

**OIL INDIA LIMITED**  
**(A Government of India Enterprise)**  
**P.O. Duliajan, Pin - 786602**  
**Dist-Dibrugarh, Assam**

**CORRIGENDUM**  
**Amendment No. 1 Dated 24.06.2016**  
**to**  
**Tender No. SSG1167P17/01**

**This Amendment No. 1 dated 24.06.2016 to Tender No. SSG1167P17/01 for Procurement of 3LPE Seamless Line Pipe is issued as under:**

**PART - A**

1.Pipes and Bends of same size 100mm NB shall be procured from same source.

**3.0 SCOPE OF WORK AND SPECIFICATIONS FOR SUPPLY OF 3LPE LINE PIPE.**

**3.1 SPECIFICATIONS:**

3.1.1 Line Pipes must be manufactured as per API 5L Latest Edition and must bear API monogram. A valid API Specification 5L certificate from the manufacturer shall be submitted along with the quotation without which offer shall be rejected. The pipes shall be brand new, unused, and of prime quality and in double random length without any jointers.

3.1.2 Pipe ends: Ends must be prepared as per relevant API specifications. Suitable end protectors as specified shall be used to protect the ends.

**3.2 MILL INSPECTION / CERTIFICATION**

All line pipes shall be manufactured, tested and certified in accordance with API Specification 5L, 44<sup>th</sup> / Latest Edition.

**3.3 PHYSICAL / MECHANICAL TEST:**

The following tests shall be carried out on each heat of steel from which the pipes are manufactured as per API Specification 5L, Latest Edition, and test results thereof shall be submitted to OIL along with the materials.

- (i) Chemical Analysis
- (ii) Heat Analysis
- (iii) Product Analysis
- (iv) Recheck Analysis
- (v) Mill-Control Check Analysis
- (vi) Tensile tests
- (vii) Yield strength tests
- (viii) Mill control tensile tests
- (ix) Dimension and weight tests including drift and straightness.

3.3.1 While conducting the above tests if any of the pipe fails, retest of the same shall be carried out as per API Specification 5L, API 5L Latest Edition.

### 3.4 **Hydrostatic Test:**

Each joint of pipe shall be tested hydrostatically to the recommended pressure at the mill in accordance with the relevant API specifications.

### 3.5 **Non-Destructive Tests:**

Non-destructive tests shall be carried out as specified in API Specification 5L Latest Edition.

3.6 SUPPLIERS should give details of mills inspection and QC methods available. OIL may require such details in case of an Order.

### 3.7 **SPECIFICATION FOR LINE PIPE FOR ONSHORE APPLICATION**

#### Maximum Carbon Equivalent

For pipes of all grades, size and wall thickness, Carbon Equivalent shall comply with the following limits :

$$CE (Pcm) \leq 0.20\%$$

$$CE (IIW) \geq 0.40\%$$

#### Tensile Properties

The finished pipes shall conform to the requirements of Table 3B of API Spec 5L.

#### Charpy Impact Test for PSL 2

As per API Spec 5L.

#### Metallographic Examination

Vickers hardness test shall be carried out on each specimen taken for metallographic examination in accordance with ASTM E-92. The resulting Vickers hardness value at any point shall not exceed 248HV<sub>10</sub>. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80 HV<sub>10</sub>. Modalities of retest shall be in accordance with para 9.10.2 of API Spec. 5L

#### WALLTHICKNESS

In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerance shall comply with the requirements of API Spec 5L specification.

#### 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 12.0 m. API Spec 5L Table 11 shall not be acceptable. The minimum 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.

#### STRAIGHTNESS

The deviation from a straight line for shall not exceed 0.2% along any length. Each pipe shall be checked for conformance to this requirement.

#### PIPE ENDS

Unless specified otherwise, the pipe ends shall be beveled 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 elsewhere in this specification, shall be a cause for rebeveling. In case root face of bevel is less than that specified, the pipe ends shall be re bevelled and rectification by filing or grinding shall not be done.

### 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 applicator.

### PURCHASER AND THIRD PARTY INSPECTION(ENGAGED BY PURCHASER)

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 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 accordance with this specification.

## **4.0 THIRD PARTY INSPECTION**

### **4.1 THIRD PARTY INSPECTION FOR LINE PIPES:**

4.1.1 Inspection by an independent third party to cover the following will be required against line pipes:

- (i) Material Identification
- (ii) Stage inspection at random visit basis during manufacturing
- (iii) Audit and endorsement of all chemical analysis and physical test reports
- (iv) Witness dimensional checks
- (v) Witness mechanical tests (as per API 5L, the Latest Edition)
- (vi) Witness NDT
- (vii) Witness hydrostatic tests
- (viii) Visual inspection for imperfection
- (ix) Longitudinal defect identification
- (x) Transverse defect identification (The same is not required for ERW Pipe)
- (xi) Wall thickness measurement
- (xii) Joint Inspection & Grade confirmation
- (xiii) End area defect identification
- (xiv) Inspection of end bevelling
- (xv) Check and verify length of each joint of pipe
- (xvi) Issue of certificate

4.1.2 Manufacturer will carry out physical / chemical / mechanical / hydrostatic, NDT tests etc. for raw material and finished pipes as per relevant API specification (Latest Edition) for all the pipes i.e. 100% (hundred percent). Third Party will check & verify manufacturer's test data, records, reports etc. of raw materials and finished tubes in respect of all the pipes i.e. 100% (hundred percent). Over and above checking and verification of records and reports, third party will carry out inspection for the followings on the percentage basis given below in his presence:

#### (a) **Raw material inspection for chemical composition and mechanical properties:**

10% of number of heats and plates of raw materials will be tested at random by the third party. If the percentage of number of heats/plates for manufacture of particular item is 05(five) or less, then all the raw materials will be tested for chemical composition and mechanical properties, as per relevant codes.

#### (b) **Finished tube inspection:**

- (i) Checking dimensions, wall thickness, quality, end beveling (for Beveled ended pipes), surface imperfection etc. : 5% of the tubes at random will be checked/tested by third party.
- (ii) Checking chemical composition and mechanical properties – Sample frequency as per API 5L Latest Edition will be tested by the third party.

(c) **Witnessing NDT through ultrasonic testing/magnetic particulars method/other methods:**

- (i) Longitudinal defects - 5% of the tubes at random will be tested by third party.
- (ii) Transverse defects - 1% of the tubes at random will be tested by third party.

(d) **Hydraulic testing:** 10% of the tube at random will be tested by third party.

4.1.3 The Third Party Inspection is to be carried out by an internationally reputed inspection agency. SUPPLIERS must indicate the availability of such a Third Party Inspection Agency in their area furnishing following information:

- (i) Name of the Inspection Agency (OIL's clearance has to be obtained prior to engagement except for M/s. Lloyds, M/s. Rites, M/s. I.R.S., M/s DNV, M/s. BV and M/s. Tuboscope Vetco).
- (ii) All inclusive charges for Third Party Inspection per metre (to be indicated separately).

4.1.4 SUPPLIERS to confirm that transportation will be carried out as per API-RP-5L1 (Latest Edition).

**4.2 THIRD PARTY INSPECTION FOR COATINGS:**

4.2.1 Independent Third Party Inspection for coatings is to be carried out by an internationally reputed Inspection Agency in their area furnishing following information:

- (i) Name of the Inspection Agency (OIL's clearance has to be obtained prior to engagement except for M/s. Lloyds, M/s. Rites, M/s. IRS, M/s DNV, M/s. BV and M/s. Tuboscope Vetco).
- (ii) All inclusive charges for Third Party Inspection per metre (to be indicated separately).

4.2.2 Third Party shall carry out inspection of the coating as per para 6.10 'INSPECTION AND TESTING' and quantum of inspection to be carried out by TPIA shall be as per table 4.2.2(t1) below.

**Table 4.2.2(t1)**

Sl.no.	Inspection and testing description.	Scope of TPIA.	Quantum of check.	Verifying document.
1.	Visual Inspection	Visual check	10% of total ordered quantity	
2.	Coating Thickness	Physical check	10% of total ordered quantity	
3.	Holiday Detection	Witness	10% of total ordered quantity	
4.	Bond Strength Test	Verify.	Random	Suppliers test report.
5.	Impact Strength	Verify.	Random.	Suppliers test report.
6	Indentation Hardness	Verify.	Random.	Suppliers test report.
7.	Air Entrapment Test	Verify.	Random.	Suppliers test report.
8.	Degree of Cure	Verify.	Random.	Suppliers test report.
9.	Epoxy Layer Adhesion Test	Verify.	Random.	Suppliers test

				report.
10.	Cathodic Disbondment Test	Verify.	Random.	Suppliers test report.

4.2.3 Third party will carry out additional tests and inspections which they feel deem necessary as per DIN-30670, 1991 and also issue necessary inspection certificate.

#### 4.3 THIRD PARTY INSPECTION FOR BENDS.

Third Party will check , verify and certify the following for the bends before coating.

4.3.1 Test certificate of chemical, mechanical tests, heat treatment, dimensional inspection and hydrotest carried out on pipe used for fabrication of bend.

4.3.2 Certificate of non-destructive test / examination carried out on bends.

4.3.3 Records of heat treatment, if carried out for bends.

4.4.4 Dimensional tolerance of bends.

Third party will check , verify and certify the following for the bends after coating.

4.4.5 Third party will carried out all necessary test / inspection as per requirement of Para – 4.0 i.e THIRD PARTY INSPECTION FOR COATINGS.

#### **5.0 SCOPE OF WORK AND SPECIFICATIONS FOR PIPE HANDLING, LOADING, TRANSPORTATION TO COATING PLANT AND UNLOADING AT COATING PLANT.**

5.1 The SUPPLIER (whether they are pipe manufacturer or pipe coating applicator or supplier of the pre-coated pipes as referred to PART B, Bid rejection criteria & Bid evaluation criteria) shall be fully responsible for the custody of the pipes from the start of manufacturing until the time the coated pipes are 'handed over' to COMPANY and/ or installed in permanent installation of the COMPANY in the case may be as per terms of the tender.

5.2 The SUPPLIER shall load, transport, the bare pipes to the coating plant(s) and unload and stockpile the same using suitable means and in a manner to avoid damage to pipes. The SUPPLIER shall stockpile the bare pipes at the storage area of the coating plant. The SUPPLIER shall prepare and furnish to COMPANY a procedure/calculation generally in compliance with API RP-5L1 for stacking of pipes of individual sizes, which shall be approved by COMPANY prior to commencement.

5.3 The SUPPLIER shall load, unload, transport and stockpile the bare pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe. The COMPANY shall approve such procedure prior to commencement of work.

5.4 In case bare line pipe supply is from foreign origin, it will be the sole responsibility of the SUPPLIER to receive and take-over the line pipes from the pipe manufacturer and SUPPLIER shall be solely responsible for port clearance, stevedoring, liaison, port fees, easements, warehousing, wharf age, handling, unloading / loading as applicable. SUPPLIER shall then transfer the pipes to the coating facility.

5.5 Coated pipes may be handled by slings and belts of minimum 60 mm width made of non-abrasive/ non-metallic materials. In this case, stacked pipes shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of

round sectional slings is prohibited. Fork lifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber.

- 5.6 Bare / coated pipes at all times shall be stacked completely clear from the ground, at least 300 mm, 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 be of dry, germ free straw covered with plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes. Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. SUPPLIER 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.
- 5.7 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 2 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes. All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe.
- 5.8 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 SUPPLIER'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. The SUPPLIER shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials that are susceptible to change in properties and characteristics due to unsuitable storage. If necessary the SUPPLIER shall provide for a proper conditioning.
- 5.9 In case of any marine transportation of bare/coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. SUPPLIER shall furnish all details pertaining to marine transportation including drawings of cargo barges, storing/stacking, sea fastening of pipes on the barges/marine vessels to the company for approval prior to undertaking such transportation works. In addition SUPPLIER 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.
- 5.10 The above scopes from 5.1 to 5.9 shall also cover transportation of requisite bare pipes from pipe manufacturing yard to LR bend fabrication unit and onward transportation of the LR bends to coating unit.

5.11 The above scopes from 5.1 to 5.9 shall also cover transportation of bare line pipes to be supplied against item nos. 30 & 40 of 1.1 which are to be supplied along with pre-coated pipes at designated points

## 6.0 **SCOPE OF WORK AND SPECIFICATIONS FOR 3 LAYER SIDE EXTRUDED POLYETHYLENE COATING**

### 6.1 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 for Steel Pipes and Fittings' and the requirements of this specification.

### 6.2 REFERENCE STANDARDS

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 Method of Test for Tensile Properties of Plastics.
- f) ASTM D-792 : Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- g) ASTM D-1238 : Test Method for Flow Rates 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) IEC 454 – 2 : Specification for Pressure-Sensitive Adhesive Tapes for Electrical Purposes.
- s) ISO 8501-1 : Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness : Part 1 - Representative Photographs of the Change of Appearance imparted to Steel when Blast Cleaned with different Abrasives
- t) 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)
- u) ISO 9002 : Quality Systems : Model for Quality Assurance in Production, Installation and Servicing
- v) ISO 11124 : Preparation of Steel Substrates Before Application of Paints and Related Products
- w) API 5L 44<sup>th</sup> / Latest Edition: Specification for Line Pipe
- x) ASME B31.8 : Gas Transmission and Distribution Piping Systems.
- y) ASME B31.4 : Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols.

- z) CSA Z245.20-02 : External Fusion Bond Epoxy Coating for Steel Pipe.

The SUPPLIER 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.

### **6.3 PLANT SCALE AND INSTALLATION**

6.3.1 SUPPLIER 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 SUPPLIER 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.

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

6.3.3 The SUPPLIER 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, SUPPLIER shall provide necessary agreements as required with the land owner(s) / relevant Authorities, and, on work completion, to clean and pay settlement and claims for damages, as applicable.

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

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

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

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

### **6.4 MATERIALS**

6.4.1 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 approved by COMPANY in accordance with provisions of Para 6.5.4, Annexure I of this specification. SUPPLIER shall obtain prior approval from COMPANY for the coating system and coating materials.

6.4.2 The coating materials Manufacturer shall carry out tests for all properties specified in para 6.5.1 and 6.5.2 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 SUPPLIER and the same shall be submitted to COMPANY for approval prior to their use.

6.4.3 In addition to Manufacturer's certificate, the SUPPLIER 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 test certificates.



**(a) Epoxy Powder:**

- Gel Time
- Cure time
- Moisture content
- Thermal Characteristics (Tg1, Tg2 , ΔH)

**(b) Adhesive:**

- Specific Gravity
- Melt Flow Rate
- 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 6.5.1 and 6.5.2 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.

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

- Name of the Manufacturer
- Type of Material
- Batch Number
- Place and Date of Manufacture
- Shelf Life/Expiry Date (if applicable)
- 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 SUPPLIER at his expense.

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

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

## **6.5 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING**

6.5.1 The coating shall 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 at least (+)80°C, without impairing its serviceability and properties specified.

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

6.5.3 Properties:

Properties of coating system and coating material shall comply the requirements indicated in subsequent paragraphs. 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.

Properties of Epoxy Powder and Adhesive

SUPPLIER 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 6.5.1 and 6.5.3 of this specification respectively. Epoxy powder properties shall be as per CSA Z245.20-02. 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:

SI. No	Properties	Unit	Requirement	Test Method
a	Melt Flow Rate (190°C / 2.16 kg)	g/10 min	1.0 min	ASTM D 1238
b	Vicat Softening Point	°C	100 min	ASTM D 1525
c	Specific Gravity	.-	0.926 min	ASTM D 792

6.5.2 Properties of Polyethylene Compound

SI. No	Properties	Unit	Requirement	Test Method
a	Tensile Strength @ + 25 0 C	N/mm 2	17 min	ASTM D 638
b	Melt Flow Rate (190°C / 2.16 kg)	g/10 min	0.25 min.	ASTM D 1238/ 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 <sup>15</sup> 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
k	Environmental Stress Crack Resistance (ESCR) (for F <sub>50</sub> ) - Medium Density, Condition "C" - High Density, Condition "B"	Hours	300 300	ASTM D1693
l	Carbon Black Contn	%	2 min.	ASTM D 1603

6.5.3 Properties of Coating System

SI. No	Properties	Unit	Requirement	Test Method
a	Bond Strength (using Type 2 Test Assembly i.e.	Kg/Cm	8.0 min	DIN 30670

	Dynamometer) - @ 20 +/- 5°C - @ 65 +/- 5°C		5.0 min	
b	Impact Strength (Min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 Kv)	Joules/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 <sup>2</sup>	10 <sup>8</sup> 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 dis bondment	15 max. 7 max	ASTM G42
i	Degree of Cure of Epoxy (***) - Percentage Cure, ΔH - Δ Tg %	% °C	95 +3 / -2	CSA Z 245.20-98

(\*) 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 G 42.

(\*\*\*) TEMPERATURE TO WHICH THE TEST SPECIMENS ARE TO BE HEATED DURING CYCLIC HEATING SHALL HOWEVER BE AS PER THE RECOMMENDATIONS OF EPOXY POWDER MANUFACTURER.

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

### **ANNEXURE-I:LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS**

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

<b>Epoxy Powder (Manufacturer)</b>	<b>Adhesive (Manufacturer)</b>	<b>PE Compound (Manufacturer)</b>
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 (JOTUN) or SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	HE 3450 (BOREALIS)
CORRO-COAT EP-F 2001 (JOTUN) or CORRO-COAT EP-F 2002 (JOTUN)	LE – 149 V (S K CORPORATION)	ET 509 B (S K CORPORATION)

Although the above combinations would be acceptable to COMPANY, the responsibility of suitability for application, performance and compliance to the coating system requirements shall unconditionally lie with the SUPPLIER. SUPPLIER shall ensure that adhesive as well as polyethylene is manufactured by the same Manufacturer.

#### **6.6 MEASUREMENT AND LOGGING**

The SUPPLIER shall maintain records in computer using standard 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. SUPPLIER's documentation shall be designed to ensure full traceability of pipe and coating materials through all stages of coating and testing. SUPPLIER shall submit this information in the form of a report at the agreed intervals. The above data shall also be provided in MS ACCESS format in Compact Disc (CD). SUPPLIER shall provide the use of one Computer Terminal to COMPANY Representative for monitoring/tracking of the above. In addition SUPPLIER shall also submit the material balance details to COMPANY for information.

#### **6.7 COATING PROCEDURE AND QUALIFICATION**

6.7.1 Upon award of the PURCHASE ORDER, the SUPPLIER 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:

- Details of plant(s), location(s), layout, capacity and production rate(s).
  - 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.
  - Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.
  - 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.
  - Plant Organisation Chart and availability of manpower including coating specialist
  - Details of utilities/facilities such as water, power, fuel, access roads and communication etc
- After COMPANY has given approval, no change in plant set-up shall be made. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY.

6.7.2 At least four (4) weeks prior to the commencement of production coating, a detailed procedure of the SUPPLIER's methods, material proposed, etc., shall be formulated by the SUPPLIER and submitted for COMPANY approval in the form of a bound manual. The procedure shall include, but not limited to, the following information and proposals:

- Pipe inspection at the time of bare pipe receipt.
- 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.
- Pipe heating, temperatures and control prior to epoxy application.

- Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendations from manufacturer(s).
- Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.
- Quenching and cooling, including time and temperature.
- Quality Assurance System, Quality Plan, Inspection and Test Plan and reporting formats, including instrument and equipment types, makes and uses, etc
- Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repair thereof including coating stripping technique
- Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.
- Complete details and inventory of laboratory and equipment for procedure qualification and regular production
- Pipe handling and stock piling procedures
- Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause 6.0 of this specification.
- Complete details of test certificates for raw materials including test methods and standards used.
- 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
- Health, Safety and Environment Plans.
- Storage details of coating materials and chemicals.
- 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 the COMPANY has given approval. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY.

6.7.3 Prior to start of production, the SUPPLIER 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. SUPPLIER shall give seven (7) working days notice to witness all procedures and tests. A batch representing a normal production run, typically 15 pipes, shall be coated in accordance with the approved coating procedure and the coating operations 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 (optional) for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. COMPANY Representative shall witness all tests. Out of 5 (five) test pipes, 1 (one) pipe partly coated with epoxy and partly coated with both epoxy and adhesive layers shall be included. Remaining 4 (four) test pipes shall have all three layers. During PQT, the SUPPLIER shall qualify various procedures forming a part of coating operations as detailed subsequently.

#### 6.7.4 Qualification of Procedures

**6.7.4.1 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 PQ. Also, the SUPPLIER shall remove samples of reclaimed powder from the reclamation system. These samples 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, SUPPLIER shall not use the reclaimed powder during the regular production.

6.7.4.2 **Pipe Pre-heating** : The SUPPLIER shall establish the temperature variation due to incoming 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.

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

6.7.4.4 **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.

## 6.7.5 Qualification of Applied Coating

### 6.7.5.1 Tests on pipe coated partly with epoxy and partly with epoxy & adhesive layers

- Degree of Cure: Epoxy film samples (minimum 4 no.) shall be scrapped from the 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 ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) shall comply with the specified requirements.
- Epoxy Layer Thickness: Epoxy layer thickness shall be checked at every one metre spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply with the specified thickness requirements.
- Adhesive layer Thickness: Adhesive layer thickness shall be checked at every one metre spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply with the specified thickness requirements.
- 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.
- 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.245.20-02, 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.
- 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.245,20-02, Table 4.
- 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.245,20-02, Table 4.

### 6.7.5.2 Tests on pipes coated with all three layers

- 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 65 mm. None of these samples shall fail.

- Impact Strength: Three test pipes shall be selected for impact strength test and the test shall meet the specified requirements.
- Indentation Hardness: Two samples for both temperatures from all pipes shall be taken. If any one of these samples fail to satisfy the specified requirements, then the test shall be repeated on four more samples. In this case, none of the samples shall fail.
- d. Elongation at failure: Six samples each from three coated pipes i.e. 18 samples in all shall be tested and the test shall comply the specified requirement. Only one sample per pipe may fail.
- Cathodic Disbondment Test: Two CD tests 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.
- Holiday Inspection: All the pipes shall be subject to holiday inspection. The test voltage shall be as specified in para 6.10.4.
- Coating Thickness Measurement: All pipes shall be subject to coating thickness measurements. Acceptance criteria shall be as per para 6.10.3.
- 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.
- 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. Silicon coated sulphite paper shall be placed between the epoxy layer and adhesive layer immediately after epoxy application, to ensure physical separation of epoxy & adhesive as well as to prevent contamination of epoxy with adhesive layer, at a location from where the epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) shall comply with the specified requirements.

#### 6.7.5.3 Inspection of all test pipes

All pipes shall be subject to the following inspections :

- Surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test immediately after deionised water wash.
- pH of pipe surface before and after phosphoric acid wash.
- 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.

6.7.6 After completion of the qualification tests and inspection as per para 6.7.5.2 and 6.7.5.3 above, the SUPPLIER 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, SUPPLIER shall commence production coating.

6.7.7 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 SUPPLIER'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

6.7.8 The SUPPLIER 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.

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

## **6.8 PIPE SURFACE PREPARATION**

- 6.8.1 Unless specified otherwise, the pipes shall be supplied free from mill applied oils but may be subject to contamination occurring during transit.
- 6.8.2 Prior to cleaning operation, SUPPLIER shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The SUPPLIER shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers to ensure traceability of pipe after coating.
- 6.8.3 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. Solvent cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.
- 6.8.4 All pipes shall be preheated to a temperature of 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blast cleaning units to achieve the specified surface cleanliness and profile. 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. During abrasive blast cleaning, the metallic abrasive shall be continuously sieved to remove "fines" and "contaminants" and the quality checked at every four hours. Abrasives used for blast cleaning shall comply ISO-11124
- 6.8.5 Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into the pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively the SUPPLIER may link the pipes suitably together to prevent the entry of any short/grit into the pipe.
- 6.8.6 All pipes shall be tested for salt contamination after blast cleaning unit. One test shall be carried out on each pipe. The acceptance criteria shall be 2 µg/cm<sup>2</sup>. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations. Any pipe having salt contamination exceeding 2 µg/cm<sup>2</sup> shall be either reblasted or deionised water washed and then rechecked for salt contamination. In case salt level less than 2 µg/cm<sup>2</sup> is consistently achieved, the frequency of salt contamination testing may be relaxed to at least one pipe per hour at the sole discretion of the COMPANY Representative.
- 6.8.7 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 2 ½ of ISO 8501-1. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 80 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. Tape used for assessment of degree of dust shall comply IEC 454-2. Pressure shall be exerted on the applied tape using a 4 kg roller, prior to peeling-off to assess the degree of dust.
- 6.8.8 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.
- 6.8.9 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The SUPPLIER shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.



- 6.8.10 The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall the surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. 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 the anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/oil and water traps. Where burnishing results in destruction of anchor pattern, the anchor pattern shall be restored by suitable means. Pipes that 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.
- 6.8.11 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 SUPPLIER'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.
- 6.8.12 In order to ensure that pipe with defects are not processed further, provisions shall be available to lift the pipes from inspection stand.
- 6.8.13 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 an 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.

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

## 6.9 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:

### 6.9.1 Pipe Heating

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

6.9.1.2 Induction heater or gas fired heating 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 blueing or other apparent oxide formation) is not acceptable.

6.9.1.3 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.

6.9.1.4 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 linepipe. 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, re-cleaned and recoated.

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

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

### 6.9.2 Pipe Coating

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

- 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.
- Grafted co-polymer adhesive application by extrusion, minimum thickness 0.200 mm.
- Polyethylene application by extrusion. The coated pipe shall be subsequently quenched and cooled in water for a period that shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

6.9.2.2 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.

- 6.9.2.3 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 dry air as per the directions of COMPANY Representative.
- 6.9.2.4 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 subject to
- Satisfactory qualification of the reclaimed system during PQT stage
  - The proportion of the reclaimed powder in the working mix does not exceed 20% at any one time.
  - 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 6.5.1
- 6.9.2.5 Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and filters, dehumidifier/dryer as required along with 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.
- 6.9.2.6 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.
- 6.9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed and within the window recommended by the manufacturer. The SUPPLIER 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 SUPPLIER shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.
- 6.9.2.8 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.
- 6.9.2.9 SUPPLIER 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, SUPPLIER shall supplement by other methods to avoid air entrapment. The methods used shall be witnessed and approved by COMPANY.
- 6.9.2.10 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.
- 6.9.2.11 Coating and/or adhesive shall terminate 120 mm (+) 20 / (-) 0 mm from pipe ends. The adhesive shall seal the end of applied coating. SUPPLIER 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°.

6.9.2.12 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 SUPPLIER's expense.

## **6.10 INSPECTION AND TESTING**

**6.10.1 General :** The SUPPLIER 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.

**6.10.2 Visual Inspection:** Immediately following the coating, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating shall be of natural colour and gloss, smooth and uniform and shall be blemish free with no dust or other particulate inclusions. The coating shall not show any defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts, swellings, disbonded zones, air inclusions, tears, voids or any other irregularities. Special attention shall be paid to the areas adjacent to the longitudinal weld (if applicable), adjacent to the cut-back at each end of pipe and within the body of the pipe. In addition inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focussed at the middle of the pipe at one end while inspection is carried out visually from other end.

### **6.10.3 Coating Thickness**

- The coating thickness shall be determined by taking at least 10 measurements at locations uniformly distributed over the length and periphery of each pipe. In case of welded 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 readings must meet the minimum requirements. However, localized coating thickness of less than the permissible minimum thickness can be tolerated on the condition that it does not attain a total extent of more than 5 cm<sup>2</sup> 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, but may be reduced depending upon consistency of results, at the sole discretion of COMPANY Representative. Results of all measurements shall be recorded.
- Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipes shall be at SUPPLIER's expense.
- Coated pipes not meeting the above requirements shall be rejected. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at SUPPLIER's expense.

### **6.10.4 Holiday Detection**

- 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.
- The holiday detector shall be a low pulse D.C. full circle electronic detector with audible alarm and precise voltage control complying with DIN VDE 0433 Part 2. The set voltage for inspection shall be minimum 25 kV. Travel speed shall not exceed 300 mm/s.
- SUPPLIER shall calibrate the holiday detector at least once every 4 hours of production. SUPPLIER shall have necessary instruments or devices for calibrating the holiday detector.
- Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm<sup>2</sup> in size are detected in its length attributable to coating process.
- Holidays which are lesser in size than those mentioned above, shall be repaired in accordance with a approved procedure and shall be at SUPPLIER's expense.

### **6.10.5 Bond Strength Test**

- SUPPLIER shall conduct bond strength test for composite coating as per Clause 5.3.3(a) of this specification. A minimum of 65 mm length shall be peeled. First 20 mm and last 20 mm shall not be counted for assessment of bond strength.
- 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.
- In case the test fails to comply the specified requirement, the SUPPLIER shall test the preceding and succeeding coated pipe. 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 that shift shall be tested until the coating is proved acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at SUPPLIER's expense.
- The frequency of bond strength test as per para 6.10.5 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.

#### **6.10.6 Impact Strength**

- Impact strength test shall be conducted as per clause 5.3.3(b) of this specification. Initially the frequency of test shall be two (2) coated pipes per shift that may be further reduced to one coated pipe per 2 weeks depending upon consistently acceptable results at the sole discretion of COMPANY's Representative.
- Minimum thirty (30) impacts located equidistant along the length of coated pipe shall be performed.
- 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.
- In case of test failure, retesting and disposal of coated pipe shall be as per para 6.10.5 (c) above.

#### **6.10.7 Indentation Hardness**

- 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 the middle of the pipe for this test.
- In case of test failure, retesting and disposal of coated pipe shall be as per para 10.5 (c) above.

#### **6.10.8 Air Entrapment Test**

- 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.
- 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.
- 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.
- All examination shall 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.

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

#### **6.10.9 Degree of Cure**

- 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. Silicon coated sulphite paper shall be placed between the epoxy layer and adhesive layer immediately after epoxy application, to ensure physical separation of epoxy & adhesive as well as to prevent contamination of epoxy with adhesive layer, at a location from where the epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (.Tg) and % cure (.H) shall comply the specified requirements.
- 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 SUPPLIER for this purpose
- In case of test failure, production carried out during the entire shift shall be rejected, unless the SUPPLIER proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

#### **6.10.10 Epoxy Layer Adhesion Test**

- Adhesion of epoxy layer shall be determined at ambient temperature by the “St Andrews Cross” method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30°/150°. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/lift the coating from the 30° angle with a sharp knife.
- Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion on the pipe from which the Degree of Cure test has been carried out as per para 10.9 above.
- In case of test failure, retesting and disposal of coated pipe shall be as per para 10.9 (c) above.

#### **6.10.11 Cathodic Disbondment Test**

- 48 hours CD test shall be conducted as per clause 5.3.3 (h) of this specification.
- 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.
- In case the test fails to conform to the specified requirement, at the option of the SUPPLIER, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test 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 SUPPLIER.

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

6.10.13 Repairs occurring on account of the production tests are however excluded from above mentioned limitations at para 6.10.4 above.

6.10.14 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 despatch and also testing of raw materials. SUPPLIER 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 SUPPLIERS obligation to perform the required inspection and tests.

6.10.15 In case rate of defective or rejected pipes and/or samples tests are 10% or more for a single shift (typically 8 hours), SUPPLIER shall be required to stop production and carry

out a full and detailed investigation and shall submit findings to COMPANY for approval. SUPPLIER 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 SUPPLIER of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plant unless authorized by COMPANY in writing.

#### 6.11 REPAIR OF COATING

SUPPLIER shall submit to COMPANY, its methods and materials proposed to be used for executing a coating repair and shall receive approval from COMPANY prior to use. In open storage the repair coating materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. SUPPLIER 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 or porosity on 100% of the surface. Defects, repairs and acceptability criteria shall be as follows:

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm<sup>2</sup> or linear damage (cut) of less than 3 cm shall be repaired by stick 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 mm and an area not exceeding 20 cm<sup>2</sup> shall be rebuild by heat shrink patch only and without exposing to bare metal.
- Defects of size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrink 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 500 mm shall be repaired using heat shrinkable sleeves of HTLP 80 or equivalent.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, SUPPLIER 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 140 mm of linear length of pipe then the coating shall be repaired by the use of heat shrink sleeves thereby making up the coating cut back length of 120 mm.

Notwithstanding the above, if any defect exceeds 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

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

- Holiday repair of size =100 cm<sup>2</sup> attributable to process of coating application shall be maximum one number 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 SUPPLIER.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the COMPANY Representative. In any case the SUPPLIER shall establish his material, methods and procedure of repair that result in an 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. SUPPLIER shall test repairs to coating as and when required by COMPANY.

## **6.12 MARKING**

SUPPLIER 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:

- Pipe number, Heat number
- Diameter & Wall thickness
- Coated pipe number
- Colour band
- Any other information considered relevant by COMPANY.
- Pipe Manufacturer Name
- Inspection Mark/Punch

SUPPLIER shall obtain prior approval on marking procedure to be adopted from the COMPANY.

## **6.13 QUALITY ASSURANCE**

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

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

6.13.3 The SUPPLIER shall submit the procedures that comprise the Quality System to the COMPANY for agreement.

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

6.13.5 The SUPPLIER 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-SUPPLIERS 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.

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

**6.14** Para – 6.1 to 6.13 shall also cover scope for 3 layer polyethylene coating for the LR bends.

## **7.0 SCOPE OF WORK FOR DELIVERY OF PRE-COATED PIPES AND SPECIFICATIONS.**

7.1 Handling, loading and transportation of coated pipes from SUPPLIER's coating yard to designated dumpsites to be shown by OIL's Engineer which shall be within 40 km aerial radius from Duliajan P.S. and will be motorable for pipe carrying trailers. Varied quantities of bare/coated pipes will be required to be delivered at various dumpsites as per instructions of OIL's engineers, however all such dumpsites shall lie within 40 km radius of Duliajan P.S. Unloading of the pipes at designated dumpsites to be shown by OIL's Engineer will not be responsibility of the SUPPLIER. The installation agency will unload pipes at the dumpsite within 48 hours after arrival and reporting at the designated dumpsite by the transporting agency. However minimum 3 days prior intimation (written or fax only) about arrival of the pipes will have to be provided to OIL.



7.2 The SUPPLIER shall load, transport, and deliver the bare/coated pipes from the yard of coating plant(s) to the dumpsite using suitable means and in a manner to avoid damage to pipes.

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

7.4 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 2 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes. All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe.

7.5 In case of any marine transportation of bare/coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. SUPPLIER shall furnish all details pertaining to marine transportation including drawings of cargo barges, storing/stacking, sea fastening of pipes on the barges/marine vessels to the company for approval prior to undertaking such transportation works. In addition SUPPLIER 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.

7.6 SUPPLIER shall carry out Inspection of all the bare and coated line pipes in the presence of Company's representative while handing over of pipes to the Installation Agency at the dumpsite and also keep necessary records for the same. Repair of damaged pipes, beveled end defects and damaged coating (including supply of repair coating materials) noticed at the time of handling over of bare / coated line pipes to Installation Agency shall be carried out by SUPPLIER only and necessary jobs as regards to repair, replacement, transportation of pipes & coating shall be responsibility of the SUPPLIER only.

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

7.8 The above scope from para 7.1 to 7.7 shall also cover delivery of pre-coated LR bends.

## **8.0 SCOPE OF WORKS AND SPECIFICATION FOR FABRICATION OF LONG RADIUS BENDS, INCLUDING 3 LAYER SIDE EXTRUDED POLYETHYLENE COATING OF THE BENDS, HANDLING, DESPATCH AND DELIVERY OF THE BENDS AT DESIGNATED POINTS.**

### **8.1 SCOPE :**

- 8.1.1 Fabrication of long radius bends as per clause 1.4 and as per clause 8.2 to 8.8.
- 8.1.2 Handling, loading, transportation to coating plant and unloading at coating plant as per Para -5.0 PART – A.
- 8.1.3 External coating of the bends by using 3 layer side extruded polyethylene coating as per Para- 6.0 PART – A.
- 8.1.4 Handling, packing, loading, despatch and delivery of coated bends at designated points as per Para – 7.0, PART – A.

8.2 Reference has been made in this specification to the latest edition of the following codes, standards and specifications :

- a) ASME B 31.8 : Gas Transmission and Distribution Piping Systems.
- b) MSS-SP-75 : Specification for High Test Wrought Welding Fittings.

### 8.3 MATERIAL

8.3.1 Bends shall be fabricated from steel line pipes of specification as per **SCOPE OF SUPPLY** mentioned in Para – 1.4 and scope as per Para – 3.0, PART – A.

8.3.2 Heat treatment shall be carried out for all finished bends, Heat treatment procedure shall be such that the mechanical properties and steel microstructure of the finished bends comply with the minimum requirements specified in the applicable line pipe specification referred under clause 3.1 When TMCP and OLAC sheets and micro alloyed steels are used, specific approval of the proposed heat treatment shall be obtained before bending process is employed. The finished product shall be evaluated for mechanical properties and micro structural stability.

### 8.4 MANUFACTURE

8.4.1 Bends shall be manufactured by high frequency induction heating and forming method. Once the bending operation has commenced no stoppage shall be permitted until the entire bend has been completed. If bending temperature, bending rate, cooling medium volume or heat treatment temperature depart from the Purchase approved bend manufacturing procedure, then the pipe shall be discarded and another bend shall be made in its place.

8.4.2 Unless otherwise specified differently in the Purchase Order, the bevels at the ends shall be as per relevant pipe specification.

8.4.3 No repair by welding is allowed on any part of the bends.

8.4.4 Bulges, dents and flat areas shall not appear within 100 mm front end of the bend. For the remaining part of the bend these deviations from the original contour of the pipe are permitted provided these deviations do not exceed 6.0 mm. The same shall not extend (in any direction) over a distance of more than 25% of nominal diameter of the bend.

8.4.5 All bends shall be provided with a tangent length at the ends. Tangent length shall be 300 mm or pipe outside diameter whichever is more.

### 8.5 TOLERANCES

The dimensions of bends shall be controlled to make sure that they are manufactured according to the tolerances indicated below in addition to the requirements of MSS-SP-75. However, the ends of finished pipe bend shall meet the dimensional tolerances of the relevant pipe specification as referred in Para – 1.1 and Para – 3.0, PART - A.

- 8.5.1 Bend Angle :  $\pm 0.5$  degree of specified angle
- Bend Radius :  $\pm 1\%$  of bending nominal radius

8.5.2 The manufacturer shall measure the wall thickness of the pipe before bending along both the inside and outside radii of the bend between and including the start and stop points of the bend arc angle, at intervals approximately equal to pipe diameter or 300 mm whichever is less. The wall thickness shall be measured ultrasonically after bending at the same locations measured before bending. In addition, the wall thickness of the tangents shall also be measured. These measurements shall be taken at four equally spaced locations around the pipe circumference. The measured wall thickness shall be at least equal to :

$$t_{\min} = 0.95 (t_{\text{actual}} - \Delta t)$$

where :

$t_{\text{actual}}$  = Actual wall thickness of pipe  
 $\Delta t$  = 0.35 mm for a wall thickness < 10 mm and 0.5 mm for a wall thickness  $\geq$  10 mm

8.5.3 Out of roundness tolerance on the body and ends of the bend shall be as follows :

#### **Body**

Measurements of the outside diameter shall be taken in the plane of the bend at locations where wrinkles are present (OD max.) and at locations where wrinkles are not present (OD min.). Out of roundness shall be considered acceptable, if the value of  $(OD_{\min} - OD_{\min}) / OD_{\text{nom.}}$  does not exceed 2.5%.

#### 8.5.4 Off-Plane

Off-Plane of bends shall not exceed  $(\varnothing/90) \times 10$  mm, where  $\varnothing$  is the bend angle in degree or the tolerance limit specified in MSS-SP-75 whichever is less. The measurement shall be in accordance with MSS-SP-75.

### **8.6 INSPECTION & TESTS**

8.6.1 The manufacturer shall perform all inspection and tests as per the requirements of this specification and MSS-SP-75 prior to transfer to the coating plant. Such inspection and tests shall be as a minimum, but not limited to the following :

8.6.1.1 Verify that the uncoated bends arrive at coating shop is in full compliance with the pipe specification as referred from Para – 8.2 to Para – 8.5.

8.6.1.2 Visual inspection.

8.6.1.3 Dimensional and tolerances check as per MSS-SP-75 and requirements of Section 4.0 of this specification.

8.6.1.4 Check heat treatment, if carried out, as required and maintain its records.

8.6.1.5 Temperature against time recorder charts for each induction heating.

8.6.1.6 A check shall be performed on each bend by passing a gauging pig consisting of two discs having a diameter equal to 95% of the nominal internal diameter of the pipe, connected rigidly together at a distance equal to 500 mm. Details of the gauging pig. Including its dimensions shall be approved by Purchaser.

8.6.2 Purchaser reserves the right to perform stage wise inspection and witness tests on all bends as indicated in Clause 5.1 at Manufacturer's works, prior to shipment.

### **8.7 TEST CERTIFICATES**

The manufacturer shall submit the following certificates ;

8.7.1 Records of heat treatment, if carried out for bends.

8.7.2 Certified reports of dimensional tolerance of bends.

8.7.3 Certificates of all other tests as required in this specification.

The Certificate shall be valid only when signed by Third Party Inspection Agency. Only those bends which have been certified by Third Party Inspection Agency shall be dispatched from Manufacturer's works.

### **8.8 MARKING, PACKING AND SHIPMENT**

8.8.1 All bends shall be marked as per MSS-SP-75.

8.8.2 Both ends of all bends shall be suitably protected to avoid any damage during transit by means of metallic or high impact plastic bevel protectors.

\*\*\*\*\*