MAHANAGAR GAS LTD.

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Vidyanagari Marg, Kalina,
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REFERENCE NO.: MGL/C&P/EMP/CS PIPES/2016

FORM FOR EMPANELMENT OF SUPPLIERS FOR CARBON STEEL PIPES

LAST DATE OF SUBMISSION: 05.01.2017

IN SEARCH OF QUALITY SUPPLIERS FOR MGL

EMPANELMENT OF SUPPLIERS

MGL invites applications for empanelment from experienced, financially sound and eligible Suppliers for Supply of Carbon Steel pipes

GUIDELINES FOR SUBMISSION OF APPLICATION FORM

1. Application form for empanelment shall be submitted in sealed envelope superscripting**"Application for Empanelment as supplier for Manufacture and Supply of Carbon Steel pipes"**

2. The application shall be submitted along with the supporting documents and **Demand Draft of ₹5000**/-(for Indian Applicant)favoring "**MahanagarGas Limited**", payable at Mumbai**.**

3. The application shall be signed by the person/s on behalf of the organization having necessary authority/power of attorney to do so.

4. If the space in proforma is insufficient for furnishing full details, such information may be supplemented on separate sheet stating therein the part of Proforma and serial number. Separate sheet may be used for each part of application. While filling up the application with regard to list of supplies completed or on hand, the application shall also include major supplies executed by firm.

5 The applicant should ensure that the application is delivered at the given address within prescribed date and time as mentioned in the advertisement.

6 Application containing false and/ or incomplete information is liable for rejection.

DOCUMENTS TO BE SUBMITTED FOR EMPANELMENT OF SUPPLY OF CARBON STEEL PIPES (4"-12")

(i) Applicant/Manufacturer should have a valid license to use API 5L, PSL 2 monogram for manufacturing pipes.

(ii) Applicant/Manufacturer should have valid factory license for manufacturing of ERW Carbon Steel pipes.

(iii) Purchase Order copies executed in the past Five years for supply of ERW Carbon Steel pipes (as per technical specification at Annexure-I) along with third party inspection release note (of the material supplied vide the same PO).

(iv) Documents in support of ISO 9001 Or equivalent Quality management System accreditations.

(v) The Applicant/Manufacturer should have their own coating plant for coating of Line Pipes. In case the bidder is not having set up for coating then bidder should have a valid Memorandum of Understanding with the coater for getting bare pipes coated at coater's works.

Note: MGL may ask for additional documents (if required) for complete evaluation of application for empanelment. After assessing technical as well as commercial capabilities of the applicant, MGL may consider the applicant for empanelment and the same shall be communicated to the applicant.

FORM FOR EMPANELMENT

We _____are desirous of being enrolled on list of Suppliers for _____and hereby apply for the same. We give the following details for your consideration.

Sr. no	Field Name	Details
1.	Name of the Firm/ Company:	
2.	Address: Telephone No: Fax No:	
3.	Month and year of Establishment of Firm / Company:	
4.	Particulars of old firm (if present firm is new) if main partners of the present firm were working in some other name in the past (the partnership deed of the old firm be enclosed)	
5.	Particulars of sister concern (if any)	
6.(i)	What is the constitution of the firm viz. sole proprietor, partnership, Pvt Ltd. Public ltd. Etc.	
6(ii)	Enclose copy of partnership deed (in case of partnership firm) or Articles of Association etc.	
6(iii)	Fill – in and enclose Annexure "A" For Management Details	
7.	Annual turnover for last five years(enclose documentary evidence or proof to support figures)	Year Rs. In Lacs i) ii) iii) iv) v)
8.	Bank Guarantee Limits with various Banks.	i) Rs. Lacs with ii) Rs. Lacs with

9.	Indicate name & address of person to whom the queries to be sent.	
10.	Indian agent details & details of Indian service provider in case of foreign Applicants	
11.	Fill – in and enclose Annexure "B" for List of Major Supply Jobs executed.	
12.	Any other information, the applicant might like to provide	
13.	Registration With International/ National Quality Certification (a) ISO 9001:2008 (b) EMS 14001:2004 (c) OHSAS 18001:2007 Please enclose copies of Certificates	

Note: It is mandatory to fill in all the columns by the company and submit the same along with all necessary documents / credentials / copies of the certificates etc. Any other relevant information in support of empanelment may be volunteered by the applicant. All pages may be signed in ink with stamp by the authorized signatory of the Company.

Place: Signature:

Name & Designation:

Date: Company Seal:

ANNEXURE - A

Management Details

Sr. No.	Name of the Partner orDirector or other High Level Officials	Age	Share	Technical Experience in Years	Whether power of Attorney Holder?

ANNEXURE - B

LIST OF MAJOR SUPPLY JOBS EXECUTED

Sr.No	Purchase Order Ref. & Date	Quantity of CS pipes supplied (4"-12")	Name of the Client

Note: The copies of the documents referred in above table to be submitted

(To be submitted on the Suppliers Letter Head)

D E C L A R A T I O N

1. I/ We hereby confirm that the information furnished in this application is true to the best of my / our knowledge and belief.

2. I / We have read the Form for Empanelment and I / We understand that if any false information is detected at a later date, any future contract made between ourselves and MGL, on the basis of the information given by me / us can be treated as invalid by MGL and I / We will be solely responsible for the consequences.

3. I / We agree that the Mahanagar Gas Limited has the right to empanel or not to empanel, issue or not to issue tender form in any particular case and also to suspend, remove or blacklist our name from the Mahanagar Gas Limited list of suppliers in the event of our submitting of non – bonafide tenders or for technical or other delinquency in regards to which the decision of the Mahanagar Gas Limited shall be final and conclusive.

4. I / We agree that I / we have no objection if enquiries are made about the supply orders listed by me / us in the accompanying sheets.

5. I / We agree that I / We have not applied in the name of sister concern for the subject empanelment process.

6. I/We understand and agree that mere empanelment does not entitle us for award of Order.

7. I/ We agree to notify Mahanagar Gas Limited of any changes in the foregoing particulars as they occur.

Place: Signature

Date: Name & Designation

Seal of Organization

Annexure-I

Mahanagar Gas Ltd

MGL/ENG/STEEL/SP 04 R1

TECHNICAL SPECIFICATION FOR LINEPIPES

1. SCOPE

1.1 This specification establishes the minimum requirements for the manufacture of Seamless, Electric welded and Submerged Arc Welded Steel line pipes in accordance with the requirements of American Petroleum Institute Specification 5L(45th Edition)/ISO 3183:2007(Modified) and makes restrictive amendments to API Spec 5L. Unless modified and referred by this specification, the requirements of API Spec. 5L shall be valid.

In case of conflict between the requirements of this technical specification and requirements in the standards / specifications, the requirements of this specification along with purchase order conditions shall govern.

The coverage by this specification is limited to line pipe to be used in onshore pipelines transporting Natural Gas.

The Manufacturer shall have a valid license to use API 5L PSL 2 Monogram for manufacturing of line pipes in accordance with the requirements of Latest edition of API Spec. 5L specification

1.2 PRODUCT SPECIFICATION LEVEL (PSL)

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

1.3 GRADES

This specification is applicable to PSL-2 line pipes of Grade B through X60.

1.4 DIMENSIONS

This specification shall be applied to line pipes of size 4 ½ through 18 (both size included).

2. REFERENCES

The latest edition of following additional references are included in this Specification

ASTM

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

BS

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

5. PROCESS OF MANUFACTURE AND MATERIAL

5.1 Process of Manufacture

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

The plates / skelp shall be by hot rolling with automatic monitoring of rolling conditions and full length automatic gauging system for thickness and width.

The manufacturing Procedure Specification (MPS) as described in Annexure – I of this specification shall be prepared and submitted to Company for approval prior to start of Production and MPQT (Manufacturing Procedure Qualification Test) for the first day production shall be done in the presence of Company Representative as per Annexure –II attached to this specification.

5.1.1 Seamless Process

Cold sizing and straightening of pipe is permissible provided the total strain does not exceed 3.0%

5.1.2 Welding Processes

5.1.2.1.1 Continuous Welding

Not acceptable

5.1.2.1.2 Electric welding

Electric Welding using High frequency electric welding process, having a minimum frequency of 200 KHz shall be used.

5.1.2.2.1 Submerged Arc Welding (SAW)

All welds shall be done by automatic welding

5.1.2.2.2 Gas Metal Arc Welding (GMAW)

This process is only acceptable for tack welding pipes which shall subsequently be welded by the SAW process.

5.1.3 Types of pipe

5.1.3.2 Continuous Welded Pipe

Not acceptable

5.1.3.3 Electric Welded Pipe

Electric welded pipes shall be manufactured from hot rolled coils only.

A normalizing heat treatment of the weld and the heat affected zone shall always be carried out, irrespective of grade and chemical composition.

5.1.3.3.2 PSL 2 ELECTRIC WELDED PIPE

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

- Time
- Welding speed
- Current and Voltage
- Heat treatment temperature

The weld seam and the entire heat affected zone(HAZ) shall receive a normalizing heat treatment in order to control the structure so that no untempered martensite remain in the weld seam and the HAZ, and the mechanical properties of heat treated zone approximate that of the parent metal.

Automatic Monitoring of heat treatment of weld seam with continuous chart recorder with automatic seam detector and seam tracking system shall be provided for monitoring weld seam heat treatment.

5.1.3.5 Longitudinal Seam Submerged-Arc Welded Pipe

The full length of the weld seam shall be made by automatic submerged arc welding, using run-on and run-off tabs. The welding procedure shall be approved by the Company. Welding shall be

checked at regular intervals to ensure that current, voltage and travel speed remain within the ranges of the welding procedure.

5.1.3.6 Gas Metal Arc Welded Pipe

Gas Metal Arc Welded Pipes are not acceptable

5.1.3.7 Combination of Gas metal-arc and Submerged-arc welded pipe

Gas metal arc welding is only acceptable for making a continuous tack weld in SAW pipe. This pipe is further considered as SAW pipes.

5.1.3.8 Double Seam Submerged-arc Welded Pipe

Not acceptable

5.1.3.9 Double Seam Gas Metal-arc Welded pipe

Not acceptable

5.1.3.10 Double Seam Combination Gas Metal-arc & Submerged-arc welded pipe

Not acceptable

5.1.3.11 Helical Seam Submerged-arc Welded pipe (HSAW)

HSAW is only acceptable if it meets all the requirements for SAW welding and inspection indicated in this specification

Each edge of the strip shall be ultrasonically examined for laminations over a width if 25 mm along its longitudinal edges prior to welding

Welds shall be inspected on their full length by ultrasonic method as per section 9.8.5.1

The transition between parent metal and weld deposit shall not display undercutting.

The over thickness of the weld deposit shall not exceed 2 % for the pipe wall thickness lesser than 15 mm.

5.1.4 Type of Seam Welds

5.1.4.5 Skelp End Weld

Not acceptable

5.1.4.6 Jointer Weld

Not acceptable

5.1.4.7 Tack weld

Tack welds shall be made in accordance with a qualified tack welding procedure using automatic SAW, GMAW, gas shielded FCAW, or shielded metal arc welding using low hydrogen electrodes. When low hydrogen electrodes are used the diffusible hydrogen content of the resulting weld metal shall not exceed 5 ml / 100g of deposited metal.

Tack weld shall be removed subsequently by careful grinding or machining only.

5.2 Cold Expansion

EW pipe shall not be cold expanded.

LSAW pipes shall be mechanically cold expanded for full length. The expansion measured on the circumference shall range between 0.8 to 1.5% of the value measured before the expansion. The expansion shall be measured and recorded for one out of every 50 pipes.

5.4 Heat Treatment

The heat treating process shall be performed in accordance with a documented procedure. The Manufacturer shall establish and follow procedures for maintaining heat and or lot identity.

Seamless pipes shall be furnished in the hot formed, normalized and tempered or quenched and tempered condition. For hot formed pipe, the finishing temperature shall be greater than 780^0 C. Pipe furnished at a lower temperature than 780^0 C shall be subjected to a further normalizing heat treatment with a minimum holding time of 30 minutes.

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

6. MATERIAL REQUIREMENTS

6.1 CHEMICAL PROPERTIES

6.1.1 Chemical Composition

The chemical composition of each heat of steel on product analysis shall be in accordance with Table 5 and notes given below. Table 5 of API Spec. 5L(44th edn) is cancelled.

TABLE - 5 : Chemical requirements for Heat and product analysis.

Element	Product Analysis by percentage weight (maximum permitted)		
	SEAMLESS	ELECTRIC WELDED	SUBMERGED ARC WELDED
C	0.16	0.15	0.16
Mn	1.6	1.5 (For Gr. B to X 52) 1.6 (For Gr. X 56 to X 70	1.5 (For Gr. B to X 52) 1.6 (For Gr. X 56 to X 70
Si	0.45	0.45	0.45
P	0.02	0.02	0.02
S	0.01	0.01	0.015
V	0.08	0.05	0.08
Nb	0.05	0.05	0.05
Ti	0.04	0.06	0.06
Cr	0.20	0.20	0.20
Mo	0.25	0.08	0.10
Ni	0.30	0.20	0.20
Cu	0.25	0.35	0.35
Al	0.06	0.07	0.07
N	0.012	0.012	0.012
B	0.0005	0.0005	0.0005
Ca	0.006	0.006	0.006

NOTES:

i. V + Nb + Ti shall not exceed 0.15 percent
ii. Cu + Ni shall not exceed 0.40 percent.
iii. Al : N ratio shall not be less than 2:1

NOTES: h (New)

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

6.1.2 Elements Analysed

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

6.1.3. Carbon equivalent (PSL 2 Only)

6.1.3.1 Calculation of Carbon Equivalent

Boron content shall be considered in CE (Pcm) formula even if it is less than 0.001%.

6.1.3.2 Maximum Carbon Equivalent

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

CE (Pcm) ≤ 0.20
CE (IIW) ≤ 0.40

6.2 MECHANICAL PROPERTIES

6.2.1 Tensile Properties

The actual yield strength shall be as close as possible to the specified minimum yield strength (SMYS) as per API 5L (44th edn) but in no case it shall exceed the limits specified here under:

API Spec 5L Grade	Permissible in excess of SMYS, psi (MPa)
Upto and including X-46	19000 (131)
Above X 46	22000 (152)

Table 7 of API 5L (44th edn) stands modified accordingly.

The ratio of body yield strength and body ultimate tensile strength of each test pipe on which body yield strength and body ultimate tensile strength are determined, shall not exceed 0.90. The minimum elongation of base metal shall be determined in accordance with the formula given in foot note(f) of Table 7 of API 5L(44th edn).

The ultimate tensile strength of the weld shall be equal to or better than the specified minimum ultimate tensile strength of the base metal.

6.2.2 Flattening Test Acceptance criteria

Acceptance criteria for flattening test shall be as per API 5L

6.2.5 FRACTURE TOUGHNESS TEST

6.2.5.2 Charpy Impact Tests for PSL 2

Unless otherwise specified in the Purchase Order, the test temperature shall be $+32^0$ F (0^0C).

Unless otherwise specified in the Purchase Order, the required minimum average (set of three specimens) absorbed energy based on transverse full size specimen shall be as follows:

Pipe Size	Base Metal (Joules)	Weld Metal and HAZ (Joules)
4 ½ to 16	27	27
18 to 24		

In case longitudinal specimen is applicable as per Table 20 of API Spec 5L, the acceptance criteria for absorbed energy value shall be 1.5 times that indicated above.

e.New Additionally, for SAW pipes of all sizes and specified wall thickness, additional fracture toughness requirements as per Supplementary requirements SR 19 and as modified in this specification shall be applicable for body, weld and heat affected zone.

6.2.5.3 Supplementary Fracture Toughness Tests.

EW pipes

For pipe sizes 16 and larger, Drop weight Tear Test in accordance with Supplementary requirements SR 6 of this specification and as modified herein shall also be performed.

For SAW pipes

Drop weight Tear Test in accordance with Supplementary requirements SR 6 of this specification and as modified herein shall be performed for all pipe size, grade and wall thickness.

6.2.6 Metallographic Examination & Hardness

New Micro graphic examinations with 100X magnification as per ASTM E 112 including micrographs shall be carried out.

6.2.6.1New For EW pipes

A test specimen for Metallographic & hardness examination shall be taken transverse to the longitudinal weld, from one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs maximum) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered. The specimen shall be suitably ground, polished and etched to reveal the microstructure. The specimen shall be visually examined using adequate magnification to provide evidence that heat treatment of weld zone is adequate and there is

no untempered martensite left. In case defects are observed, it will become a cause of revaluation of welding parameters and heat treatment as deemed necessary by purchaser's Representative.

For SAW pipes

A test specimen for Metallographic & hardness examination shall be taken transverse to the longitudinal weld, from one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs maximum) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered. The specimen extraction shall be as per Figure 6.2.6.1 of this specification. The specimen shall be suitably ground, polished and etched to reveal the microstructure. The specimen shall be visually examined using a minimum 10X magnification to provide evidence that proper fusion has been obtained for the full thickness, and there is proper interpretation of passes, their alignment and texture of weld zone. In case defects are observed, it will become a cause of revaluation of welding parameters and heat treatment as deemed necessary by purchaser's Representative.

6.2.6.2$_{New}$ For EW pipes

Vickers hardness tests shall be carried out on each specimen taken for macroscopic examination in accordance with ASTM E-92, at locations indicated in figure 6.2.6.2 (a). The resulting Vickers hardness value at any point shall not exceed 248 HV_{10}. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80 HV_{10}. Modalities of retest shall be in accordance with para 10.2.12 and annexure N of API Spec. 5 L (44^{th} end)

For SAW pipes

Vickers hardness tests shall be carried out on each specimen taken for macroscopic examination in accordance with ASTM E-92, at locations indicated in figure 6.2.6.2 (b) of this specification. Indentation in the Heat Affected Zone shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 HV_{10}. Modalities of retest shall be in accordance with para 10.2.12 and annexure N of API Spec. 5 L

6.2.7$_{(New)}$ Reverse Bend Test (Applicable only to EW pipes)

6.2.7.1$_{New}$ Reverse bend test shall be executed with the same number of tests and retests specified for flattening test in para 10.2.4.7 of API Spec 5L (44^{th} edn). Ring Specimen 100mm to 115 mm long, taken from the pipe, shall be reverse bend tested according to the procedure given below and Fig. 6.2.7 of this specification. Reverse bend test shall be performed on the pipe piece cut from the crop end, selected from the front end of the first length & the back end of the last length produced from each coil.

6.2.7.2$_{New}$ Selection of Mandrel

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

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

where D - Outside diameter of pipe, mm.
t - Wall thickness of pipe, mm.
1.4 - Peaking Factor.
e - Strain.

Minimum value of 'e' shall be as follows:

Grade of Steel	Min 'e' value
Gr. B	0.1425
X 42	0.1375
X 46	0.1325
X 52	0.1275
X 60	0.1225

6.2.7.3 (New) Procedure

The mandrel shall be plunged into the specimen, with the weld in contact with the mandrel, to such a depth that the angle of engagement between mandrel and specimen reaches 60^0 (see Fig. 6.2.7). If the combination of diameter and wall thickness of pipe, and radius of mandrel is such that the angle of engagement does not reach 60^0 the mandrel shall be plunged into the specimen until opposite walls of the specimen meet.

6.2.7.4 Acceptance Criteria

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

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

Measuring equipment for inspection and testing shall be selected such that it has a resolution and accuracy at least five times finer than the tolerance of the parameter being measured. Similarly, standards against which a piece of equipment is calibrated shall be at least five times as accurate as the equipment being calibrated.

Only measuring equipment which can be demonstrated to have been previously calibrated satisfactorily and still be within its documented calibration period shall be used for inspection and testing.

7.2 Diameter

Pipe Body

The outside diameter of pipe body, as determined by taping the circumference, shall not deviate by more than the values given below from that given in API Spec 5L Table 10 stands modified accordingly.

Pipe Size	Value
≥ 4 ½ and < 20	± 0.75 % of specified OD or ± 3 mm whichever is smaller
≥ 20 and ≤ 36	+ 3 mm, - 0.25% of specified OD

Pipe Ends

Diameter tolerances for the pipe ends indicated in API 5L table 10 shall be applicable on inside diameter for sizes ≥ 14" and on outside diameter for pipe sizes ≤ 12.

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

Out of Roundness

Out of Roundness i.e. the difference between the maximum and minimum diameter (inside for pipe size ≥ 14 and outside for pipe size ≤ 12) at pipe ends shall comply with the following limits. Out of roundness tolerance indicated in API 5L Table 10 stands deleted.

For Pipe size ≤ 10 ¾	3mm (Note "a" of API 5L Table 10 applicable)
For Pipe size ≥ 12 ¾	5mm (Note "a" of API 5L Table 10 applicable)

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

7.3 Wall Thickness

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

The tolerances on specified wall thickness shall be (+) 10 % & (-) 5 %. However, specified wall thickness tolerance up to (+) 15 percent for a distance of 25 mm on either side of longitudinal weld seam is also acceptable API Spec 5 L. Table 11 stands cancelled.

Wherever depth of surface defects tolerance mentioned related -12.5% wall thickness shall be read as -5%.

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

7.5 Length

All pipes shall be supplied with length between 11.5 M and 12.5 M. The minimum average length of the entire order shall be 12 meter. Pipes with length 10 m to 11.5 m used for sampling are acceptable. API 5L Clauses shall not be applicable.

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

7.6 Straightness

The deviation from a straight line for all pipe sizes shall not exceed 20 mm. Each pipe shall be checked for conformance to this requirement.

Straightness shall be measured and recorded atleast 3 times per operating shift (12 hours maximum).

End Square ness of pipe ends: Pipe ends shall be at 90^0 to the longitudinal axis of the pipe so as to obtain a good fit-up while joining / welding. Maximum out of square ness shall be less than or equal to 1.6 mm and frequency of measurements shall be same as Straightness.

7.7 Jointers

Jointers on pipes are not permitted.

7.8 Workmanship and Defects

7.8.1 Dents

Allowable dent size shall be as per API Spec. 5L. Disposition of dents shall be carried out in accordance with API 5L. E.10 (c) or (d).Disposition of defect by Grinding or Welding is not acceptable Dents on weld and heat affected zone (HAZ) are not acceptable.

7.8.2 Offset of Plate Edges

All pipes shall be checked for offset of skelp edges and offset shall be measured and recorded three times per operating shift (12 hours maximum).

7.8.3 Out-of-line weld bead for pipe with filler metal welds

A misalignment of weld seam exceeding 3.5 mm shall be rejected. The misalignment shall be measured on radiographic film and calculated using the formula (a+b)/2 where 'a' and 'b' are the relative offsets of the outside edges of the seam (refer Figure 7.8.3 of this specification). All pipes shall be checked for out-of-line weld bead and shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

7.8.4 Height of Outside and Inside Weld Beads-Submerged Arc Welds

The maximum height of outside and inside weld bead shall not be more than 3.18 mm (1/8 inch) for all specified wall thickness. All pipes shall be checked for weld bead height using a template having a cut out for weld bead and shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

Reinforcement inside and outside shall be ground smooth to a length upto 25 mm from both pipe ends.

7.8.5 Height of Flash of Electric welded pipe

Each pipe shall be checked for conformance of height of flash and height of flash shall be measured and recorded three times per operating shifts (12 hours maximum)

7.8.7 Trim of Inside Flash of Electric Welded Pipe.

Each pipe shall be checked for conformance of depth of trim and depth of trim shall be measured and recorded three times per operating shifts (12 hours maximum).

7.8.8 Hard Spots

Any hard spot having a minimum dimension greater than 2 inch (50.8 mm) in any direction and hardness greater than 248 HV_{10} shall be rejected. The section of pipe containing the hard spot shall be removed as a cylinder.

7.8.9 Cracks, Sweats and Leaks

Sections of the pipe containing cracks, sweats and leaks shall be cut off as per the requirement of API 5L. E.10 (c) or (d).

7.8.10 Lamination

Any lamination or inclusion extending into the face of bevel of the pipe is considered unacceptable defect and pipe containing such defects shall be cut back until such defects are eliminated.

The acceptance limit and disposition of lamination type defects on the skelp / pipe body shall be as per API 5L section E.5.5.

7.8.11 Arc Burns

Arc burns produced during the manufacturing of pipes are injurious defects and shall be disposed off in accordance with the requirements of API 5L. para E.10 (c) or (d). As a reference method for conforming the existence of an arc burn the area shall be buffed with wire brush or sanding disc and etched with 5 percent nital solution. However, arc burns can be considered for acceptance, in case the same is recrystallized by seam heat treatment. In such case, the Manufacturer shall demonstrate the recrystallization to Purchaser by taking a sample as per 6.2.6.1.

7.8.12 Undercuts

b. Undercutting not classified as minor shall be considered a defect. Disposition shall be as follows:

i. Undercut defects not exceeding 1/32 in (0.79mm) in depth and not exceeding 5% of the specified wall thickness shall be removed by grinding in accordance with API 5L para E.10 (a) and as modified in this specification.

Disposition of undercuts greater in depth than 1/32 in (0.79mm) or 5% of the specified wall thickness shall be in accordance with API 5L para E 10 (c) or (d).

7.8.14 Other Defects

Any imperfection on OD or ID with a depth greater than 5% of the specified thickness of the pipe is considered unacceptable and shall be repaired in accordance with API 5L. para E.10 (c) or (d) and as modified herein.

7.815_{New} Peaking

In respect of SAW pipes, deviation from the circular arc at the weld seam at pipe ends shall not exceed 1.6 mm. Each pipe shall be checked for conformance to above requirement. Peaking shall be measured and recorded at least 3 times per operating shift (12 hours maximum). Pipes not complying to these requirements shall be disposed off as per API 5L para E.10 (c) or (d).

7.9 Pipe Ends

7.9.1 General

Pipes shall be furnished with plain ends.

7.9.3 Plain Ends

Unless specified otherwise, the pipe ends shall be 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 in para. 7.3 of this Specification shall be a cause for rebevelling. In case root face of bevel is less than that specified, the pipe ends shall be rebevelled and rectification by filing or grinding shall not be done.

7.9.6$_{New}$ Bevel Protectors

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

9. INSPECTION AND TESTING

9.2.1 Heat Analyses

Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of production.

9.2.2 Product Analyses

9.2.2.1 Sampling Frequency

Two pipes per inspection lot shall be analyzed. Inspection lot shall be 50 pipes per heat. Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented.

9.2.2.2 Sampling Methods

9.2.2.2.2 Welded Pipe

Product analysis shall be carried out from finished pipes. Product analysis from skelp is also acceptable provided that the traceability is guaranteed.

9.3 Testing of Mechanical Properties

9.3.1 Tensile Tests

Tensile properties shall be determined from specimen removed from pipe which has been subjected to all mechanical and heat treatment operations.

9.3.1.2 Tensile Testing Frequency

Tensile test shall be performed on samples taken from two pipes per inspection lot. Inspection lot shall be 50 pipes per heat. API Spec Table 18 stands modified accordingly.

9.3.1.4 Transverse Tensile Tests

The transverse tensile tests shall be carried out on flattened rectangular specimen for pipe size above 6″NB. For pipe size less than 6″NB, longitudinal tensile tests can be conducted.

9.3.1.5 Weld Tensile Tests

For EW pipes

Inside and outside flash of weld in excess of pipe wall thickness shall be removed from the specimen either by grinding or machining. Specimen shall be tested for ultimate tensile strength only. The testing frequency shall be one test per inspection lot. Inspection lot shall be 50 pipes per heat.

For SAW Pipes

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

A cylindrical all weld tensile test shall be carried out at the time of first day production as specified in Annexure – I of this specification to determine the yield strength, UTS & elongation.

The cylindrical weld specimen shall have gauge length, L=5d, where

L = gauge length (mm)
D = diameter of the test specimen (mm)

The results of the test shall meet the minimum requirements of the plate / skelp with regard to yield, tensile and elongation parameters.

The testing frequency shall be one test per inspection lot. Inspection lot shall be 50 pipes per heat.

9.3.2 Flattening Tests

Flattening tests shall be performed as per API 5L. The frequency of testing, sample location, test orientation and applicable pipe sizes shall be as shown in Fig 6 of API 5L.

9.3.4 Guided-Bend Tests (Not applicable for EW Pipes)

Guided-Bend tests shall be performed as per API 5L. The frequency of tests shall comply with the requirements of API 5L.

9.3.5 Fracture Toughness Tests

9.3.5.1 Charpy Test Specimens

In addition to the specimen taken from the body of the pipe, three transverse specimens with weld in middle and three specimens with heat affected zone (HAZ) in the middle shall also be taken.

9.3.5.2 Charpy Testing Frequency

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

9.4 Hydrostatic Tests

9.4.1 Hydrostatic Test Requirements

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

9.4.2 Verification of Hydrostatic Test

The pressure gauge used for hydrostatic testing shall be calibrated with a "Dead Weight" tester and the record shall be maintained. Calibration Records shall be furnished to Purchaser's Representative on request.

9.4.3 Test Pressure

The test pressure for all sizes and grades of pipe shall be not less than maximum pressure calculated based on either of the following:

a) The test pressure shall be such that hoop stress generated is at least 90% of SMYS computed based on the formula mentioned in API 5L para 10.2.6.5 .

b) Test pressure shall be such that hoop stress generated is at least 95% of SMYS and end load compensation as per requirement of para 10.2.6.6 shall be taken into account while computing the test pressure

9.5 Dimensional Testing

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

9.7 Visual Inspection

All pipes shall be visually examined both externally and internally (to the extent feasible) and shall be free of defects in the finished condition. Adequate illumination shall be provided to enable proper inspection.

9.8 Non Destructive Inspection

New Purchaser Inspection

The purchaser reserves the right to depute its Representative(s) to perform inspection and witness tests in all phases of manufacturing and testing starting from steel making to finished line pipe ready for shipment. Manufacturer shall comply with the provisions regarding inspection notice, plant access, compliance and rejection mentioned in API Spec. 5L. The Manufacturer shall give the Purchaser reasonable notice of the starting date of normal production and the work schedule. Any action or omission on part of Purchaser's Representative shall not relieve the Manufacturer of their responsibility and obligation to supply material in strict accordance with this specification.

9.8.1 Qualification of Personnel

All personnel performing NDT activities shall be qualified in the technique applied, in accordance with ISO 9712 or ASNT No. ASNT-TC-IA or equivalent.

For UT atleast level III qualified inspector shall be available to the mill for overall supervision. A level II inspector is required for shift supervision, manual weld inspection and calibration of all systems (both manual and automated).

A level I inspector is acceptable for all other NDT methods. A level II inspector is acceptable for supervision of all other NDT methods.

NDT for acceptance of the pipe (final inspection) shall take place after all heat treating and expansion operation and, for welded pipe after hydrostatic testing of the pipe. It may, however, take place before cropping, bevelling and end sizing.

9.8.3 Methods of Inspection

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

Refer a) Non-destructive inspection of welds in welded pipe shall be done after cold expansion, heat treatment, hydrostatic testing and straightening operation of pipe.

9.8.3.1 Pipe End Weld Inspection

Submerged arc welds shall be inspected over their entire length, for both longitudinal and transverse defects, using ultrasonic examination in accordance with (Section E). In addition, each end of the weld seam in SAW and SPW pipe shall be examined radiographically for a distance of at least 200 mm.

EW pipe welds shall be examined for longitudinal defects over their entire length by ultrasonic methods in accordance with E.5. Pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment. After beveling, the complete circumference of both the pipe end shall be tested ultrasonically from the inside for laminations. This inspection shall cover a width which includes the entire bevel. Alternatively the pipe may be tested from the outside prior to beveling in which case a band of atleast 25mm. wide, to include the eventual beveled area, shall be tested. If ultrasonic testing has not been performed from the outside before cutting and if ultrasonic testing from the inside is not feasible because of dimensional limitations, then magnetic particle or dye penetrant shall be applied to the bevel face.

9.8.3.3$_{New}$ Lamination Detection

Each plate or skelp rolled shall be ultrasonically inspected for laminations using an oscillating scanning pattern. The scanning coverage using this technique shall be a minimum of 12.5%. Alternatively, the scanning shall be executed along straight, evenly distributed parallel lines with a scanning coverage of atleast 25%. Coils for EW pipe may be tested after welding of the longitudinal seam by rotary ultrasonic testing of the pipe body. The coverage in this case shall be 100 %

In addition, the longitudinal edges of the skelp shall be 100 % ultrasonically tested, over a width of atleast 25mm from the trimmed plate / skelp edge. This may be performed either before or after pipe forming. For EW pipe subjected to 100% rotary ultrasonic testing of the pipe body, strip edge testing is not required.

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

9.8.3.4$_{New}$ Seamless pipe

Ultrasonic lamination testing of each seamless pipe body shall be performed using a helical pattern with at least 25 % scanning of the pipe surface.

Ultrasonic thickness testing of the pipe body and ends of seamless pipe shall be performed by scanning along a helical or straight pattern in such a way that at least 10% of the pipe surface is covered.

The body and ends of all seamless pipe shall be 100% ultrasonically tested for inside and outside surface defects as well as transverse, longitudinal and inclined embedded defects.

EMT may be applied for nominal wall thickness less than 6 mm.

9.8.4 Radiological Inspection – Weld seams of SAW Pipes

9.8.4.1 Radiological Inspection Equipment

The radiographic examination shall be executed with X-ray equipment using fine-grain type film (e.g. Gevaert type D7 or equivalent) and lead intensifying screens.

For acceptance of the radiographic films, the technique used shall result in sensitivity better than 2% of the thickness of the weld metal and in a relative film density of 2.0 to 3.5 in the weld metal.

The manufacturer shall record on a review form accompanying the radiograph and disposition of the pipe inspected.

9.8.5 Ultrasonic and Electromagnetic Inspection

9.8.5.1 Equipment

The automatic ultrasonic equipment shall incorporate:

1. A device which monitors the effectiveness of the coupling.

In the case where a zero degrees compression wave probe is used to monitor coupling, or where a through transmission technique is used for seamless or HFW pipe, loss of coupling exists when the sensitivity

(echo height) decreases by more than 10dB relative to the static calibration.

In case where a through transmission technique through the weld seam is used for SAW linepipe, loss of coupling exists when the signal drops below the electronic noise level plus 10 dB at the position of the through transmission signal.

A clear acoustic warning system and an automatic paint spray system (or equivalent) shall be activated when loss of coupling occurs.

2. The equipment shall be fitted with an automatic paint spraying device, or equivalent system, which is activated when the received ultrasonic echo exceeds the present acceptance limit. This alarm shall operate without any interference of the ultrasonic operator and shall be applied within 25 mm advancement past the detected defect. The reset time of the alarm system, after detection of a defect, to be again available for detection shall be shorter than the time needed for 25 mm advancement in the scanning direction.

3. An automatic weld tracking system for correct positioning of the probes / crystals with respect to weld centre of all welded pipe.

Entrance angles of shear wave probes shall be as follows:

Seamless pipe	: 45 (40-48) deg.
EW pipe	: 45 – 70 deg.
SAW and SPW pipe longitudinal defect detection	: 45 (40-48) deg. (on weld bead)
SAW and SPW pipe transverse defect detection	: 50 – 70 deg. (X or K transmission)

Lamination testing may be performed in pulse echo or transmission mode; wall thickness only in pulse echo mode. The probe(s) used for wall thickness / lamination check should satisfy the following requirements:

- Twin crystal probes	: The focal length should be 50% of the wall thickness

- Single crystal probes
  in be better pulse echo mod : The near surface resolution should be 25 % of the wall thickness, measured at the primary reference sensitivity level.

The transducer arrangement shall be such that the sound intensity in both the longitudinal and circumferential directions does not decrease by more than 3 dB at any point in the pipe wall; referred to the maximum sound intensity adjusted in the static calibration.

The equipment arrangement shall be checked with an applicable reference standard (test piece) as described in (section 5) at least every four hours and at the beginning and end of a batch in order to demonstrate the effectiveness of the inspection procedures and show that the equipment is functioning correctly.

In case of discrepancies of more than 3dB occur, then all pipes inspected since the previous check shall be re-inspected. Proper functioning of the UT equipment and the linearity of the electronic instrumentation shall be checked at least once every six months of if a change is made to the equipment.

From each pipe under test, an automatic "on-line" record shall be made without operator intervention. For every pipe, a summary record shall be made showing pipe identification number, time and examination results, including re-examinations.

If parts of the ultimate pipe ends are not covered by an automatic UT system (untested area), manual ultrasonic shall be carried out using approved procedures for manual ultrasonic examination based on the requirement given above.

The complete circumference of seamless pipe ends or rotary tested HEW pipe ends shall be tested manually over the length of the untested area plus 25 mm overlap of the automatically tested area.

9.8.5.1.1 (New) Electromagnetic Equipment

If permitted by the Purchaser, EMT methods such as eddy current testing or magnetic flux leakage testing may be applied for surface defect detection in seamless pipe.

EMT shall be performed in accordance with ASTM F 309 or ASTM E 570. Testing shall be performed by automatic equipment over the entire surface of the pipe.

If parts of the ultimate pipe ends are not covered by an automatic EMT system (untested area), then manual ultrasonic shall be carried

out using approved procedures for manual ultrasonic examination based on the requirements given above. The complete circumference of the pipe ends shall be tested by manual UT, over the length of the untested area plus 25 mm overlap of the automatically tested area.

9.8.5.2 Ultrasonic Inspection Reference Standards

The reference standard (calibration pipe) shall have the same specified diameter and wall thickness as the pipe being inspected and shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in normal production. The reference standard shall also be of the same material, type and have the same surface finish and heat treatment as the pipe being inspected. It shall be free from discontinuities or other conditions producing indications that may interfere with detection of the reference reflectors. The reference standard shall contain notches N5 or N10 Radially drilled holes 1.6 mm or 3.2 mm as applicable.

The manufacturer may use a type of reference reflector not specified above, provided he can demonstrate to Purchaser that the examination is at least as sensitive as prescribed in this specification. In such cases, the manufacturer shall obtain approval from Purchaser.

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

Examination type	Type of pipe		
	SMLS	SAW/SPW	EW
Lamination detection	FBH 6.3 mm	FBH 6.3 mm	FBH 6.3 mm
Surface defect detection	Notch N5		
Defect detection Body and Pipe Ends	Notch N5		
Defect Detection Welds		Notch N5 and RDH 1.6 mm	Notch N5 and RDH 1.6 mm
Defect Detection Plate and Axial Defect		Notch N5	

For all reference reflectors except for RDH 3.2 mm, the acceptance limit signal shall be equal to the primary reference sensitivity level i.e., equal to the height of the signal produced by the reference reflector. For the RDH 3.2 mm reference reflector, the acceptance limit shall be 10 dB below the primary reference sensitivity level.

All sensitivity adjustments shall be done dynamically.

Flat bottomed holes for lamination detection shall be drilled to mid-wall position.

9.8.5.4 Acceptance Limits

Following also shall be noted

For all examination types, indications exceeding the acceptance limit signal are unacceptable.

For lamination detection in plate / coil, seamless pipe body and pipe ends, the acceptance limits shall be based on the lamination size and frequency and be in accordance with the classification SEL – 072 as described below or as per BS 5996.

Location	SEL-072 Lamination Acceptance Levels
Plate / Coil body	Table 1. Class 3
Plate / Coil edges	Table 2. Class 1
Seamless pipe body	Table 1. Class 3

9.8.6 Magnetic Particle Inspection

Defect depth is 5% instead of 12.5% and shall include bevel edges also.

9.8.6.2 Equipment

Following also to be noted

MPT shall be performed in accordance with the requirements of ASTM E 709.

Prior to the inspection, the surface to be examined and all adjacent areas within 25 mm shall be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil or other extraneous matter that could interfere with the examination.

9.8.7 Residual Magnetism Measurement Requirements

Residual Magnetism shall be carried out after completion of all NDT and shall not exceed more than 20 gauss measured by using Hall Effect Gauss meter and measurement shall be made and recorded on each end of the selected pipe minimum three pipes per shift.

c. All residual magnetism measurements shall be recorded.

9.9 Disposition of Pipe Containing Defects

Following shall also be noted

In all cases where grinding repairs are made as a result of imperfections being disclosed by NDT, the part of the pipe containing such repairs shall be subjected to additional NDT using the same technique, and MT, after the grinding operation.

9.10 Test Methods

9.10.4 Charpy Test

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

9.12 Retests

9.12.1 Recheck Analysis

Modalities of recheck analysis shall be as per API Spec. 5L as applicable to the lot being tested (Refer clause 9.2.2.1). However during individual testing each pipe shall be fully analysed to meet the requirements of Table 5 of this specification.

9.12.6 Charpy Retests

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

9.13. Reprocessing

This para stands cancelled.

10. MARKING

10.1 General

Marking specified in API paragraphs and otherwise specified in the Purchase Order shall be in English language and international system (SI) of units. Marking shall also include API Monogram, Purchase Order Number, item No., pipe number, and heat No and weight.

10.2 Location of Markings

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

10.3 Sequence of Marking

10.3.4 Specified Dimensions

Actual pipe weight in kg shall also be marked.

10.3.5 Grades and Class

A colour code band shall be marked on inside surface of finished pipe if specified for the Grade, in API 5L. The colour code band shall be 50 mm wide and shall be marked at a distance of 150 mm from the pipe ends. The color shall be as recommended by API 5L Specification.

10.5 Length

Actual length shall be marked in metres.

10.7 Die Stamping

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

11. COATING AND PROTECTION

11.1 Coatings

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

12 DOCUMENTS

12.1.2 PSL 2 Certification requirements

The manufacturer shall furnish to Purchaser a certificate of compliance including the requirements of SR 15 (Appendix F, SR 15)

The certificate shall comply with ISO 10474 type 3.1.c. for tests witnessed by the Purchase, type 3.1.c. certificate shall be issued.

12.2 Retention of Records

In addition to the records indicated in API 5L para 13, the Manufacturer shall retain the records of all additional tests mentioned in this specification including the hard copy records of ultrasonic testing carried out on pipe / skelp as well as pipe ends.

12.3 (New) Production Reports

The Manufacturer shall provide three copies of production report in English language indicating atleast the following for each pipe. International system of units (SI) shall be adopted.

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

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

- All test certificates mentioned in clause SR 15.1.
- Certified reports of dimensional, workmanship and defects inspection.
- Data on test failures, rejected heats/ lots, etc..
- Information on production and shipping.
- All other reports and results required as per this specification.

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

In the event of small quantities of pipes supplied against this specification the production report may consist of only test certificates required as per SR 15 of API Spec. 5L and other test reports/ results required as per this specification.

12.4 (New) Line Pipe Tracking Data

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

- All marking information.
- Date of skelp and pipe manufacture.
- All mechanical properties from test results.
- All dimensional records.
- All workmanship and defects inspection records.
- Final inspection and release date.
- Description and disposition of repair.
- Load-out/ dispatch date.
- Destination.
- Consignment details.

13. PIPE LOADING

Manufacture shall prepare and submit the loading diagram which detail how the pipe is arranged, protected and secured on trucks, barges or ocean going vessels. All relevant loading calculation shall be submitted to the purchaser as a part of Manufacturing Procedure Specification (Refer Annexure I of this specification).

14. INSPECTION OF FIELD TEST AND WARRANTY

(New)

Purchaser shall be reimbursed by Manufacturer for any pipe furnished on this order that fails under field hydrostatic test if such failure is caused by a material / manufacturing defect in the pipe. The reimbursement cost shall include pipe, labour and equipment rental for finding, excavating, cutting out and installation of replaced pipe in position. The field hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 90 percent of specified minimum yield strength.

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

APPENDIX – B REPAIR OF DEFECTS BY WELDING (NORMATIVE)

B.1.2 Weld Seam of Welded pipe

Delete existing clause and replace with the following:

a) Repair of the weld seam or heat treated region of EW pipe is not acceptable.

b) Repair of the weld seam of SAW pipe is not acceptable within 300 mm of the bevel ends.

c) The nature of any weld defect indicated by non-destructive inspection shall be ascertained before any repair is performed. Where necessary, complementary ultrasonic and radiographic inspections shall be carried out to characterize the defect. Repair welding to rectify pipe welds containing crack is not permitted.

d) Repairs to the weld seam shall be limited to three per pipe. The length of repair weld shall not exceed 5% of the total weld length on each pipe.

e) Weld repairs shall not be carried out after cold expansion or hydrostatic testing of a pipe

f) Repair welding shall be executed only after specific approval by Purchaser Representative for each repair.

g) No repair of repaired weld is permitted.

h) The repair weld shall be performed with a minimum of two passes.

B.2 Procedure for Repair by Welding of Seamless Pipe and Parent Metal of Welded pipe

Delete existing section and replace with the following:

Repair welding on seamless pipe and parent metal of welded pipe is not acceptable.

B.3 Procedure for Repair of Submerged Arc and Gas Metal Arc Welds

B.3.1 The defective part of the weld shall be clearly marked on the pipe so that the defect can be easily located and repaired.

B.3.4New Repair welding shall be executed using qualified procedures and in accordance with the requirements of Appendix C.

The repaired area shall be non-destructively tested by RT, manual UT and MT.

B.3.5New The manufacturer shall also maintain a record of repairs carried out. The records shall include number, pipe identification number, welding procedure applicable and NDT details.

B.4 Procedure for repair of Electric and Laser Weld repair welding of EW weld is not acceptable.

APPENDIX-C REPAIR WELDING PROCEDURE (NORMATIVE)

C.2 Repair Welding Procedure Qualification

C.2.2 Mechanical Testing

C.2.2.3 Transverse Guided-Bend Test

The radius of male member of the jig used for guided bend tests shall be RA = 2.25t, where't' is specified wall thickness of pipe.

C.2.2.5New For all pipes where fracture toughness test is specified, Charpy V-Notch impact test as specified shall be included in the Repair Welding Procedure Qualification.

C.2.2.6New Hardness test as specified in para 6.2.6 of this specification shall be included in the procedure qualification. The location of the hardness measurements is to be indicated taking into account the new HAZ of the repaired area.

APPENDIX – F SUPPLEMENTARY REQUIREMENT SR 5

SR5 FRACTURE TOUGHNESS TESTING (CHARPY V-NOTCH) FOR PIPE SIZE NPS 2 OR LARGER

SR 5.1 The Manufacturer shall perform Charpy V-notch test for determination of Shear Area and Absorbed Energy.

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

SR 5.4 Impact testing shall be carried out using 10 x 10, 10 x 7.5 or 10 x 5 mm cross section specimens. The largest possible shall be used. Where the nominal pipe dimensions are insufficient to extract a 10 x 5 mm specimen, impact testing is not required.

For pipes of DN 150 or less, impact test specimens shall be taken parallel to the axis of the pipe (i.e. longitudinal specimens shall be taken)

For pipes greater than DN 150, impact test specimens shall be taken transverse to the axis of the pipe, except where the wall thickness prevents extraction of a 10 x 5 mm specimen, in which case longitudinal specimens shall be taken.

For weld centerline and HAZ impact tests, only transverse specimen shall be used.

SR 5A Shear Area

SR 5A.1 Three transverse specimens representing one test shall be taken from one length of pipe per inspection lot. Inspection lot shall be 100 pipes per heat.

SR 5A.2 Unless specified otherwise in the Purchase Order, the specimen shall be tested at $+32^0$ F (0^0 C). The average shear value of the fracture appearance of three specimens shall not be less than 75 percent and the all heat average for each order, per diameter, size and grade shall not be less than 80 percent.

NOTE: The acceptance criteria of shear area as referred in API Spec. 5L para SR 5A.3 SR 5A.4 and SR 5A.5 stand modified based on above mentioned requirements. Wherever 'heat' indicated in API Spec 5L SR5 A.3, SR 5A.4, SR 5A.5 and SR 5A.6 shall be replaced by 'lot'. Lot shall be as per SR 5A.1 as above.

SR5B.2 One set of three specimens shall be taken from the mid-thickness location in the pipe wall at the following positions:

Seamless Pipe : Pipe Body

SAW Pipe :
- Pipe body at 90 degrees to the weld
- Weld Centerline
- Fusion line
- Fusion line + 2 mm
- Fusion line + 5 mm

HFW :
- Pipe body at 90 degrees to the weld
- Weld centerline

SR5B.3 Delete existing and replace with the following

The maximum absorbed energy requirements for full size (10x10) specimens taken transverse to the pipe axis are given in the following table:

Grade	Minimum Average Value (J)	Minimum Individual value (J)
Gr. B	27	22
X 42	27	22
X 46	32	24
X 52	36	27
X 56	39	29
X 60	41	31

For other specimen sizes and orientations, the values above shall be multiplied by the following factors:

Size	Orientation	Factor
10 x 10	Longitudinal	1.5

10 x 7.5	Transverse	0.75
10 x 7.5	Longitudinal	1.125
10 x 5	Transverse	0.5
10 x 5	Longitudinal	0.75

The shear area at the fracture surface of the test specimens shall be recorded. Each sample shall exhibit not less than 50 % of fibrous shear.

APPENDIX-F SUPPLIMENTARY REQUIEMETNS (NORMATIVE) SR 6

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

SR 6.1 Fracture toughness for pipe sizes 16" and larger, all grades, and wall thickness shall be determined by Manufacturer using Drop Weight Tear Test (DWTT) in accordance with the requirements of Annex G

SR 6.2 Two transverse specimens shall be taken from one length of pipe per inspection lot. Inspection lot shall be 100 pipes per heat. Unless specified otherwise, the test shall be conducted at 00 C.

Full transition curves shall be established for one hat out of ten, with a minimum of one.

SR 6.4 At least 80% of the heats shall exhibit a fracture appearance shear area of 75% or more for the specified test temperature.

Note: Acceptance criteria for retesting indicated in API Spec 5L clause stands modified based on above mentioned requirements. Wherever 'heat' indicated in API Annex.G shall be replaced by 'lot'. Lot shall be as per SR 6.2 as above.

APPENDIX-F SUPPLEMENTARY REQUIREMENTS (NORMATIVE) SR 17

SR17 NON DESTRUCTIVE INSPECTION OF WELDS IN ELECTRIC WELDED PIPES

SR 17.1 **Supplementary Non-Destructive Inspection**

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

SR 17.2 **Equipment and Reference Standards**

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

SR 17.3 **Acceptance Limits**

If during production repeated ultrasonic indications occur requiring re-inspection by other methods and it appears that the nature of defects causing ultrasonic indications cannot be definitely established, the Manufacturer shall prove by other inspection

methods (such as making cross-sections as per para 6.2.6.1 of this specification) that these defects are not injurious defects as stipulated in this specification.

SR 17.4 **Disposition**

Disposition of defects shall be in accordance with API 5L. Annex E10 (c) or (d)

APPENDIX-F SUPPLIMENTARY REQUIREMETNS (NORMATIVE)

SR 19

SR 19 Additional Fracture Toughness Requirements (Transverse Charpy V-Notch) for PSL 2 pipe

SR 19.1 Except as allowed by SR 19.2 of API Spec 5L, fracture toughness testing shall be performed in accordance with the requirements of para 9.3.5.1 and 9.3.5.2 of API Spec 5L and as modified in this specification, with a test temperature of 0^0 C. The required minimum all heat average full size absorbed energy value for body specimen shall be the greater of SR 19.1 (a) and SR 19.1 (b) of API Spec 5L. The required minimum average full size absorbed energy value of weld and HAZ specimen shall also be the greater of SR 19.1 (a) and SR 19.1 (b) of API Specification.

APPENDIX - H

PURCHASER INSPECTION (NORMATIVE)

H.4 Rejection

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

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

H.5 NEW The manufacturer shall engage M/s DET NORSKE VERITAS (DNV) as Independent Third Party Inspection Agency. The scope of M/s DNV shall include Review of Manufacturing Procedure Specification, Inspection Test Plan, Witness First Day production and testing, Monitor regular production, Witness of all destructive testing (Mechanical, Impact, Metallographic and Chemical), Minimum 30% Witness of NDT of weld seams, Skelps / plates, Ends inspection, Hydrotests etc.., 100% Radiography, where applicable. The scope of inspection shall also include other tests as per the technical specification, API 5L and other applicable codes. All the charges towards all kinds of tests and Inspection charges of M/s DNV shall be included in the quoted rates. No additional payment to this effect will be made.

H.6 NEW Mahanagar Gas Limited (MGL), reserves the right to engage their own personnel and or MGL's Inspection agency over and above that stated at H.5. All the charges towards all kinds of tests shall be included in the quoted rates. No additional payment to this effect will be made. The charges towards MGL's Inspection agency, if engaged, shall be borne by MGL.

ANNEXURE - I (New)

MANUFACTURING PROCEDURE SPECIFICATION

A Manufacturing Procedure Specification (MPS) outlining the successive steps and associated inspection procedures from steel making to finished line pipe shall be prepared and submitted to Purchaser for approval prior to start of production. Manufacture of pipes shall start only after the approval

of Manufacturing Procedure. The approved Manufacturing Procedure shall be strictly followed in all phases of the production of pipes.

The manufacturing procedure shall as a minimum include the following information.

- Project Specific Quality Plan and Inspection Plan for entire manufacturing process for plates / coils and final product.

- Steel / skelp maker and plant at which steel is produced.

- Steel making process with details of secondary refining process and continuous casting process nominal weight of each heat.

- Target chemistry, range of intentionally added elements, limits on heat and product analysis to be placed on steel maker.

- Skelp rolling procedure indicating number of passes, their temperature and thickness reduction in each pass required by Controlled Rolling Procedure and the finishing temperature.

- Heat treatment procedure document established as per para 5.4.

- Ultrasonic testing of skelp and pipes using automatic and manual equipment including details of equipment, techniques, scanning pattern, no. of probes, sketch indicting probe arrangement, probe frequency, extent of probe coverage, scanning sensitivity, reference standard for calibration, dynamic calibration procedure, method of marking defects and indicating loss of coupling, inspection and recording.

- Pipe making procedure including skelp edge preparation, forming, flash trimming and any other special process proposed.

- Production welding procedure giving details of welding speed, current and voltage, welding temperature, heat treatment temperature etc, alongwith welding equipment details with the integrated control system.

- Ultrasonic testing of weld seam of pipe using automatic equipment including details of equipment, techniques, scanning pattern, no. of probes, type of probes, sketch indicating probe arrangement, probe frequency, scanning sensitivity, reference standard for calibration, dynamic calibrations procedure, extent of weld length at pipe ends not covered by all probes, method of marking defect and indicating loss of coupling, inspection and records.

- Weld tracking equipment details

- Pipe no / pipe tracking procedure including traceability to final product

- Dimensional workmanship and defects - tolerances, frequency of checking measurement and record in a tabular form including details of instruments and equipments proposed.

- Detail of techniques proposed for measurement of end square ness and peaking at the welds.

- Hydrostatic testing including details of testing equipment, procedure and the relevant test pressure calculations.

- Marking details

- Handling, storage and shipment procedure including loading diagram and loading calculations.

- Production Report Formats

- Complete details of computerized pipe tracking system

- Procedure for preparation of Final data book including contents

- The welding procedure for production and repair welding of SAW / SPW

- First Day Production and Production testing requirements schedule with type of test / frequency of testing and acceptance values.

NOTE: In the event of small quantities of pipe ordered against this specification, the requirements of submission of manufacturing procedure details can be moderated subject to agreement between Purchaser and Manufacturer.

ANNEXURE - II (New)

FIRST DAY PRODUCTION TESTS

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

These first day's production shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser's representative. The first day production tests shall be carried out on pipes for each wall thickness, each diameter and each grade of steel.

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

Note: In the event of small quantities of pipes ordered against this specification, like those for bends and other similar applications, as specifically called out in the purchase order, the first day production test shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

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

a. Visual Examination

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

b. Ultrasonic Examination

The weld seam of all pipes shall be examined ultrasonically.

c. Radiographic Examination

The weld seams of all SAW Pipes shall be radiographically examined throughout their full length in accordance with sections 9.8.4 to 9.8.4.9

d. Mechanical properties

The mechanical properties of all pipes shall be tested and shall meet the requirements of the relevant sections of this specification. Purchaser will select the places in pipe where the test specimens shall be removed.

The following tests shall be conducted.

i. Two flattening test specimens shall be removed; one specimen shall be tested with weld at 0^0 and other at 90^0.

ii. Two transverse base material specimens and two transverse weld test specimen for tensile test shall be tested. In case it is not feasible to obtain transverse specimen longitudinal specimen may be taken.

iii. Six weld cross-section specimens shall be taken at equally spaced points along the pipe length. They shall be polished and etched to show the metallurgical structure.

Two of these specimens shall be tested for hardness at room temperature after light etching. Manufacturer shall propose alternate scheme of location of six specimens which ensure similar coverage for checking the weld quality.

For SAW pipes, this examination shall provide evidence that proper fusion has been obtained throughout the full thickness of the joint, the extent of interpretation and the alignment of internal and external weld passes. For EW pipe, this examination shall provide proof that heat treatment of the weld zone has been adequate.

iv. Three fracture toughness test specimens shall be taken from pipe transverse to pipe axis out of base metal at 90^0 from weld and tested at specified temperature. Both shear and absorbed energy values shall be determined.

Three weld specimens shall be removed perpendicular to and across weld with V-notch in the middle of the weld and shall be tested at the same specified temperature. The specimen shall be according to para SR 5.4 of this specification.

v. Two reverse bend test specimens shall be removed and tested.

vii. At points selected by Purchaser, 12 DWTT specimen shall be removed from base metal in a transverse direction. The sets of 3 base metal specimen shall be tested at -40, -10, 0 + 20^0 C for shear area. The value at the specified test temperature mentioned in SR 6 of this specification shall be used to evaluate the test.

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

f. In case of any test failure, no retesting shall be allowed and the entire first day production shall be rejected.

ANNEXURE III (New)

INFORMATION TO BE FURNISHED AT THE TIME OF BIDDING

The following information as applicable shall be furnished at bid stage with respect to line pipe to be supplied.

- Name(s) of proposed manufacturer(s)

- Authorization letter(s) from manufacturer(s) where applicable.

- Authorization letter(s) from manufacturer(s) of skelp , in case of skelp manufacturing facility is not an integral part of the Supplier's pipe mill.

- Record of similar supplies made earlier by the manufacturer for both skelps and pipes, giving complete details of diameter, thickness, length, grade of plate / pipe, service, year, name of project, name of client and contact person.

In particular details of similar supplies made in last five years shall be furnished.

- Descriptive technical catalog(s) of the proposed manufacturer(s) clearly indicating the mill capacity, existing range of production, facilities at pipe mill, etc.

Pipe manufacturing facilities / equipment details viz.

- Welding system having integrated control as per Cl.5.1
- Heat treatment facilities as per Cl.5.1
- Automatic ultrasonic testing for skelp, pipe body and weld as per Cl.9.8.5
- Copy of valid certificate of Authority to use API monogram as per clause 1.2 of this specification
- A clause wise list of technical deviations, if any, from the requirements of this specification shall be furnished in the proforma enclosed with the enquiry. Deviation indicated anywhere else in the offer shall not be considered valid. In case of no deviations, Bidder shall write "NO DEVIATIONS" in the said proforma.

EXCEPTIONS AND DEVIATIONS

PROJECT : CITY GAS DISTRIBUTION PROJECT
CLIENT : MAHANAGAR GAS LIMITED
BIDDER : _____

EXCEPTIONS AND DEVIATIONS TO SPEC. NOS. MGL/ENG/STEEL/SP 04 R1

BIDDER may stipulate here exceptions and deviations to technical Specifications, if considered unavoidable.

SL. NO.	CLAUSE NO. OF SPEC.	DEVIATION	REASON FOR DEVIATION

_____

BIDDER'S SIGNATURE

NOTE:

1. ANY EXCEPTIONS / DEVIATIONS EXPRESSED OR IMPLIED ANYWHERE ELSE IN THE OFFER SHALL NOT BE CONSIDERED VALID.

2. BIDDER SHALL ENDEAVOR TO AVOID TAKING ANY TECHNICAL DEVIATIONS. BIDS WITH MAJOR TECHNICAL DEVIATIONS ARE LIABLE TO BE REJECTED.

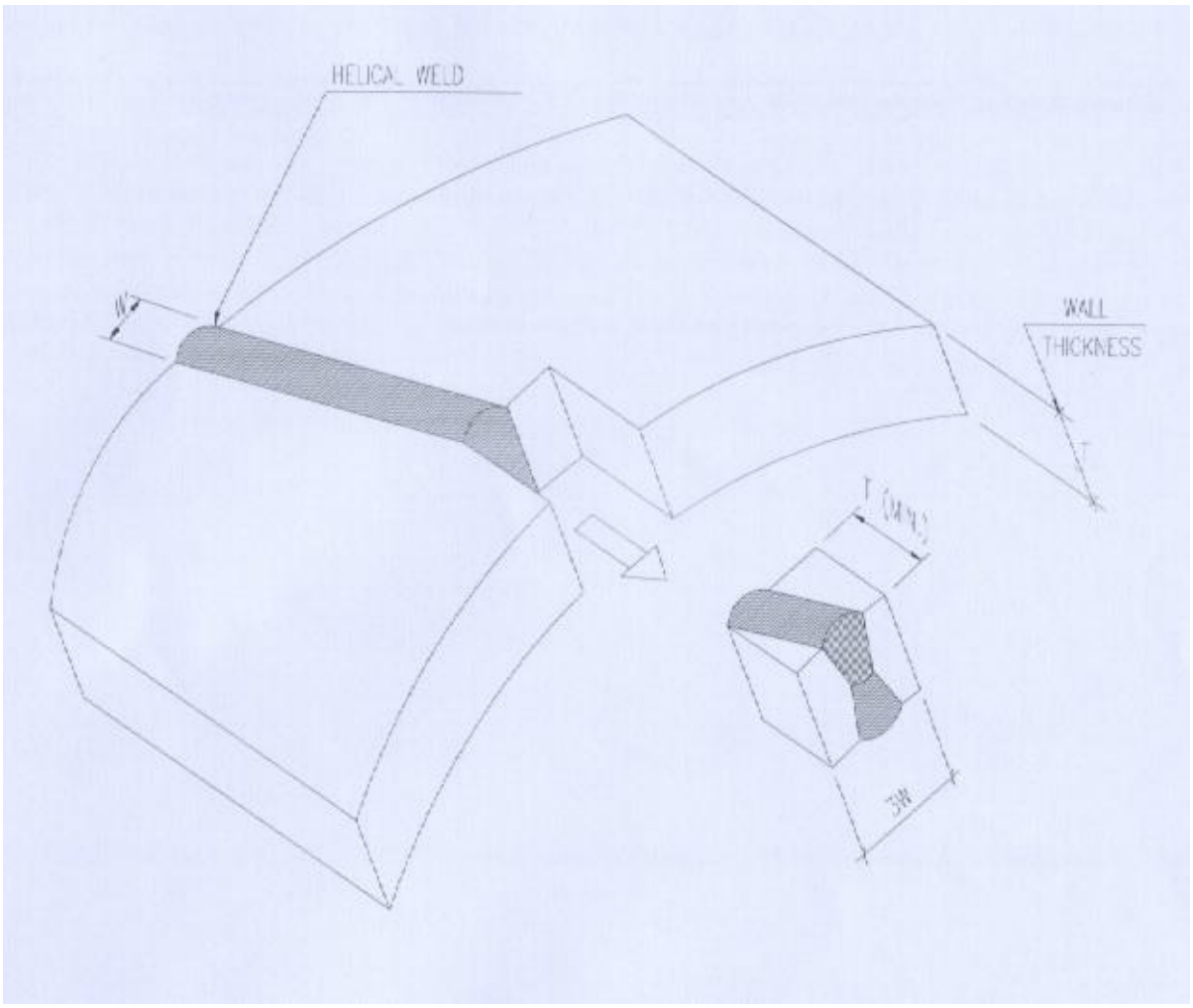

FIGURE 6.2.6.1

METALLOGRAPHIC SPECIMEN EXTRACTION PLAN

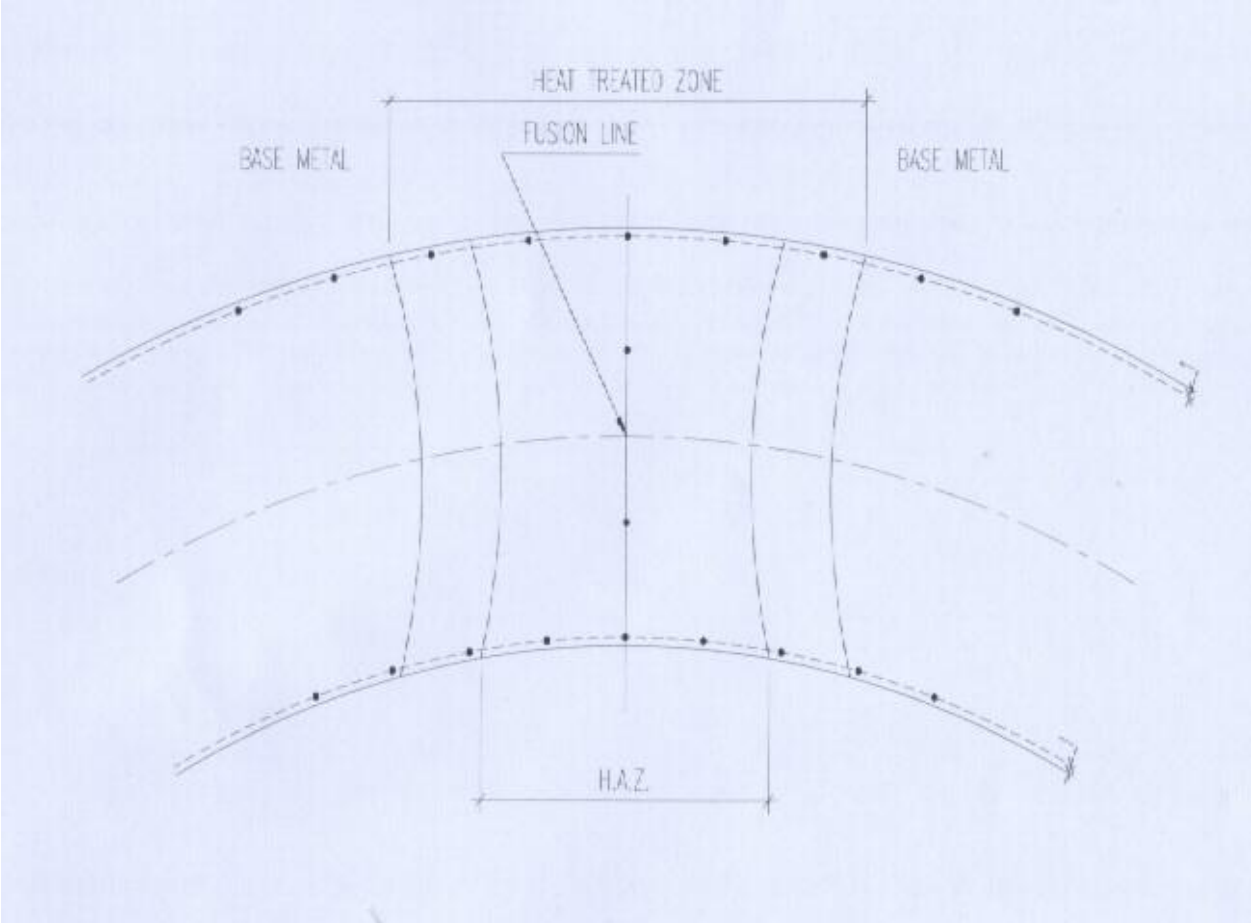

FIGURE 6.2.6.2(a)

——●——LOCATIONS WHERE HARDNESS MEASUREMENT TO BE CARRIED OUT

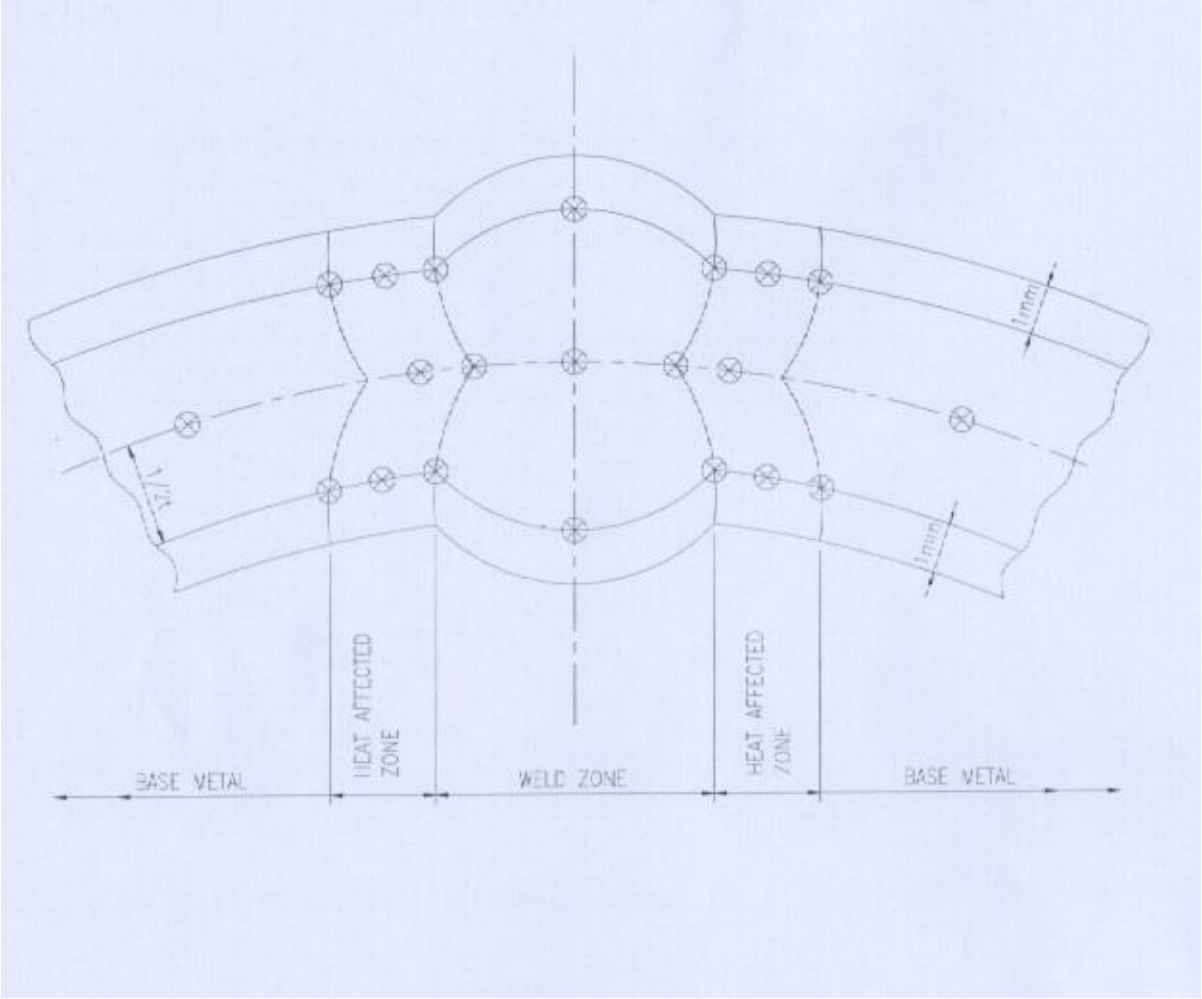

FIGURE 6.2.6.2(b)

LOCATIONS FOR HARDNESS MEASUREMENT

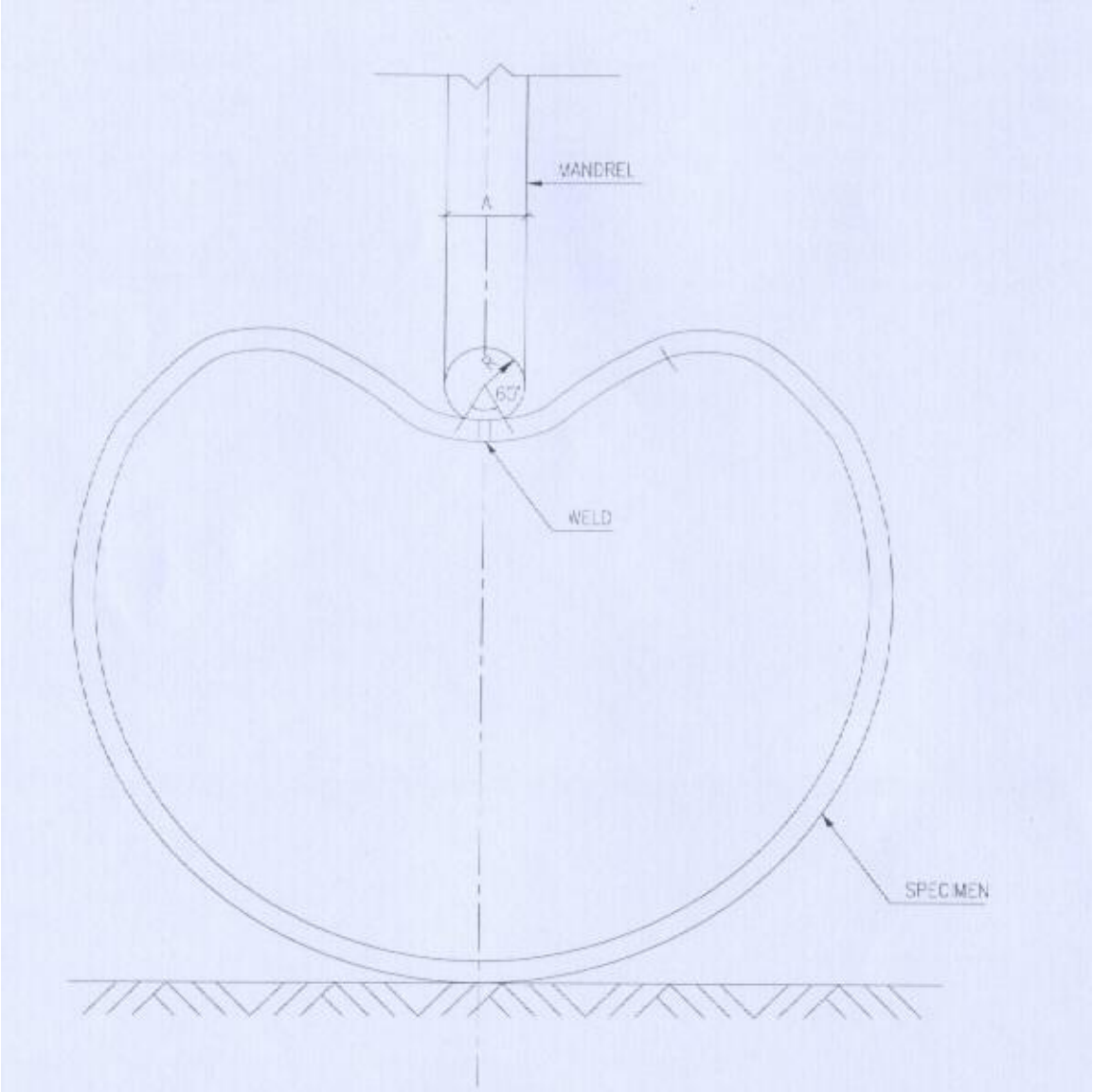

FIGURE 6.2.7

REVERSE BEND TEST SPECIMEN

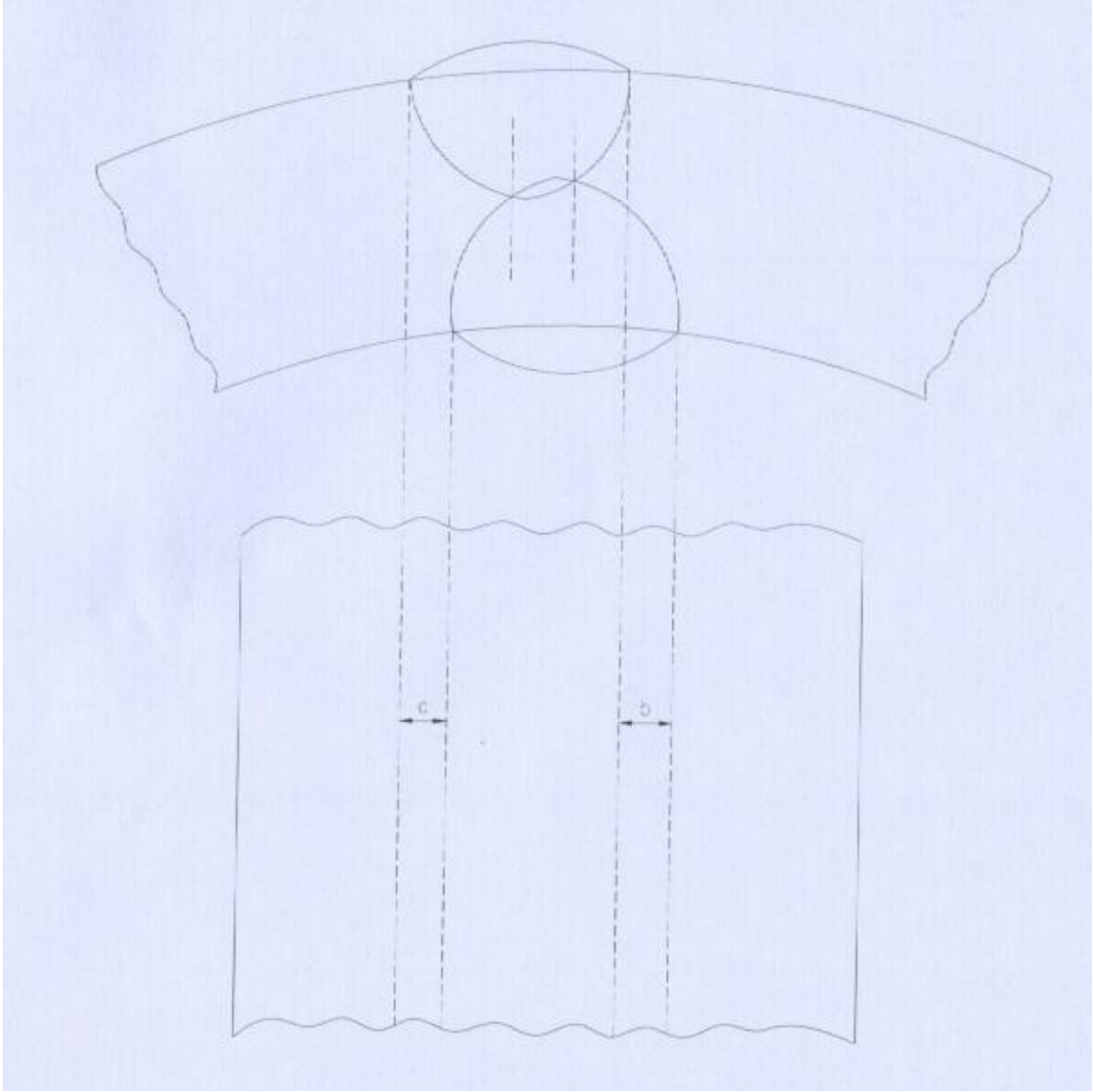

FIGURE 7.8.3

X-RAY FILM
PROCEDURE FOR MEASUREMENT OF OUT OF LINE WELD BEAD

Mahanagar Gas Ltd

MGL/ENG/STEEL/SP 07

TECHNICAL SPECIFICATION FOR 3 LAYER PE COATING ON BARE CARBON STEEL PIPES

CONTENTS

Mahanagar Gas Ltd

MGL/ENG/STEEL/SP 07

TECHNICAL SPECIFICATION FOR 3 LAYER PE COATING ON BARE CARBON STEEL PIPES

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for supply/arrangement of all materials, plant, equipment, plant sites, consumables, utilities and application including all labor, 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.

The Design temperature range shall be 5^0 C to 65^0 C.

In case of conflict between the requirements of this technical specification and requirements in the standards / specifications, the requirements of this specification along with purchase order conditions shall govern.

2.0 REFERENCE DOCUMENTS

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

a)	ASTM D-149	:	Standard Test Methods of Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Frequencies.
b)	ASTM D-257	:	Standard Test Methods for D-C Resistance or Conductance of Insulating Materials.
c)	ASTM D-543	:	Standard Method of Test for Resistance of Plastics to Chemical Reagents.
d)	ASTM D-570	:	Standard Method of Test for Water Absorption of Plastics.
e)	ASTM D-638	:	Standard Method of Test for tensile properties of plastics.
f)	ASTM D-792	:	Standard Test Method for Specific Gravity and 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 50049	:	Certificates on Material Testing
r)	DIN 53735	:	Testing of Plastics: Determination of Melt Index of Thermoplastics.
s)	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)
t)	ISO 9001	:	Quality Systems: Specification of production and installation
u)	ISO 11124	:	Preparation of Steel Substrates Before Application of paints and Related Products
v)	SIS 055900	:	Preparation of Steel substrates before Application of Paints and Related Products –

			Visual Assessment of Surface Cleanliness
w)	API 5L	:	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 CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the coating plant to all persons concerned with carrying out the works specified in this specification.

3.0 PLANT SCALE AND INSTALLTION

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

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

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

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

3.5 The CONTRACTOR shall at its own expense provide a fully equipped laboratory and test facilities and 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.

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

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

3.8 The contractor shall have established HSE Policy and management system and responsible for implementation of system by dedicated team at yard or site.

3.9 The Contractor shall have established Quality Management System and all works shall be under the responsibility of dedicated Project QA / QC Team at yard or site.

3.10 The contractor shall have established Project store management system at coating yard / site

4.0 MATERIALS

4.1 The three layer coating system shall comprise of a powder epoxy primer, Polymeric adhesive and a Polyethylene topcoat. Coating materials shall be suitable for the service condition and the pipe sizes involved. The basic coating materials i.e. epoxy powder, adhesive and polyethylene compound shall have proven compatibility. The group(s) of compatible materials shall be pre-qualified and approved by COMPANY in accordance with provisions of Annexure I of this specification. CONTRACTOR shall obtain prior approval from COMPANY for the coating system and coating materials.

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

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

a. Epoxy Powder:

i. Gel Time

ii. Cure Time

iii. Moisture content

iv. Thermal Characteristics (Tg1, Tg2, ΔH)

b. Adhesive:

i. Specific Gravity

ii. Melt Flow Rate

iii. Vicat Softening Point

c. Polyethylene

i. Melt Flow Rate

ii. Specific Gravity

iii. Vicat Softening Point

iv. Moisture Content

v. Oxidative Induction Time

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

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

a. Name of the Manufacturer

b. Type of Material

c. Batch Number

d. Place and Date of Manufacture

e. Manufacturing Standard

f. Shelf Life/Expiry Date (if applicable)

g. Health, Safety & Environmental Instructions

h. Storage Instructions

i. 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 CONTACTOR at his expense.

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

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

5.0 **FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING**

5.1 The coating shall be able to withstand a maximum in service operating temperature of (+) 60^{o} C and shall conform to 'V' type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of at least $+80^{0}$ C, without impairing its serviceability and properties specified.

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

5.3 Properties

Properties of coating system and 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 here in below, the same may be accepted provided the test procedures and test conditions are more stringent than the specified.

5.3.1 Properties of Epoxy Powder and Adhesive

CONTACTOR shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirements and properties of coating system as

specified in para 5.1 and 5.3.3 of this specification respectively. Epoxy powder properties shall be as per CSA Z245.20.02 .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:

Sr No.	Properties	Unit	Requirement	Test Method
a.	Melt Flow Rate (190^0C / 2.16 kg)	g/10 min	1.0 min	ASTM D 1238
b.	Vicat Softening point	^{0}C	90 min	ASTM D 1525
c.	Specific Gravity	-	0.926 min	ASTM D 792

5.3.2 Properties of Polyethylene Compound

Sr. No	Properties	Unit	Requirement	Test Method
a.	Tensile Strength @ +25° C	N/mm^2	17 min	ASTM D 638
b.	Melt Flow Rate (190^0C / 2.16kg)	g/10 min	0.25 min	ASTM D 1238 or DIN 53735
c.	Specific Gravity @ +25° C	-	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 Resistively @ +25°C	Ohm-cm	10^{15} min	ASTM D 257
g.	Dielectric withstand, 1000 Volt/sec rise @ + 25° C	Volts / mm	30,000 min	ASTM D 149
h.	Vicat Softening Point	^{0}C	110 min	ASTM D 1525
i.	Elongation	%	600 min	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 220^0 C, Aluminum pan, no screen	Minutes	10 min	ASTM D 3895
k.	Environmental Stress Crack			

	Resistance (ESCR) (for F_{50}) •High Density, Condition "B"	Hours	300	ASTM D 1693
l.	Carbon black Content	%	2 min	ASTM D 1603

5.3.3 Properties of Coating System

Sr. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) - @ 20 +/- 5^0 C - @ 65 +/- 5^o C	Kg/cm	 8.0 min 5.0 min	Din 30670
b.	Impact Strength (Min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 KV)	Joules per mm of coating thickness	7 min	DIN 30670
c.	Indentation Hardness - @23+/-2^o C - @70 +/- 2^o C	MM	0.2 max 0.3 max	DIN 30670
d.	Elongation at Failure	%	300 min	DIN 30670
e.	Coating Resistivity(*)	Ohm-m^2	10^8 min	DIN 30670
f.	Heat Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of original value	DIN 30670
g.	Light Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of	DIN 30670

			original value	
h.	Cathodic Disbondment - @+65^0 C after 30 days - @+65^0 C after 48 hrs	mm radius of disbondment (**)	15 max 7 max	ASTM G42
i.	Degree of Cure of Epoxy - Percentage Cure, Δ H - Δ Tg	% ^{0}C	95 min +3 / -2	CSA Z 245.20 - 02(***)

(*) Test carried out in a reputed independent laboratory.

(**) 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.

5.4 The acceptable combination(s) of coating materials are given in Annexure I.

6.0 MEASUREMENT AND LOGGING

CONTRACTOR shall maintain records in computer using MS ACCESS database Software containing all the relevant data of individual pipe and pipe coating including pipe number, heat number, diameter, length, wall thickness, defects, coating number, pipe number, batches of materials, material balance, sampling, testing, damages, repairs, rejects and any other information that COMPANY considers to be relevant and required for all incoming bare pipes and COMPANY approved outgoing coated pipes as applicable.

Contractor's documentation shall be designed to ensure full traceability of pipe and coating materials through all stages of coating and testing. CONTRACTOR shall submit this information in the form of a report at the agreed intervals.

The above data shall also be provided in MS ACCESS format in Compact Disc(CD). The CONTRACTOR shall provide one computer terminal to COMPANY Representative for monitoring/tracking of the above. The CONTRACTOR shall also submit the material balance details to COMPANY for information at the end of each shift.

7.0 COATING PROCEDURE AND QULIFICATION

7.1 Alongwith the bid, CONTRACTOR shall submit, for COMPANY approval, a detailed report in the form of bound manual outlining, but not limited to, the following:

a. Details of plant(s), location(s), layout, capacity and production rate(s)
b. Details of the equipment available to carry out the coating works including surface preparation, epoxy powder application and its recycling system, adhesive & polyethylene extrusion, moisture control facilities available for coating materials.
c. Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.
d. 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.
e. Plant Organisation chart and availability of manpower including coating specialist.
f. Details of utilities/facilities such as water, power, fuel, access roads and communication etc.
g. Details of chemical pre-treatment facilities including process control and inspection equipment for phosphoric acid wash, de-ionised water wash and chromate wash.
h. Details of Final marking and traceability of coating / linepipes during various stages of coating activity.
i. Details of procedure qualification / repair procedure qualification tests.

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

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

a. Pipe inspection at the time of bare pipe receipt.
b. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile; methods of measurements and consumables.
c. Complete details of chemical pre-treatment viz phosphoric acid wash, de-ionized water wash, and chromate wash including product data sheets, health and safety sheets and manufacturer's recommended application procedure.
d. Pipe heating, temperatures and control prior to epoxy application.
e. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommended from manufacturer(s).
f. Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.
g. Quenching and cooling, including time and temperature.
h. Quality Assurance System, Quality Plan, Inspection and Test Plan and reporting formats, including instrument and equipment types, makes uses, etc.
i. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repair thereof including coating stripping technique.
j. Detailed of instrument and equipment calibration methods including relevant standards and examples of a calibration certificates.

k. Complete details and inventory of laboratory and equipment for procedure qualification and regular production.

l. Pipe handling and stock piling procedures.

m. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause 6.0 of this specification.

n. Complete details of test certificates for raw materials including test methods and standards used.

o. Test certificates from PE compound manufacturer for tests for thermal aging, coating resistively and aging under exposure to light. These test certificates shall not be older than three years.

p. Health, Safety and Environment plans.

q. Storage details of coating materials and chemicals.

r. Continuous temperature monitoring at various stages of coating.

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

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

A batch representing a normal production run, typically 10 pipes, shall be coated in accordance with the approved coating procedure and the coating operation witnessed by Company Representative. Out of these pipes, at least one pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers.

At least 5 (five) test pipes shall be selected by COMPANY Representative for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. All tests shall be witnessed by the COMPANY Representative. 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 Contractor shall qualify various procedures forming a part of coating operations as detailed subsequently.

7.4 Qualification of Procedures

7.4.1 Epoxy Powder Application & Recycling

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

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

7.4.2 Pipe Pre-heating

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

7.4.3 Surface Preparation

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

7.4.4 Chemical Pre-treatment

7.4.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash

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

7.4.4.2 Chromate Treatment

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

7.4.5 Coating Application

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

7.5 Qualification of Applied Coating

The FBE coating shall be visually inspected and shall be free from blisters, visual holidays, scratches or any other irregularities and shall have uniform colour and gloss and uniformity.

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

a. Degree of Cure

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

b. 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.

c. Adhesive layer Thickness

Adhesive layer thickness shall be checked at every one metre spacing at 3,6,9 and 12'O clock position The thickness shall comply with the specified thickness requirements.

d. Holiday Inspection

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

e. Adhesion Test

i. Adhesion Test 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.

Iii Additional test for FBE shall be carried out during Procedure Qualification –
Hot water resistance @ 80^0 C for 5 hours using a ring sample of 200 mm length from the PQT pipe and visual inspection shall not show no evidence of blistering or disbonding and shall show no failure of adhesion when tested as per Clause 7.5.1 e (ii)

f. 2.5^0 Flexibility Test

2.5^0 Flexibility test shall be carried out on the epoxy coated pipe at test temperature of 0^0 C. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245, 20-02, Table 4.

g. Cross-section & Interface Porosity Test

Cross section porosity and interface porosity tests shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply with CSA Z.245, 20-02, Table 4.

7.5.2 Tests on pipes coated with all three layers

a. Bond Strength:

Three test pipes shall be selected for bond strength tests. On each of the selected pipes, three bond strength tests shall be performed for each specified temperature i.e one at each end and one in the middle (or as far as practically possible due to pipe internal diameter limitations), 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.

b. Impact strength:

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

c. Indentation Hardness:

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

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.

e. Cathodic Disbondment Test:

CD tests shall be carried out for the total lot of test pipes having all three layers. One test shall be carried out for 30Days duration and other test for 48 hours duration shall be carried out as per Clause 10.11. The test shall comply with the specified requirement. In case of obtaining satisfactory test results for 30 days, for subsequent procedure qualification test for different pipe size with same coating material combination, an accelerated CD test (48 hours) is also acceptable in place of 30 days test and the test shall comply the specified requirement.

f. Holiday Inspection

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

g. Coating Thickness Measurement

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

h. Air Entrapment

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

i Degree of Cure

Epoxy film samples (min. 4 nos. equally spaced) shall be scraped from one coated pipe and samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Silicon coated sulphite paper shall be placed between epoxy layer & adhesive immediately after epoxy application, to ensure physical separation of epoxy and adhesive as well as to prevent contamination of epoxy with adhesive layer, at the location from where epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply with the specified requirements.

7.5.3 Inspection of all test pipes

All pipes shall be subject to the following inspections:

a. Surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test immediately after deionised water wash.

b. pH of pipe surface before and after phosphoric acid wash

c. Visual inspection of chromate coating, if applicable.

d. Visual inspection of finished coating cut back dimension, internal / external cleanliness, and sealing and bevel inspection.

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

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

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

7.8 The CONTRACTOR shall re-establish the requirement 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 specification.

- 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 materials manufacture.

- Every time the coating yard is shifted from one location to the other or every time the critical coating equipments (induction heater, epoxy spray system, extruder, etc) are shifted.
- Any change in line speed during coating application
- Any time when in COMPANY's opinion the properties are deemed to be suspect during regular production tests.

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

8.0 PIPE SURFACE PREPARATION

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

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

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

8.4 All pipes shall be preheated to a temperature of 65^{o}C to 85^{o}C or as per manufacturer's recommendation, prior to abrasive blast cleaning. The external

surface of the pipe shall be cleaned by 2 nos. dry abrasive blast cleaning units to achieve the specified surface cleanliness and profile. After first abrasive blast cleaning chemical pretreatment with phosphoric acid solution as per para 8.7 shall be carried out prior to second abrasive blast cleaning. However, at the option of the contractor, chemical pretreatment with phosphoric acid solution as per para 8.7 may be carried out after the second abrasive blaster. The abrasive blast cleaning unit(s) shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from pipe surface. The equipment used for abrasive blast cleaning shall meet the specified requirements and shall be free from oil, water soluble salts and other forms of contamination to ensure that the cleaning process is not impaired. Traps, separators and filters shall be checked for condensed water and oil at the start of each shift and emptied and cleaned regularly. During abrasive blast cleaning, the metallic abrasive shall be continuously sieved to remove "fines" and "contaminants" and the quality checked at every four hours. Abrasives used for blast cleaning shall comply with ISO-11124.

8.5 The pipe bevel area shall be protected from blast cleaning operation by suitable end caps to avoid damages to bevel ends. In addition 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 CONTRACTOR may link the pipes suitably together to prevent the entry of any short / grit into the pipe.

8.6 All pipes shall be tested for salt contamination after blast cleaning unit. One test shall be carried out at each end and at the center of each pipe. The acceptance criteria shall be 2 $\mu g/cm^2$. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations. Any pipe having salt contamination exceeding $2\mu g/cm^2$ 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.

8.7 Chemical Pre-treatment with Phosphoric Acid Solution

8.7.1 All pipes shall be provided chemical pre-treatment with phosphoric acid solution. 10% solution of phosphoric acid, Oakite 31/ 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminants. The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 75^0 C.

8.7.2 Phosphoric acid treatment shall be followed immediately by washing with de-ionised water. De-ionised water used shall conform to the following requirements:

Sl.No.	Properties	Unit	Requirement
a.	Turbidity	NTU	1 max.
b.	Conductivity	µmho / cm	5max
c.	Hardness	-	Nil
d.	Total Alkalinity as $CaCo_3$	mg/l	2 to 3
e.	Chloride as Cl^-	mg/l	1max
f.	Sulphate as SO_4	mg/l	1max
g	PH	-	6.5 to 7.5

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

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

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

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

8.7.4 After the de-ionised water wash, the pipe shall be dried with dry air and preheated to a temperature of 65^{o} to 85^{o}C

8.7.5 The salt tests shall be carried out after de-ionised water rinse. One test shall be carried out at one end of each pipe. The Acceptance criteria shall be 2µg/cm^{2}. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations.

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

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

8.9 All pipes shall be visually examined for presence of any short /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 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 suitable means (mechanical brush, high pressure air jets, by tilting of pipe etc.).

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

8.11 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 scared 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 and 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 which have damages repaired by grinding and have ground areas more than 50mm in diameter shall be re-blasted.

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

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

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

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

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

8.14 Chemical Pre-treatment with Chromate Solution

8.14.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically pretreated with a 10% strength chromate solution.

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

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

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

8.14.5 The CONTRACTOR shall ensure that the temperature of the substrate is maintained between 40^0 C and 80^oC and the chromate solution temperature does not exceed 60^0 or as recommended by the manufacturer

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

8.15 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
More than 80	2 hours
70 to 80	3 hours
Less than 70	4 hours

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

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

9.0 COATING APPLICATION

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

9.1 Pipe Heating

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

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 bluing or other apparent oxide formation) is not acceptable.

9.1.3 External surface of the pipe shall be heated to about 200^{o} C or within a temperature range (min to max) and in no case the temperature shall exceed 260 degree centigrade as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.

9.1.4 Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each 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.

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

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

9.2 Pipe Coating

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

i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150mm, unless otherwise specified.

ii Grafted co-polymer adhesive application by extrusion, minimum thickness 0.200mm .

iii. Polyethylene application by extrusion. Total thickness shall correspond to Standard "V" as per DIN 30670

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.

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

Pipe size (Specified Outside Diameter)	Minimum Coating Thickness (mm)

	Reinforced Type (v) special coating as per DIN 30670 – S – v
Upto 10¾" (273.1mm)	2.7
Over 10¾" (273.1mm) to below 20" (508.0mm)	2.9

Tolerance of + 50 Microns for epoxy / adhesive thickness is allowed.

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

9.2.4 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:

a. Satisfactory qualification of the reclaimed system during PQT stage
b. The proportion of the reclaimed power in the working mix does not exceed 20% at any one time.
c. The quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at para 5.3.1

9.2.5 Dry air, free of Oil and moisture shall be used in the coating chamber and spraying system and filter, 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^{o} C and this shall be monitored during the regular production.

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

9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed and within the window recommended by the manufacturer. The CONTRACTOR shall establish, to the satisfaction of the COMPANY Representative, that the adhesive is applied with the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The CONTRACTOR shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.

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

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

entrapment. The methods used shall be witnessed and approved by COMPANY.

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

9.2.11 Coating and / or adhesive shall terminate 120 mm(+) 20 / (-) 0 mm from pipe ends. The adhesive shall seal the end of applied coating. CONTACTOR shall adopt only mechanical burnishing for termination of the coating at pipe ends and surface shall be made free from any residual coating material on cut back area. Edge of the coating shall be shaped to form a bevel angle of 30^{o} to 45^{o}.

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

10.0 INSPECTION AND TESTING

10.1 General

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

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 seam weld (if applicable), adjacent to the cut-back at each end of pipe and within the body of the pipe. Also inspection of cut back and marking for correctness shall be for least one pipe per lot of 15.

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.

10.3 Coating Thickness

a. 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^2 per meter length of coated pipe, and the actual coating thickness does not drop more than 10% below the permissible minimum coating thickness at these locations. The frequency of thickness measurement as stated above shall be initially on every pipe, but may be reduced depending upon consistency of results, at the sole discretion of COMPANY Representative. Results of all measurements shall be recorded.

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

c. 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 CONTRACTOR's expense.

10.4 Holiday Detection

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

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

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

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

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

10.5 Bond Strength Test

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

b. The frequency of test for cut back portions shall be one pipe in every fifteen (15) & 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 the pipe. The system shall fail cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive. Disbondment / separation at epoxy to steel interface or epoxy / adhesive interface or adhesive / polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.

c. In case the test fails to comply with the specified requirement, the CONTRACTOR shall test the preceding and succeeding coated pipes. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during the shift shall be tested until the coating is proved acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at CONTRACTOR's expense.

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

10.6 Impact Strength

a. 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 shift depending upon consistently acceptable results at the sole discretion of COMPANY' s Representative.

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

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

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

10.7 Indentation Hardness

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

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

10.8 Air Entrapment Test

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

b. Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the edge of the coating to a 45^{o} angle and view with a microscope. Similar examination shall be done in the coating cut back area.

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

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

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

10.9 Degree of Cure

a. Epoxy film samples shall be removed from cut back portion of the coating pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Where applicable, Silicon coated sulphite paper shall be placed between epoxy layer & adhesive immediately after epoxy application, to ensure physical separation of epoxy and adhesive as well as to prevent contamination of epoxy with adhesive layer, at the location from where epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply the specified requirements.

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

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

10.10 Epoxy Layer Adhesion Test

a. Adhesion of epoxy layer shall be determined at ambient temperature by the " St Andrews Cross" method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30^{o} / 150^{0}. The epoxy coating shall resist disbondment form the steel when attempts are made to flick / lift the coating from the 30^{o} angle with a sharp knife.

b. Frequency of this test shall be three per shift ,one each at the start of shift,middle of shift and end of shift. The test shall be carried out at the cut back potion on the pipe from which the Degree of cure test has been carried out as per para 10.9 above:

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

10.11 Cathodic DisbondmentTest

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

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

c) In case the test fails to confirm to the specified requirement at the option of the CONTRACTOR, all pipes coated after the previous acceptable test shall be or the test shall be repeated using two additional samples taken form the same sample of the affected pipe.

When both retests conform to the specified requirement, the lot of pipe shall be accepted. When one or both the retest 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 striped, re-cleaned and recoated. COMPANY may consider a further retest program to determine whether any of the pipe meet the criteria for acceptance upon written request by the CONRTACTOR.

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

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

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

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

Under no circumstances any action or omission of the COMPANY's Representative shall relieve the CONTRACTOR of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plant unless authorized by COMPANY in writing.

11.0 HANDLING, TRANSPORTATION AND STORAGE

11.1 The CONTRACTOR shall be fully responsible for the pipe and for the pipe identification marking from the time of " taking over" of bare pipe from COMPANY until such time that the coated line pipes are "handed over" and /

or installed in the permanent installation as the case may be according to the provisions of the CONTRACT.

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

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

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

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

11.4 Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-abrasive / non-metallic materials. In this

case, pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings in prohibited. Forklifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber.

11.5 Bare / coated pipes at all times shall be stacked completely clear from the ground, at least 300 mm, so that the bottom rows of pipes remain free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. Bare /coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can, for example, consist of dry, germ free straw 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. CONTRACTOR shall submit calculations for COMPANY approval in this regard. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes.

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

11.6 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there as pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min.3 nos. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from

all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe. The inspector of the coating contractor shall clear every lorry before loading the pipes and proper records of the same shall be maintained.

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

CONTRACTOR shall strictly follow Manufacture'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 CONTRACTOR shall provide for a proper conditioning.

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

12.0 REPAIR OF COATING

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

All pipe leaving coating plant, shall have sound external coating with no holiday 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^2 or linear damage (cut) of less than 3 cm shall be repaired by stick welding using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2 mm and an area not exceeding 20cm^2 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 300mm 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 500mm 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, CONTRACOR 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 140mm 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 120mm.

Not withstanding the above, under no circumstances, if the 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 $\leq$ 100 cm^2 attributable to process of coating applications 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 CONTRACTOR .

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 CONTRACTOR shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from COMPANY prior to use.

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

13.0 MARKING

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

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

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

14.0 QUALITY ASSURANCE

14.1 The CONTRACTOR 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.

14.2 The CONTRACTOR shall have established a Quality Assurance Group within its organization that shall be responsible for reviewing quality system and ensuring that it is implemented.

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

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

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

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

15.0 Final Documentation (MDR)

The CONTRACTOR shall submit following documents & certificates in hard & soft copies as per the requirements.

- Approved Procedure and QA/QC plans.
- Material Batch certificates / Check test results
- Type certificates
- Coating Certificates
- Coating application qualification test records

- Pipe receipt inspection / MTC records
- Production records / Inspection records
- Repair procedure / Qualification records / Batch certificates
- Approved calculations for stacking of bare pipes / coated pipes
- Pipe traceability records and acceptance tally sheet
- Load out tally sheet / Packing list
- Instrument calibration records
- Manufacturer's certificate and guarantee certificates
- Final acceptance certificates from Company

Annexure I

Coating System / Material Prequalification

Coating material Manufacturers acceptable to Company are as follows:

Epoxy	:	BASF / Basepox Jotun 3M Dupont
Adhessive	:	BASF / Basell Borealis Dupont SK Corporation
Polyethylene	:	Novacorp BASF / Basell Borealis / Borogue SK Corporation

Bidders shall propose coating system(s) indicating specific grade of epoxy, adhesive and polyethylene manufactured by any of the above mentioned material Manufacturers and submit the details as per Table-I. The proposed coating system shall be capable of meeting the functional requirements and properties of coating indicated in this specification. The coating system must have been pre-qualified by the coating material Manufacturer, by actual application on 5 pipes and must have been successfully subjected to the tests as indicated in Table - 2.

In case the Contractor proposes any coating system (combination of epoxy, adhesive and polyethylene) that has been previously approved by Company, the above tests need not be carried out by the coating Manufacturer.

Although the 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 bidder.

Bidder shall ensure that adhesive as well as polyethylene is manufactured by the same Manufacturer (s). However, bidder shall use any other combinations, which are approved by EIL, subject to MGL's approval. Bidder shall furnish relevant back up documents for the same along with their bid.

Table – 1			
Coating System Data	Epoxy	Adhesive	Polyethylene Compond
Coating System Designation	Manufacturer's Name	Manufacturer's Name	Manufacturer's Name
Coating material combinations	Product Trade Name	Product Trade Name	Product Trade Name
Properties as per specification	Technical data sheets	Technical data sheets	Technical data sheets
Compliance of all properties	Lab Reports	Lab Reports	Lab Reports
Certificate of compatibility of proposed materials	Certificate of compatibility with Adhesive	Certificate of compatibility with epoxy and Polyethylene	Certificate of compatibility with Adhesive
Application procedure	Storage instructions	Storage instructions	Storage instructions
	Shelf life	Shelf life	Shelf life
	Safety data sheets and HSE instructions	Safety data sheets and HSE instructions	Safety data sheets and HSE instructions

Table – 2			
Sr.No.	Properties	Frequency	Applicable Requirement
1	Bond strength	5 pipes	Para 10.5
2	Impact strength	3 pipes	Para 10.6
3	Indentation hardness	5 pipes	Para 10.7
4	Elongation at Failure	3 pipes	Para 5.3.3(d) & 7.5.2(d)
5	Cathodic Disbondment	2 pipes	Para 5.3.3(h) & 7.5.2(e)[(2)]
6	Degree of cure	2 pipes	Para 5.3.3(i) & 10.9

			(a)
7	Coating resistivity	2 pipes	Para 5.3.3(e)[3]
8	Heat ageing	2 pipes	Para 5.3.3(f)[3]
9	Light ageing	2 pipes	Para 5.3.3(g)[3]

1) Test frequency for Procedure Qualification shall be as indicated in this table and the frequency indicated in the applicable paragraphs of the specific are not applicable
2) Two tests each on the selected pipes i.e. 30 days and 48 hours test shall be carried out on each test pipe
3) Previously carried out tests in an independent laboratory of national / international recognition on PE top coat are also acceptable