of API 5L (effective October 2008) shall apply.

The sections, paragraphs and appendices 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 Manufacturer shall have a valid license to use API Monogram in accordance with the requirements of API Spec. 5L. Forty Third Edition, 2004 on line pipe as Product Specification Level PSL-2.

1.2 **Product Specification Level (PSL)**

Line pipes supplied to this specification shall conform to Product Specification Level PSL-2.

1.3 **Grades**

This specification is applicable to PSL-2 line pipes of grade B through X-70.

1.4 **Dimensions**

This specification shall be applied to line pipes of size 4½” through 20” (both size included).

2 **REFERENCES**

All pipes and their dimensions, chemical composition, physical properties, heat treatment, hydrotest and other testing and marking requirements shall confirm to the latest codes and standards specified in MR.

5 **PROCESS OF MANUFACTURE AND MATERIAL**

5.1 **Process of Manufacture**

Following paragraphs of API Spec. 5L shall be applicable to the line pipe manufactured as per this Specification :

Seamless Process : As per para 5.1.1

5.3 **Material**

5.3.3 (New) Line pipe furnished to this specification shall be made from steel produced in basic oxygen or electric arc furnace. The steel used for manufacture of pipe shall be fully killed and fine grained with a grain size of ASTM 7 or finer as per ASTM E 112. Steel shall be made by continuous casting only.

6 **MATERIAL REQUIREMENTS**

6.1 **Chemical Properties**

6.1.1 **Chemical Composition**

The chemical composition of each heat of steel on product analysis shall be in accordance with Table-2B and notes given below. Table-2B of API Spec. 5L is cancelled.

Table-2B : PSL 2 - Chemical requirements for Heat and Product Analysis

Element	Maximum Permitted Alloy Content, Wt. % EW (for Grade B to Grade X-70)
C	0.16
Mn	1.5 (For Gr. B to X-52) 1.6 (For Gr. X-56 to X-70)
Si	0.15 min. - 0.45 max.
P	0.02
S	0.010
V	0.08
Nb	0.10
Ti	0.04
Cr	0.20

Element	Maximum Permitted Alloy Content, Wt. % EW (for Grade B to Grade X-70)
Mo	0.28
Ni	0.20
Cu	0.35
Al	0.07
N	0.012
B	0.0005
Ca	0.006

Note: g(New)

1. V+Nb+Ti shall not exceed 0.15%.
2. Cu+Ni shall not exceed 0.4%.
3. The AL/N ratio shall not be less than 2:1

NOTE: h (New)

If alloying elements other than those specified in Table 2B above are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

Note : i (new)

Minimum for Si is not applicable for Al killed steel.

6.1.2 Elements Analysed

For heat analysis and product analysis, all the elements listed in Table-2B of this specification shall be analysed and reported, even if those are not purposely added but are present as residuals only.

6.1.3 Carbon equivalent (PSL 2 Only)

6.1.3.1 Calculations of Carbon Equivalent

Boron content shall be considered in CE (*Pcm*) formula even if it less than 0.0005%.

6.1.3.2 Maximum Carbon Equivalent

For pipes of all grades,, size and wall thickness, carbon equivalent shall comply the following limits:

$$CE (Pcm) \leq 0.25\%$$

$$CE (IIW) \leq 0.43\%$$

6.2 Mechanical Properties

6.2.1 Tensile Properties

The finished pipe (after all heat treatment and expansion or sizing operations) shall conform to the requirements of Table 3B 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:

<u>API Spec. 5L Grade</u>	<u>Permissible in excess of SMYS, psi (Mpa)</u>
Up to and including X46	19,000 (131)
X52 to X-65	22,000 (152)
X70	20,000 (138)

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

The ultimate tensile strength of the weld shall be equal to or better 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 (a) of Table-3B and shall comply with the minimum values of API Spec. 5L Appendix D. However elongation in no case shall be less than 20%. API Spec. 5L Appendix D stands modified accordingly.

7 DIMENSIONS, WEIGHTS, LENGTHS, DEFECTS, AND END FINISHES

Each pipe shall be measured for conformance to API 5L requirements. All dimensions and tolerances shall be measured and recorded .

7.3 Wall Thickness

In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerances shall comply with the requirements of this specification.

The tolerances on specified wall thickness shall be (+) 15% and (-) 0%. API Spec. 5L Table 9 stands cancelled.

7.5 Length

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 max. of 5% of the ordered quantity. The minimum average length of the entire ordered quantity in any case shall be 12.0m. API Spec 5L Table 11 shall not be applicable. Overall length tolerance shall be (-) Zero and (+) One pipe length to complete the ordered quantity.

Each pipe shall be measured for conformance to above requirements and all measurements shall be recorded.

7.6 Straightness

The deviation from a straight line for all pipe sizes shall not exceed 12mm. Each pipe shall be checked for conformance to the requirements. Straightness shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

7.9. Pipe Ends

7.9.1 General

Pipes shall be furnished with plain ends.

7.9.3 Plain Ends

Unless specified otherwise, the pipe ends shall be bevelled as per API Spec. 5L.

In removing the inside burrs at the pipe ends, care shall be taken not to remove excess metal and not to form an inside cavity or bevel. Removal of excess metal beyond the minimum wall thickness as indicated in para 7.3 of this specification, shall be a cause for rebeveling. In case root face of bevel is less than that specified, the pipe ends shall be rebevelled and rectification by filing or grinding shall not be done.

7.9.6 Bevel Protectors (New)

Both pipe ends of all pipes 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 contractor for providing on coated pipes subsequent to coating of line pipes.

9 **INSPECTION AND TESTING**

9.1 All pipes shall be hydrostatically tested .

9.2 All pipes shall be tested by U.T. / Eddy Current Test

9.3 Material Test Certificates (Physical properties, Chemical composition , Heat Treatment Report, NDT Reports & dimension test report shall also be furnished.

10 **MARKING**

10.1 **General**

Marking specified in API Paragraphs and otherwise specified in the Purchase Order shall be in English language and International System (SI) of units. Marking shall comply with Appendix I of API Spec 5L and as modified in this specification.

11 **COATING AND PROTECTION**

11.1 **Coatings**

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.

12 **DOCUMENTS**

12.2 **Retention of Records**

In addition to the records indicated in APL Spec 5L Table 27, 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/skelp as well as pipe ends.

12.3 **Production Report**

(New)

The Manufacturer shall provide six 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 six copies of acceptance certificates which shall include the results of all tests required as per this specification and performed on delivered material giving details

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

12.4
(New)

Line Pipe Traceability Data

The manufacturer shall establish and follow procedures for maintaining heat and lot identity of all pipes as per Supplementary Requirements SR 15.2 of API Spec. 5L.

14
(New)

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, 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 week 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.

APPENDIX-I

MARKING INSTRUCTIONS FOR API LICENSEES (NORMATIVE)

I.1 General

I.1.1 Marking shall also include Purchase Order number, item number, pipe number, heat number and weight.

I.2 Location of Markings

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.

I.3 Sequence of Marking

I.3.4 SPECIFIED DIMENSIONS

Actual pipe weight in kg shall also be marked.

I.3.5 GRADE AND CLASS

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.

I.5 Length

Actual length shall be marked in metres.

I.7 Die Stamping

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

**SPECIFICATION
FOR
3-LAYER POLYETHYLENE COATING OF LINEPIPES**

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ANNEXURE-I	: COMBINATION OF COATING MATERIALS

1.0

SCOPE

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

2.0

REFERENCE DOCUMENTS

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

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

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

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

3.0 PLANT SCALE AND INSTALLATION

- 3.1 CONTRACTOR shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), both new or existing shall be installed into a yard whose geometry and dimensions are such as to allow the execution of a continuous work schedule. For this purpose the CONTRACTOR shall ensure non stop work execution owing to prohibitive adverse weather conditions and install requisite equipment and plant in roofed and adequately weather protected areas.
- 3.2 Plant equipment, machinery and other facilities shall be in first class operating condition to atleast meet the job requirements of quality and production. Worn out and improvised plants are not acceptable.
- 3.3 The CONTRACTOR shall, at his own responsibility and cost, provide and prepare all necessary area for the storage of bare and coated pipe and all other materials, for coating yard, stock-piling and other temporary installation. For each area, CONTRACTOR shall provide necessary agreements as required with the land Owner(s) / relevant Authorities, and, on work completion, to clean, restore and pay servitude and claims for damages, as applicable.
- 3.4 CONTRACTOR shall at its own responsibility and cost, provide for water and power supply and other utilities and consumables and obtain authorisation regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing authorities.
- 3.5 CONTRACTOR shall at its own expense provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and during regular production. Outside testing for qualification and regular production is not acceptable to COMPANY.
- 3.6 The CONTRACTOR shall be fully responsible for adherence to all statutory regulations applicable for handling and disposal of the hazardous chemicals during the coating works.
- 3.7 The CONTRACTOR shall be responsible for obtaining all statutory approvals/ clearances from relevant Authorities including Pollution Control Board, as applicable for the coating plant(s).

4.0 **MATERIALS**

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

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

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

a) Epoxy Powder

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

b) Adhesive

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

c) Polyethylene

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

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

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

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

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

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

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

5.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING

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

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

5.3 Properties

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

5.3.1 Properties of Epoxy Powder and Adhesive

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

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

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

5.3.2 Properties of Polyethylene Compound

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

5.3.3 Properties of Coating System

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

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

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

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

6.0

MEASUREMENT AND LOGGING

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

7.0

COATING PROCEDURE AND QUALIFICATION

7.1

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

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

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

7.2

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

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

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

7.3

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

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

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

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

7.4 Qualification of Procedures

7.4.1 Epoxy Powder Application & Recycling

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

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

7.4.2 Pipe Pre-Heating

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

7.4.3 Surface Preparation

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

7.4.4 Chemical Pre-Treatment

7.4.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash

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

7.4.4.2 Chromate Treatment

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

7.4.5 Coating Application

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

7.5 Qualification of Applied Coating

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

a. Degree of Cure

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

b. Epoxy Layer Thickness

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

c. Adhesive Layer Thickness

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

d. Holiday Inspection

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

e. Adhesion Test

- i) Adhesion Test (24 hrs or 48 hrs) shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table 4.
- ii) Adhesion of FBE shall also be separately determined at ambient temperature at two locations by the "St Andrews Cross" method and the test shall comply with the specified requirements.

f. 2.5° Flexibility Test

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

g. Cross-section & Interface Porosity Test

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

7.5.2 Tests on pipes coated only with all three layers

a. Bond Strength

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

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

b. Impact Strength

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

c. Indentation Hardness

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

d. Elongation at Failure

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

e. Cathodic Disbondment Test

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

f. Holiday Inspection

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

g. Coating Thickness Measurement

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

h. Air Entrapment

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

i. Degree of Cure

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

7.5.3 Inspection of all test pipes

All pipes shall be subject to the following inspections:

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

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

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

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

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

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

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

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

8.0 PIPE SURFACE PREPARATION

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

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

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

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

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

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

8.6 Chemical Pre-treatment with Phosphoric Acid Solution

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

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

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

Sl. No.	Properties	Unit	Requirement
a.	Turbidity	NTU	1 max.
b.	Conductivity	µmho/cm	5 max.
c.	Hardness	-	Nil
d.	Total Alkalinity as CaCO ₃	mg/l	2 to 3
e.	Chloride as Cl	mg/l	1 max.
f.	Sulphate as SO ₄ =	mg/l	1 max.
g.	PH	-	6.5 to 7.5

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

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

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

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

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

- 8.6.5 The salt tests shall be carried out after de-ionised water rinse. One test shall be carried out at one end of each pipe. The acceptance criteria shall be $2\mu\text{g}/\text{cm}^2$. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendation.
- 8.7** Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2½ of Swedish Standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns(Rz). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO:8502 - 3. Acceptance limit shall be either quality rating 2 or Class 2.
- 8.8** All pipes shall be visually examined for presence of any shot/ grit/ loose material left inside the pipe during blast cleaning. Suitable mechanical means (stiff brush) shall be employed to remove the same before the pipes are processed further. In addition, inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focused at the middle of the pipe at one end while inspection is carried out visually from other end. Any foreign material or shots/ grit present in the pipe shall be completely removed by mechanical/ brush, high pressure air jets, by tilting of pipe etc.
- 8.9** At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The CONTRACTOR shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.
- 8.10** The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall be surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. After blast cleaning, all surfaces shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application. All surface defects such as slivers, scab, burns, laminations, welds spatters, gouges, scores, indentations, slugs or any other defects considered injurious to the coating integrity made visible during blast cleaning shall be reported to the COMPANY Representative and on permission from COMPANY Representative, such defects shall be removed by filing or grinding. After any grinding or mechanical repairs, the remaining wall thickness shall be checked and compared with specified thickness. Any pipes having thickness less than 95% of specified thickness shall be kept aside and disposed off as per the instructions of COMPANY Representative. The method employed to remove surface defects shall not burnish or destroy then anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/ oil and

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

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

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

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

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

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

8.13 Chemical Pre-treatment with Chromate Solution

- 8.13.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically Pre-treated with a 10% strength chromate solution.
- 8.13.2 The CONTRACTOR shall provide data sheets and supporting documentation for the chemical to be used. The documentation shall verify that the chemical is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.
- 8.13.3 The chemical pre-treatment shall be applied fully in accordance with the chemical suppliers' instructions and in a manner that ensures 100% uniform coverage of the pipe surface without introducing surface contamination.
- 8.13.4 The CONTRACTOR shall check that the concentration for the chemical pre-treatment solution remains within the range recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at the make up of each fresh solution and once per hour, using a method approved by the chemical manufacturer. The CONTRACTOR shall also ensure that the chemical pre-treatment solution remains free from contamination at all times. Recycling of chemical pretreatment solution is not permitted.

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

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

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

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

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

8.15 Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm² in area/ or having contamination of steel surface shall be rejected and sent for re-blasting.

9.0 COATING APPLICATION

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

9.1 Pipe Heating

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

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

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

- 9.1.3 External surface of the pipe shall be heated to about 190°C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.
- 9.1.4 Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each line pipe. The monitoring instrument shall be able to raise an alarm/ activate audio system (hooter) in the event of tripping of induction heater/ gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped and recoated.
- 9.1.5 Temperature measuring & monitoring equipment shall be calibrated twice every shift and/ or as per COMPANY representative's instruction.
- 9.1.6 Contractor shall ensure that pipe surface emissivity variations are minimised during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.

9.2 Pipe Coating

- 9.2 .1 Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe.
- i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150 mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.
 - ii. Grafted co-polymer adhesive applied by extrusion, minimum thickness 0.200 mm.
 - iii. Polyethylene coating by extrusion.
- The coated pipe shall be subsequently quenched and cooled in water for a period which shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

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

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

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

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

- 9.2.3 Coating materials shall be inspected in accordance with the manufacturer's recommendation prior to coating application and it shall be ensured that the materials are moisture free. In case the relative humidity exceeds 80%, the adhesive and polyethylene material shall be dried using hot air as per the directions of COMPANY representative.
- 9.2.4 Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subjected to:
- a) satisfactory qualification of the reclaimed system during PQT stage
 - b) the proportion of the reclaimed powder in the working mix does not exceed 20% at any one time.
 - c) the quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at para 5.3.1.
- 9.2.5 Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and for this purpose filters, dehumidifier/ heater as required alongwith control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-) 40°C and this shall be monitored during the regular production.
- 9.2.6 Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm/ activate audio system (hooter) in the event

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

- 9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed. The application of the adhesive layer shall not be permitted after epoxy is fully cured. The CONTRACTOR shall establish, to the satisfaction of the COMPANY representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The CONTRACTOR shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.
- 9.2.8 Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/ temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.
- 9.2.9 CONTRACTOR shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on to the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, CONTRACTOR shall supplement by other method to avoid air entrapment. The methods used shall be witnessed and approved by COMPANY.
- 9.2.10 Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.
- 9.2.11 Coating and/ or adhesive shall terminate 150mm (+)20/(-)0 mm from pipe ends. The adhesive shall seal the end of applied coating. CONTRACTOR shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.
- 9.2.12 Failure to comply with any of the above applicable requirement and of the approved procedure shall be cause for the rejection of the coating and such coating shall be removed in a manner approved by COMPANY at CONTRACTOR's expense.

10.0 INSPECTION AND TESTING

10.1 General

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

10.2 Visual Inspection

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

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

10.3 Coating Thickness

- a. The coating thickness shall be determined by taking atleast 10 measurement at locations uniformly distributed over the length and periphery of each pipe. In case of weld pipes, five of the above readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All the readings must meet the minimum requirements. However, localised coating thickness of less than the permissible minimum thickness can be tolerated on the condition that it does not attain a total extent of more than 5cm² per meter length of coated pipe, and the actual coating thickness does not drop more than 10% below the permissible minimum coating thickness at these locations. The frequency of thickness measurement as stated above shall be initially on every pipe, which shall be further reduced depending upon consistency of results, at the sole discretion of COMPANY's representative. Results of all measurement shall be recorded.
- b. Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipe shall be at CONTRACTOR's expense.
- c. Coated pipes not meeting the above requirements shall be rejected. The CONTRACTOR shall remove the entire coating and the pipe shall be recycled to the cleaning and coating operations as per the approved procedure and shall be to CONTRACTOR's expenses.

10.4 Holiday Detection

- a. Each coated pipe length shall be checked over 100% of coated surface by means of a "holiday detector" of a type approved by COMPANY for detecting holidays in the finished coating.
- b. The holiday detector shall be a low pulse DC full circle electronic detector with audible alarm and precise voltage control with DIN VDE 0433 Part 2. The set voltage for inspection shall be 25 kV. Travel speed shall not exceed 300 mm/s.
- c. CONTRACTOR shall calibrate the holiday detector at least once every 4 hours of production. CONTRACTOR shall have necessary instruments or devices for calibrating the holiday detector.
- d. Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm² in size are detected in its length attributable to coating process.
- e. Holidays which are lesser in number and size than those mentioned in (d) above, shall be repaired in accordance with a approved procedure and shall be to CONTRACTOR's expense.

10.5 Bond Strength Test

- a. CONTRACTOR shall conduct bond strength test for composite coating as per clause 5.3.3 (a) of this specification. A minimum of 65mm length shall be peeled. First 20mm and last 20mm shall not be counted for assessment of bond strength.
- b. The frequency of test for cut back portions shall be one pipe in every fifteen(15) pipes coated and for middle of pipe shall be one pipe in every sixty(60) pipes coated or one pipe per shift whichever is higher. On each selected pipe, bond strength shall be performed for each specified temperature. Test shall be performed at each cut back portion and one in the middle of pipe. The system shall disbond/ separate cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive. Disbondment/ separation at epoxy to steel interface or epoxy/ adhesive interface or adhesive/ polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.
- c. In case the above tests do not comply with the above requirement, CONTRACTOR shall test all the preceding and succeeding coated pipes. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during the shift shall be tested until the coating

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

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

10.6 Impact Strength

- a. Impact resistance test shall be conducted as per clause 5.3.3 (b) of this specification. Initially the frequency of test shall be 2(two) coated pipes per shift, which may be further reduced and/ or waived depending upon consistently acceptable results at the sole discretion of COMPANY's representative.
- b. Minimum thirty(30) impacts located equidistant along the length of coated pipe shall be performed.
- c. Immediately after testing, the test area shall be subjected to holiday detection at the same voltage as used prior to impact strength test. The pipe shall be rejected if any holiday is noted in the test area.
- d. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.7 Indentation Hardness

- a. Indentation hardness test shall be as per clause 5.3.3 (c) of this specification. The frequency of test shall be initially 2(two) coated pipes per shift which shall be further reduced to one test each on 2 coated pipes per week at random after 1 week of consistently acceptable results. Two samples for each temperature shall be taken from the cut back portion of coated pipe and one in middle of the pipe for this test.
- b. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.8 Air Entrapment Test

- a. Strips from bond strength tests or coated pipe may be used to help determine the porosity of the finished coating. Strip shall be also cut from longitudinal weld (if applicable) at cut back portion and examined for the presence of voids.
- b. Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the edge of the coating to a 45° angle and view with a microscope. Similar examination shall be done in the coating cut back area.
- c. One sample each either on the bond strength strip or coated pipe and strip cut from the longitudinal weld (if applicable) shall be examined for air entrapment per shift. Strips shall be viewed from the side.
- d. All examination shall be done using a 30X magnification hand-held microscope. The polyethylene and adhesive layers shall have no more than 10% of the observed area taken up with air entrapment (porosity or bubbles). Air entrapment shall not occupy more than 10% of the thickness in each

case. Bubbles shall not link together to provide a moisture path to the epoxy layer.

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

10.9 Degree of Cure

- a. Epoxy film samples shall be removed from cut back portion of the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔT_g) and % cure (ΔH) shall comply the specified requirements.
- b. Frequency of this test shall be once per shift. Pipe shall be selected randomly by COMPANY Representative during the middle of a shift. Suitable provisions/ arrangements as per the instructions of COMPANY Representative shall be made by the CONTRACTOR for this purpose.
- c. In case of test failure, production carried out during the entire shift shall be rejected, unless the CONTRACTOR proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

10.10 Epoxy Layer Adhesive Test

- a. Adhesion of epoxy layer shall be determined at ambient temperature by the "St Andrews Cross" method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of $30^\circ/ 150^\circ$. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/ lift the coating from the 30° angle with a sharp knife.
- b. Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion of the pipe from which the Degree of Cure test has been carried out as per para 10.9 above.

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

10.11 Cathodic Disbondment Test

- a. 48 hours CD test shall be conducted as per clause 5.3.3. (h) of this specification.
- b. The frequency of this test shall be once in every two weeks or one test representing each batch of epoxy powder used, whichever is more frequent.
- c. In case the test fails to conform to the specified requirement, at the option of the CONTRACTOR, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test shall be repeated or the shall be repeated using two additional samples taken from the same end of the affected pipe.

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

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

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

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

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

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

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

11.0 HANDLING, TRANSPORTATION AND STORAGE

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

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

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

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

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

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

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

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

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

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

11.6

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

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

11.7

Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other adverse weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at CONTRACTOR's expenses. These materials, shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion. When supplied in containers and envelopes, they shall 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.

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

11.8

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

12.0**REPAIR OF COATING**

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

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

Defects, repairs and acceptability criteria shall be as follows :

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm² or linear damage (cut) of less than 3 cm shall be repaired by stick welding using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2.0mm and an area not exceeding 20 cm² shall be rebuild by heat shrink patch only and without exposing to bare metal.
- Defects or size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrinks repair patch by exposing the bare metal surface.
- Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500mm shall be repaired using heat shrinkable sleeves of HTLP80 or equivalent.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, CONTRACTOR shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 170 mm of linear length of pipe then the coating shall be

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

Notwithstanding the above, under no circumstances, if the defects exceeds 70mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

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

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

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

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

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

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

13.0

MARKING

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

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

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

14.0 QUALITY ASSURANCE

- 14.1** The CONTRACTOR shall have established within the organisation and, shall operate for the contract, a documented Quality System that ensures that the requirements of this specification are met in all aspects. The Quality System shall be based upon ISO 9001/2 or equivalent.
- 14.2** The CONTRACTOR shall have established a Quality Assurance Group within its organisation that shall be responsible for reviewing the Quality System and ensuring that it is implemented.
- 14.3** The CONTRACTOR shall submit the procedures that comprise the Quality System to the COMPANY for agreement.
- 14.4** The CONTRACTOR's Quality System shall pay particular attention to the control of Suppliers and sub-contractors and shall ensure that the requirements of this specification are satisfied by the Suppliers and Sub-contractors operating Quality system in their organisation.
- 14.5** The CONTRACTOR shall, prior to the commencement of work, prepare and issue a Quality plan for all of the activities required to satisfy the requirements of this specification. The plan shall include any sub-contracted work, for which the sub-contractors Quality plans shall be submitted. The plan shall be sufficiently detailed to indicate sequentially for each discipline the requisite quality control, inspection , testing and certification activities with reference to the relevant procedures and the acceptance standards.
- 14.6** The CONTRACTOR's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the CONTRACTOR will be monitored by the COMPANY Representatives who will witness and accept the inspection testing and associated work required by this specification.

ANNEXURE-I

LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

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

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

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

QUALITY ASSURANCE PLAN
(GUIDELINE)

INDEX

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2.0	SCOPE OF WORK BY TENDERER	
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4.0	FORMATS FOR QUALITY PLAN	
5.0	FORMAT FOR INSPECTION AND TEST PLAN (ITP)	

1.0 **INTRODUCTION**

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

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

2.0 **SCOPE**

2.1 **Prior to award of Contract**

Following documents shall be submitted along with the tender :

Quality Assurance Manual of their organisation covering :

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

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

2.2.1 a) **Quality Plan**

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

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

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

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

2.2.4 **During Job Execution**

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

GUIDELINES TO BIDDERS FOR PREPARATION FOR QUALITY PLAN

QUALITY PLAN

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

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

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

Break-down of work into activities

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

Decide Work Method

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

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

Assign Responsibilities

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

Decide Internal Controls

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

- Checker
- Reviewer/ Approver.

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

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

QUALITY PLAN

Company Name :

Client :

Project :

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