2X660 MW NTPC KHARGONE STPP
(PROPOSALNO. K-13)

TECHNICAL SPECIFICATION
FOR
CROSS COUNTRY MAKE UP WATER PIPING

OWNER: NTPC LIMITED

BHARAT HEAVY ELECTRICALS LIMITED
Project Engineering Management
Power Sector, PPEI Building
Sector-16A, Noida-210301

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SECTION-A

INTENT OF SPECIFICATION

1.00 INTENT OF SPECIFICATION

This specification is intended to cover the following Scope / activities and services in respect of Mild steel pipe with 3 layer polyethylene(3LPE) coated pipelines /Glass Fiber Reinforcement Plastics(GRP) pipe/Ductile iron(DI) pipe of adequate diameter between make-up water pump house outside plant at Omkareshwar dam to Raw water reservoir inside plant for NTPC Khargone STPP (2 X 660MW) proposed site of NTPC.

(a) Complete design, engineering, manufacturing & supply including shop fabrication, assembly, preassembly, shop testing/type testing and inspection at manufacturer's works.

(b) Packing, forwarding and transportation from the manufacturer's works to the site including unloading at port, customs clearance/port clearance, if any.

(c) Receipt, unloading, handling, storage, preservation and conservation of equipment/items at the site including taking delivery of Employer supplied equipment/items from site store, if any, for subsequent erection.

(d) All pipes & pipe fittings under the scope of supply in the package shall be manufactured/ shop fabricated and supplied to the site. No site fabrication of pipes, pipe fittings, headers and manifolds, bends, miter bends, elbows, tees, reducers/ expanders, caps and closures, plugs, sleeves and saddles, stubs and bosses and other similar fittings, ring joints, backing rings etc. are allowed.

(e) Performance and guarantee tests after successful completion of facilities.

(f) Furnishing of all commissioning spares as required for the successful pre-commissioning/ commissioning of the system and special tools and tackles. Furnishing of all mandatory spares on FOR site basis and handing over to NTPC stores, if any.

(g) The Bidder shall be responsible for providing all material, equipment and Services, specified or otherwise which are required to fulfil the intent of ensuring guaranteed performance operability, maintainability, safety and the reliability of the complete systems covered under this specification, irrespective of whether it has been specifically listed herein or not.

(h) It is not the intent to specify completely herein, all aspects of design and construction of equipment. Nevertheless, the equipment shall conform in all respects to high standards of

engineering, design and workmanship and shall be capable of performing continuously, safe and reliable commercial operation in a manner acceptable to the Employer, who will interpret the meaning of the specification, drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and or applicable international standard mentioned elsewhere in the specification.

(i) Before submitting the bid, the bidder should inspect and examine the site and its surrounding and shall satisfy himself regarding the existing facilities, nature of the ground subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No extra claim consequent on any misunderstanding or otherwise shall be allowed.

(j) In case of any deviation from this technical specification and Technical Requirements, the same shall be indicated in the schedule of deviations. In the absence of duly filled schedules it will be assumed that the bid strictly conforms to the specification.

SECTION-B

SUB SECTION I

PROJECT INFORMATION

PROJECT INFORMATION

2X660 MW KHARGONE STPP(PROPOSAL)		
1	**Owner**	NTPC LIMITED
2	**Location and Approach**	The proposed site is located near Selda village & Sanawad town in Barwah tehsil at a distance of about 105 Kms from Indore and about 30 Kms from Sanawad town in Madhya Pradesh. The site is approachable from Sanawad on Indore – Khandwa State Highway through PWD road. The road distances of proposed site from major cities/towns are as follows: Indore City : 105 Kms. Bhopal City : 290 Kms.
2.1	Nearest Railway Station	Nearest Railway Station is Sanawad on Indore – Khandwa Meter Gauge section.
2.2	Name Airport	The nearest commercial airports Indore & Bhopal are located about 105 Kms. & 290 Kms from site respectively.

Make up water requirement for the project shall be about 40 Cusecs. Narmada River is passing at approx 15 Kms (North) from proposed site. Two dams of Narmada Hydro Development Corporation (NHDC) on river Narmada {Maheshwar Dam (North - West) & Omkareshwar Dam (North East)} are located at distances of about 15 Kms and 45 Kms respectively.

Water is proposed to be drawn from Omkareshwar Dam, located at a distance of about 45 Kms. from site.

SECTION-B

SUB SECTION II

QUALIFICATION REQUIREMENTS (QR)

1.00 GENERAL QUALIFICATION REQUIREMENT

The Bidder should have supplied, engineered, erected (with Civil works) and commissioned of at least one (1) cross-country piping system of at least 3 Km. route length, consisting of steel pipes / Glass Fibre Reinforced Plastics (GRP) pipes / Ductile Iron (DI) pipes, of diameter500 mm NB / DN or above, which should have been in successful operation for at least one (1)year prior to the date of Techno-Commercial bid opening.

2.00 MANUFACTURER OF GRP PIPES

a). Manufacturer of GRP pipes should have manufactured and supplied Glass Fibre Reinforced Plastics (GRP) pipes of minimum 20 Km length in any continuous twelve (12) months prior to the date of Techno-Commercial bid opening, which includes GRP pipes of 80% of offered pipe size and/or higher size. At least 5 Km of GRP piping of 80% of offered pipe size and/or higher size supplied by Manufacturer of GRP pipes should be in successful operation for not less than one (1) year in one (1) cross-country / municipal piping system, prior to the date of Techno-Commercial bid opening.

3.00 MANUFACTURER OF DI PIPES

Manufacturer of DI pipes should have manufactured and supplied Ductile Iron (DI) pipes of minimum 20 Km length in any continuous twelve (12) months prior to the date of Techno-Commercial bid opening, which includes DI pipes of 80% of offered pipe size and/or higher size. At least 5 Km of DI piping of 80% of offered pipe size and/or higher size. Supplied by Manufacturer of DI pipes should be in successful operation for not less than one (1) year in one (1) cross-country / municipal piping system, prior to the date of Techno-Commercial bid Opening.

4.00 AMC IF GRP/DI PIPES ARE USED

Additionally, 2 years of annual maintenance contract (cost of which is to be included by the bidder in the package cost) from the date of commissioning for the GRP/DI piping system after commissioning is also to be performed to facilitate smooth operation of the relevant pumping systems without any repair and maintenance hassles suffered by the owner/employer.

For essential terms & conditions of AMC for GRP/DI pipes , refer Section –C1(Technical Requirement -Mechanical).

SECTION-C

SUB. SECTION-I

SCOPE OF WORK, SUPPLY CONDITION AND TECHNICAL PARAMETER OF MAKE-UP WATER PIPE LINE

1.00 SCOPE OF WORK

The Scope of makeup water piping system shall be as per "preliminary topographical survey of the make-up water pipe line corridor layout(all 12 sheets under Annexure-II of Section-E & Annexure 9 of Section- G and shall include the following:

a) Supply and laying of 2x50% capacity MS pipe with 03 LPE coated pipeline /GRP/DI pipelines of adequate diameter between make up water pump house outside plant at Omkeshwar dam to Raw water reservoir inside plant along with all bends, fittings with specified coating, joints with specified coating, instruments etc and cathodic protection system(in case of buried MS pipe).

b) BOM (along with fittings) of 2x50% make-up water lines (two nos.) which are about 45Km from Omkareshwar dam to raw water reservoir inlet shall be as per "preliminary topographical survey of the make-up water pipe line corridor layout(all 12 sheets under Annexure-II of Section-E & Annexure-9(plot plan) of Section- G.

As per Annexure- 10 of Section- G, P&ID (Dwg. No. PE-DG-K13-172-N101),2X50% make –up water line has to be interconnected at three places and the location of interconnection may be decided by bidder either by site visit or any other means. Also bidder shall consider manhole at 500m interval in makeup water line.

It is to be noted that for interconnection piping, valves & terminals, bidder shall consider flange ends with make- up water pipes.

c). ARV & Isolation valves are excluded from bidder scope but counter flanges are to be considered at pipe end.

d). manufacturing, supply, laying, erection, commissioning and hydro testing in line with Tech Spec. shall be done by the same agency. Additionally, 2 years of annual maintenance contract (cost of which is to be included by the bidder in the package cost) for the GRP/DI piping system after installation/commissioning is also to be performed by the same agency to facilitate smooth operation of the relevant pumping systems.

Further, anti- corrosive protection on inside/outside surfaces and cathodic protection system are not required In case of GRP/ DI pipes.

However, bidder shall clearly indicate the option of MS, GRP pipe, or DI pipe adopted in relevant sections of bid data sheets.

2.00 SUPPLY CONDITION

1. In case of any positive or negative variation in quantities, the price shall be adjusted proportionately on the basis of unit prices computed from the breakdown price. The breakdown price quoted shall be valid for price adjustment due to any variation in quantities so long as the consequential variation in total contract value remain + 30%.

2. The vendor shall ensure proper sequence of supply to meet project requirement and as directed by the employer. Payment for non-sequential supplies shall not be made by the employer.

3. Quantities given in the BOM are indicative only. Actual supplies shall be made based on approved drawings to be prepared by vendor based on employer's piping layout drgs.

4. In case supplier supplies pipes of thickness higher than specified, the payment shall be made only for the specified thickness & before using pipes of different thickness than specified by employer, specific approval for the same shall be taken from the employer.

5. No separate payment shall be made for fabrication of branch connections / fabricated Tees. For branch pipe the payment will be made for length measured upto outside diameter of main pipe.

6. Each piece/spool of pipe shall be provided with an identification mark showing service symbol and serial no. of the piece. All parts of supports/hangers shall be marked to identify the piping system to which they belong.

3.0 TERMINAL POINTS

a). Make-up water piping shall begin at the outlet of make-up water pump at Omkareshwar dam and terminate up to Raw water reservoir inlets inside Plant boundary.

b).For vent valves, bidder to provide tapping on every manhole with flange end.

4.0 TECHNICAL PARAMETER OF MAKE-UP WATER PIPE LINE

Suggestive pipe size for GRP/MS/DI pipe with design pressure and Aux. power consumption are mentioned below:

CASES	PIPE SIZE NB	PUMPS AUX. POWER(KW)			MS PIPE		GRP PIPE		DI PIPE	
		DI	CS	GRP	PIPE ODXTHK.	DESIGN PRESSURE (Kg./sq. cm)	PIPE ID	DESIGN PRESSURE (Kg./sq. cm)	PIPE SIZE NB	DESIGN PRESSURE (Kg./sq. cm)
Cases 1	1100NB	1172	1353	1147	1118X13	14.5	1100	12	1100	12
Cases 2	1000NB	1307	1605	1266	1016X14	17.5	1000	13	1000	13
Cases 3	900NB	1523	2006	1456	912X15.5	22	9000	15	9000	15.5
Cases 4	800NB	1966	2829	1846	813X19.5	32	800	19	800	20
Note: 01. Please note that ID incase of GRP is same as NB size 02. In case of DI pipe, OD & thickness shall be considerd as per std. IS:8329-2000. 03.Evaluation rate for Aux. Power is approx.Rs.2.8Lakh per KW.										

Bidder to estimate overall cost of supply, erection and CIVIL work etc. and add Aux. power loading as per data given above. Based on inputs furnished above, Bidder to specify the optimal size and clearly mention the pipe size & pipe material in the bid.

SECTION- C1 (MECH)

SUB SECTION- II

TECHNICAL REQUIREMENTS (MECHANICAL)

1.0 SPECIFIC TECHNICAL REQUIREMENT FOR GRP PIPING

i) The GRP pipes shall be designed as per the applicable codes AWWA-M-45/ ASTMD- 3517 / AWWA-C-950 / IS-12709 / IS-14402. Design calculations for selection of pressure class and stiffness class of GRP pipes against the applicable piping systems, considering the requirements of above mentioned standards shall be furnished for employer/owner's approval. The GRP pipes shall be manufactured by either CFW (Continuous Filament Winding process) or HFW (Helical filament winding process)

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ii) Pipeline shall be sized considering C value as 150 and velocity 2-4m/sec(as per guidelines of AWWA).

iii) GRP pipes shall not be used on land with expansive soil, high water table sections/marshy land/perennially water logged area or flooded area. GRP pipes should be laid always in dry soil as underground pipes, In water logged area MS pipes duly protected externally shall be used as usual. Water table should be well below (at least 500 mm below) trench bed.

iv) The manufacturing, supply, laying, erection, testing & inspection and commissioning shall be done by the same agency/sub-contractor. Bidder to ensure correct installation & proper quality trench bed as per IS Code 13916 before installation so as to make only one contracting agency responsible for any possible defect (like leakage through joints, excessive ovality or dislocation of joints & pipe spools) found in GRP piping during hydro testing / commissioning/ charging of system after erection. Improper installation methodology like poor trench bed, un compacted soil, substandard fill material, inadequate sand cushion/ earth cover etc. are not acceptable. Additional 2 years AMC contracts for the GRP piping system after installation/commissioning is also required to be given to the same agency to facilitate smooth operation of the relevant pumping systems without any repair and maintenance hassles suffered by the owner/Employer .

v) RCC thrust blocks are required to be constructed (common thrust blocks for all pipes) at the places of bends, tees & reducer. It is recommended to wrap a band of rubber around the pipe prior to placement of any concrete. Rubber should protrude(25 mm) from the pipe. It is always recommended to cast thrust blocks as laying progresses. Before the hydro test all thrust blocks should be completed. It is always recommended to have coupling on two edges when pipe comes out of thrust block. It is necessary that all joints before & after bend, including the pipe-to-bend AND bend-to-pipe also are unrestrained.

vi) GRP pipes should cross minor road/nallah through Hume pipes when buried GRP pipes are crossing roads & nallahs. Sand bags shall be put around GRP pipes within Hume pipe.

vii) For railway crossing and/or high way crossings of underground GRP pipes culverts or MS encased pipe with pushing technology should be adopted.

viii) All GRP pipes generally shall be joined with unrestrained sleeve couplings (Double REKA joint) or un-restrained double `O' ring bell-Spigot joints and thrust blocks are to be provided at each ends. For over ground piping, anchors are to be provided at reducers, branch offs, Tee-offs, expanders and terminal points of other suppliers apart from at points in straight run separated by an interval of 90 meters approx as per codes.

ix) Support span for above ground application is to be as per AWWA-M-45.

x) GRP pipes specified should have at least STIFFNESS CLASS OF 5000 N/m2 i.e. 248KPA to take care of uncertainties in various loading conditions in different terrains. However the actual stiffness class offered for the pipeline shall be based on design calculations as per AWWA-M-45 keeping the 248kpa stiffness class as minimum.

xi) Proper erection sequence is to be followed during installation of GRP pipes in underground trenches where multiple agencies are to work, else ground bed preparation is disturbed or compromised having adverse impact on GRP pipe performance. It is further advised that for future construction of any structure in the area, safe distance is to be kept from the pipe line, to avoid any collapsing / damage to trench or laid pipeline.

xii) Over ground installation , as discussed before, will be dictated by mid span deflection criterion/Axial stress criterion of AWWA and from practical experience varies from 2m to 6m support span depending on pipe size. Pipes are to be wrapped with elastomer sheets/rubber sheets before clamping on supports.

xiii) Minimum sand bed cushion of 300mm all around trench-laid underground GRP pipes (i.e. 300mm below invert level of trench, 300mm or more in trench profile on both sides and 300mm of top cover of sand over pipe crown). Excavated soil can be backfilled provided it conforms to IS, ASTM & AWWA specifications from 300 mm above pipe crown to the finished ground level.

Before providing sand cushion in trench bed, the raw earth bed in trench shall be maintained truly horizontal and finally sand filled bed should be compacted to achieve atleast 85% relative density.

Minimum earth cover required above pipe crown to avoid uplift of empty pipes is 1 meter or 1 time the diameter of pipe whichever is more.

Flooded trench condition shall be avoided as far as possible during erection of GRP Pipes. Suitable mitigation measures to prevent floatation of pipes like
a) dewatering
b) erection only after water level goes below trench bed by minimum 200mm.
c) backfilling with sand & soil above GRP pipe once pipe is jointed piece by piece.
d)Tack weld type lapping spot joints along the circumference between pipe pieces to be joined and laid in sequence thus making the empty piping heavier.

xiv) All joints shall be hydro-tested at site during erection or alternatively one can do hydro testing in stretches of suitable GRP piping length after joining a few no. of pipes/ fittings. Finally entire system shall be hydro tested at 1.5 times design pressure when erection is complete and pump charging has been done.

xv) Site lapping (butt jointing) of last joint during erection or repair butt-joint lapping shall be done at a de-humidified condition by skilled worker to ensure correct curing.

xvi) Fittings are to be generally made at works for proper curing and dimensional correctness.

xvii) Type test:

GRP pipe supplier shall carry out the following long term qualification tests (type tests):
a) Hydrostatic Design Basis (HDB) for 1000 Hrs
b) Long Term Ring Bending Test

However, in case pipe suppliers have already obtained the above long term qualification tests certificates duly approved by accredited third party agency (s) , the same are also acceptable
For other routine tests, relevant QA chapters may be referred as given elsewhere in specification.

2.00 SPECIFIC TECHNICAL REQUIREMENT FOR DI PIPE

i) DI GENERAL

This specification covers the specific requirement of design, material, manufacture /fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

ii) CODES AND STANDARDS

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage –specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

S.No.	Code No.	Code title
1.	IS 8329	Centrifugally cast(spun) ductile iron pressure pipes for water, gas and sewage – specification
2.	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage – specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods for sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing
15	ISO 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines -- Cement mortar lining
17	ISO 4633	Rubber seals -- Joint rings for water supply, drainage and sewerage pipelines – Specification for materials
18	ISO 8179	Ductile iron pipes -- External zinc-based coating -- Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes -- External zinc coating – Part 2: Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines -- Polyethylene sleeving for site application
21	ISO	Ductile iron pipelines -- Hydrostatic testing after installation

	10802	
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipes and fittings -- Seal coats for cement mortar linings
24	AWWA M 41	Ductile – Iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying & installation etc.)
25	BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods

iii) DUCTILE IRON (DI) PRESSURE PIPES:

a) Design Requirements
Pipeline shall be sized considering C value as 140 and velocity 2-3m/sec.

b) Classification:
The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

iv) Joints :

a) Generally push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

b) Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

v) DI FITTINGS & SPECIALS

Design Requirements:

a) Classification
The DI fittings shall be as per IS 9523 or equivalent international standard.

b) External layer:

The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

c) Internal lining:

The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

d) Joints between pipe and fittings:

Generally , Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

e) Rubber gaskets

All the DI fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard .

vi) TYPE TESTS

1)The contractor / manufacturer shall carry out the type tests as listed in this Specification on the pipes to be supplied under this contract.

2)The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

3)In case the contractor / manufacturer has already conducted such specified type test(s), he may submit the type test reports to the Employer during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise as deemed fit by Employer. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right towaive conducting of any or all the specified type test(s) under this contract.

4)The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

vii) THE FOLLOWING TYPE TESTS SHALL BE CARRIED OUT:

1) Joint Leak Tightness Test:

a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.

b)Tests for Leak tightness and mechanical resistance of flanged joints shall be Conducted as per ISO 2531.

2)Cement Lining Smoothness Type Test:

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the employer.

In case the contractor / manufacturer has not carried out the test, the same shall be carriedout by the contractor / manufacturer within the scope of this contract.

3)Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

viii) LAYING AND JOINTING OF DI PIPES:

1) Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced / procured.

For underground laying, Special provisions in trench shall be made for Accommodating socket (Bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

2) Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to Resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

ix) Hydraulic Testing Of Pipelines

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections. Water and other facilities as required for such hydro testing shall be arranged by the Contractor

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

xi) Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the

complete pipeline shall be carried out. This test shall be carried out at a pressure 1.5 times design pressure.

xii) DATA SHEET FOR DI PIPES, FITTINGS & SPECIALS

Sl.no.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint
2	Applicable standards		IS/ISO/AWWA/BS as listed in Technical specification
3	Hazen& william's constant		140
4	Pipe Class		K7 / K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint
6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicable) Pressure Class		. Compatible with system pressure requirement
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		Compatible with system pressure requirement.
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Other Requirements		As per technical specification.

3.0 PACKING & TRANSPORTATION OF GRP/DI PIPE

i).Bidder to submit a write up for safe handling and stacking of pipes during transportation and at site.

ii).Pipes to be properly stacked on wooden saddles with stoppers covered with rubber stick and nail to provide cushioning and shock absorption. Width, height and number of saddles to be determined depending of diameter of the pipe. The pipes should be lifted by means of the Nylon / Polyester Sling and lowered on to the runner whereby the entire length of the pipe is getting support from the wooden runner. Depending on the diameter of the pipes, 1 – 4 no of the pipes can be placed side by side on wooden runners and pipes should be strapped from both ends of the wooden runner which will ensure that the pipes do not move. The number of pipe layers to be decided based on pipe diameter & permissible height and 4Nos of wooden runners should be placed for each layer. Whole package is to be strapped with polyester/Nylon straps at two places before crimping with Aluminum seals.

iii).Smaller diameter pipes may be nested into bigger diameter pipes if the packages consist of multiple diameter pipes. To avoid any kind of abrasion, thick rubber padding shall be used between pipes strapped with nylon straps.

iv).Rubber gaskets, center registers, special fittings etc. should be wrapped in a Polyethylene bubble Sheet / Bag and sealed. For smaller sizes, all such items should be packed in a wooden box / crate and the inner surface of the wooden box should be lined with Bituminized Water Proof Paper Craft.

v).GRP pipes and fittings shall be prepared for shipment with the joining ends covered to protect from damage. The protection can be made of Covers or U-shaped profiles in plastic material wrapping with anti-shock and anti-abrasion plastic film or Wrapping with rubber tapes.

vi).Marking shall be provided on the boxes/crates indicating position of boxes for handling, storage & nature of consignment. The ink used for this purpose as well as for marking dispatch instruction shall be Non-Washable Marking Ink. The front and rear side of the boxes/crates/packing would carry the following details, duly stenciled in black paint.

a) Name & address of the consignee
b) Consignee P.O. reference no. and date
c) Port of delivery

d) Consigner name and address
e) Country of origin
f) Dimension of the box/crate/packing (mm)
g) Net weight (Kg)
h) Gross weight (Kg.)

vi).One copy of the packing list would be placed in a transparent polyethylene bag and nailed to the inside of the box/crate/packing.

vii). Another copy of the packing list also wrapped in a transparent polyethylene bag would be nailed to the external surface of the box/crate/packing.

viii). Each box/crate/packing will carry its separate identification number.

ix).In case of transport by ship, packing shall be sea worthy so as to ensure safe delivery till site.

4.0 SPECIFIC TECHNICAL REQUIREMENT IN CASE OF GRP/DI PIPE IS USED

TWO YEAR ANNUAL MAINTENANCE CONTRACT

The AMC for **GRP/DI** pipelines shall include the following: -

i) Round the clock monitoring of GRP/ DI pipe installation for any leakage / rupture / Damage of the pipeline, undue settlement of soil around the pipe / leading to overstressing of piping, any eventual accident causing damage to pipe & joints at site, etc.

ii) Repairing the damaged pipes / joints, replacing the damaged part of piping/ joints including fittings with new pipes / fittings wherever necessary, making good amaged or excavated bed & trench of GRP/DI pipe and restoring the trench bed to the original specified bed conditions.

iii) Recharging, testing and re-commissioning the entire GRP pipe/ DI pipe installation to the satisfaction of the employer.

iv) Arranging all material (temporary & permanent), manpower (including skilled & unskilled labour), machineries, testing equipment, fixtures, maintenance tools & tackles consumables etc. for repair, maintenance, re-erection/ re-commissioning of any or whole portion of GRP/ DI piping system.

Further, anti- corrosive protections on inside/outside surfaces of GRP pipes are not required.

DI pipes however shall have required internal cement mortar lining & external zinc Coat followed by finished bitumen layer as per applicable code specified. In case soil resistivity is very poor (less than 1000 ohm-cm) then polythelene sleeving in the affected stretch should also be provided for underground DI pipeline.

However, bidder shall clearly indicate the option of MS pipe or GRP pipe or DI pipe adopted in relevant sections of bid data sheets.

5.0 SPECIFIC TECHNICAL REQUIREMENT FOR MS PIPE

5.1 GENERAL

This specification covers the specific requirement of design, material, manufacture / fabrication, constructional features, inspection & testing, supply and delivery of spiral welded carbon steel pipes.

5.2 CODE AND STANDARDS

The design, manufacture, inspection and testing of MS water pipes shall comply with the latest BIS Standard (Indian Standard). IS: 3589 (Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter)) or Equivalent ASTM / API / DIN or any other International Standard unless otherwise specified elsewhere in this Technical Specification.

The equivalency of design standard proposed to be adopted by the Bidder/ Supplier with the specified Indian Standard (IS: 3589) shall be clearly brought out in the Bid by comparing the various parameters, process description etc.

5.3 DESIGN & MANUFACTURING REQUIREMENTS

i). The pipe shall conform to designation Spirally weld (SAW) Fe410 of IS: 3589 or Equivalent Standard.

ii). The pipe shall be manufactured by Submerged Arc welded process with Spiral seam welding as per IS: 3589 or Equivalent standard.

iii). The dimensional details & acceptable tolerances of the required pipes be as follows:

a) Bidder shall decide the Pipe Diameter considering the techno economics and corresponding thickness conforming to IS: 3589 or Equivalent design standard.

b) Tolerance on outside diameter and thickness shall conform to IS: 3589 or Equivalent design standard.

c) Random length of pipe to be supplied shall be 12 meters plus or minus 2 meters. (i.e.) 10 to14 M length.

e) Tolerance on Straightness of pipe shall not be more than 0.2 percent of length of each pipe.

f) The Ovality shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

iv). Both the ends of each pipe length of pipe shall be manufactured with bevel ends and shall be delivered with end protection covers.

v) They should be truly cylindrical of clear internal diameter specified, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

vi) All materials shall be new and procured directly from the manufacturers for this projects.

vii). All the pipes shall be coated with 3LPE coating except the bare pipe which shall be applied with a protective coat of red oxide primer or varnish externally to prevent rusting during the period of transportation & storage before the pipes are used for installation.

ix). Finally entire system shall be hydro tested at 1.5 times design pressure when erection is complete and pump charging has been done.

5.4 INSPECTION AND TESTING

i). All Material shall be tested as per relevant design standard.

ii). All the mechanical and chemical tests including optional tests if any as per the relevant standards shall be carried out and the test certificates for the same shall be submitted for Employer's approval.

iii). The hydraulic tests shall be conducted as per the piping standard (i.e.) IS: 3589 or Equivalent Standard

iv). Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as porosity etc. shall be repaired by gouge and re-welding.

5.5 TRANSPORTATION AND DELIVERY OF PIPES

i). All pipes fabricated in the factory and temporarily stacked in the bidder's yard or factory shall be transported to the Employer's storage site after shop testing & cleaning them internally. The loading in the factory shall be carried out by means of either a crane, gantry or with shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The equipments to be used for loading / unloading shall be as approved by the Employer or his representative.

ii). The material being delivered at site shall be jointly inspected by the Employer or his representative and the bidder and defective or damaged pipe shall be rejected by Employer or Employer may allow repair of the pipe to the satisfaction of the Employer or his Representative.

iii). Props of approved designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations.

iv). At Employer's storage site, pipes shall be stacked in such a way that suitable gaps shall be left in the pipes at intervals to permit access from one side to the other.

6.0 <u>SPECIFICATION FOR 3 LAYER POLYETHYLENE COATING (MAKE UP WATER SYSTEM)</u>

GENERAL

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

6.1 PLANT SCALE AND INSTALLATION

i. Bidder shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works.

ii. 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.

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

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

6.2 MATERIALS

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

ii). 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. Shelf Life/Expiry Date (if applicable)
f. Quantity

All materials noted to be without above identification shall be deemed suspect and shall be rejected by EMPLOYER. Such materials shall not be used for coating and shall be removed from plant site and replaced by Bidder at his expense.

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

6.3 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING

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

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

6.3.1 Properties

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

6.3.2 Properties of Epoxy Powder and Adhesive

Bidder 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 of this specification.

Epoxy powder properties shall be as per CSA Z245.20.98. The colour of epoxy powder shall be either green or dark red or any other colour approved by EMPLOYER except grey colour.

Copolymer grafted adhesive shall have the following properties:

Sl. No.	Properties	Unit	Requirement
a.	Melt Flow Rate (190°C/ 2.16 kg)	g/10 minutes	1.0 (min.)
b.	Vicat Softening Point	0 C	100 (min.)
c.	Specific Gravity	-	0.926 (min.)

6.3.3 Properties of Polyethylene Compound

Sl. No.	Properties	Unit	Requirement
a	Tensile Strength @ + 250 C	N/mm2	17 (min.)
b	Melt Flow Rate (190°C / 2.16 kg)	g/10 minute	0.25 (min.)
c	Specific Gravity	-	0.926 (min.)

	@ + 25 ° C		(MDPE) 0.941 (min.) (HDPE)
d	Hardness @ + 25 °C	Shore D	50 (min.)
e	Water Absorption, 24 hours, @ + 25 °C	%	0.05 (max.)
f	Volume Resistivity @ + 25°C	Ohm-cm	10^15 (min.)
g	Dielectric withstand, 1000 Volt/sec rise @ + 25 °C	Volts/mm	30,000 (min.)
h	Vicat Softening Point	0 C	110 (min.)
i	Elongation	%	600 (min.)
j	Oxidative Induction Time in Oxygen at 220°C, Aluminium pan, no screen	Minutes	10
k	Environmental Stress Crack Resistance (ESCR) (for F50) : -Medium Density-(Condition “C”) -High Density- (Condition “B”)	Hours	300 300
l	Carbon Black Content	%	2 (min.)

6.3.4 Properties of Coating System

Sl. No.	Properties	Unit	Requirement
a	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) @ 20 +/- 5°C @ 65 +/- 5°C	Kg/cm	8.0 (min) 5.0 (min)
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)

c	) Indentation Hardness . @ 23 +/- 2°C . @ 70 +/- 2°C	mm	0.2 (max) 0.3 (max)
d	Elongation at Failure	%	300 (min.)
e	Coating Resistivity	Ohm – m2	10^8 (min.)
f	Heat Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of original value
g	Light Ageing (*)	-	Melt Flow Rate shall not deviate by more than 35% of original value
h	Cathodic Disbondment . @ + 65° C after 30 days . @ + 65°C after 48 hrs	mm radius of disbondment(**)	15 max. 7 max.
i	Degree of Cure of Epoxy(***) . Percentage Cure, Δ H . Δ Tg	% ° C	95 +3 / -2

(*) Test for heat ageing and light ageing properties previously carried out in an independent laboratory of national/international recognition on PE top coat is also acceptable based on valid certificates in lieu of tests to be performed by the bidder.

(**) 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.

The combination of coating material indicated in Annexure-I is indicative only. Bidder can offer other proven combinations of coating material also. In any case the final combination shall be subject to employer's approval.

7.0 MEASUREMENT AND LOGGING

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

8.0 COATING PROCEDURE AND QUALIFICATION

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

a. 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.

b. 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.

c. Pipe heating, temperatures and control prior to epoxy application.

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

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

f. Quenching and cooling, including time and temperature.

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

h. Details of instrument a n d equipment calibration on methods including relevant standards and examples of calibration certificates.

i. Complete detail and inventory of laboratory and equipment for procedure qualification and regular production.

j. Pipe handling and stock piling procedures

k. Sample of recording and reporting formats, including laboratory reports, certificate and requirement as per relevant clause of this specification.

l. Complete details of test certificates for raw materials including test methods and standards used.
m. Health, Safety and Environment Plans.

n. Storage details of coating materials and chemicals.

o. Continuous temperature monitoring at various stages of coating.

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

Prior to start of production, the Bidder shall, at his expense, carry out a coating PQT for each pipe diameter on max. wall thickness, for each type of pipe, for each coating material combination, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in relevant clause of the specification, relevant standards, specifications and material manufacturer's recommendations.

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

9.0 Qualification of Procedures

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

ii). **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 EMPLOYER Representative.

iii). **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.

iv).**Coating Application**

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

10.0 PIPE SURFACE PREPARATION

i). Prior to cleaning operation, Bidder 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.

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

iii). All pipes shall be preheated to a temperature of 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blast cleaning units to achieve the specified surface cleanliness and profile.

The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. During abrasive blast cleaning, the metallic abrasive shall be continuously sieved to remove “fines” and “contaminants” and the quality checked at every four hours.Abrasives used for blast cleaning shall comply ISO-11124.

iv). 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 Bidder may link the pipes suitably together to prevent the entry of any short/grit into the pipe.

v). Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2 ½ of Swedish Standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns (RZ). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the

pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust andshape of profile. Degree of dust shall comply the requirements of I S O 8502 – 3.

Acceptance limit shall be either quality rating 2 or Class 2. Tape used for assessment of degree of dust shall comply IEC 454-2. Pressure shall be exerted on the applied tape using a 4 kg roller, prior to peeling-off to assess the degree of dust.

vi). At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The Bidder shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.
vii). The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half an hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below:

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

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

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

11.0 COATING APPLICATION

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

A).Pipe Heating

i).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.

ii). Induction heater or gas fired heating shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of induction heating, appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface.

This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of blueing or other apparent oxide formation) is not acceptable.

iii).External surface of the pipe shall be heated to about 190 °C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.

iv). 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 corerelate each line pipe. The monitoring instrument shall be able to raise an alarm / activate audio system (hooter) in the event of tripping of induction heater / gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected.
Such rejected pipes shall be stripped, re-cleaned and recoated.

v).Temperature me a s u r i n g & monitoring equipment s h a l l be calibrated twice every shift and/or as per EMPLOYER Representative's instruction.

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

B). Pipe Coating

a). 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 . 1 5 0 m m , unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.

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

iii. Polyethylene application by extrusion.

Minimum total thickness of finished coating shall be 3.0 mm.

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.

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

c).Dry air, free of oil and moisture shall be used in the coating chamber and spraying system. Filters, dehumidifier/dryer as required along with control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (–) 40°C and this shall be monitored during the regular production.

d). 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 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.

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

f). 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 and 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.

g). Bidder 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 EMPLOYER.

h). 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.

i). Coating and/or adhesive shall terminate 150 mm (+) 20 / (-) 0 mm from pipe ends. The adhesive shall seal the end of applied coating. Bidder shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.

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

12.0 HANDLING, TRANSPORTATION AND STORAGE

i). The Bidder 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 EMPLOYER shall approve such procedure prior to commencement of work.

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

iii). Bare / coated pipes at all times shall be stacked completely clear from the ground, atleast 300 mm, so that the bottom row of pipes remain free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. Bare / coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can be of dry, germ free straw covered with plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes.

Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. 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.

iv). The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.
All stanchions of lorries used for transportation shall be covered by non- abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe

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

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

vi). In case of any marine transportation of bare/coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. Bidder 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 employer 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.

13.0 REPAIR OF COATING

Bidder shall l submit to E M P L O Y E R , its m e t h o d s and m a t e r i a l s proposed to be used for executing a coating repair of the defects noticed after receipt at site and shall receive approval from EMPLOYER prior to use. In open storage the repair coating materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. 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:
i). Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm2 or linear damage (cut) of less than 3 cm shall be repaired by stick using material of same quality.

ii). Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2 mm and an area not exceeding 20 cm2 shall be rebuild by heat shrink patch only and without exposing to bare metal.
iii). Defects of size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrink repair patch by exposing the bare metal surface.

iv). Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500 mm shall be repaired using heat shrinkable sleeves of HTLP 80 or equivalent.

v). Pipes with bigger damage shall be stripped and recoated.

vi). In case of coating defect close to coating cut back, Bidder shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 140 mm of linear length of pipe then the coating shall be repaired by the use of heat shrink sleeves thereby making up the coating cut back length of 120 mm.

Notwithstanding the above, 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 ≤ 100 cm2 attributable to process of coating application shall be maximum one number per pipe.
- In addition to the above, defects to be repaired by heat shrink patch/sleeve shall be maximum 2 (two) per pipe.

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

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

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the EMPLOYER Representative. In any case the Bidder shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from EMPLOYER prior to use.
All repairs shall result in a coating thickness no less than the parent coating thickness.

14.0 MARKING

Bidder shall place marking on the outside surface of the coating at one end of the coated pipe, and marking shall indicate, but not limited to the following information:
a. Pipe number, Heat number
b. Diameter & Wall thickness
c. Coated pipe number
d. Colour band
e. Any other information considered relevant by EMPLOYER.
f. Pipe Manufacturer Name
g Inspection Mark/Punch

Bidder shall obtain prior approval on marking procedure to be adopted from employer.

15.0 LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

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

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

Although the above combinations is indicative only. The responsibility of suitability for application, performance, properties and compliance to the coating system requirements shall unconditionally lie with the CONTRACTOR

16.0 SPECIFICATION FOR EXTERNAL COATING FOR SPECIAL SECTIONS, CONNECTIONS & FITTINGS OF BURIED STEEL PIPELINES (3LPE COATED PIPE- MAKE UP WATER SYSTEM)

16.1 General:

Special sections, miter bends, tees, connections, fittings in buried steel pipeline network Shall be coated externally, with prefabricated polyolefin tape coating as per AWWA C 209- The Contractor shall perform all work in accordance with these specifications and the latest pipeline coating practices, and shall complete the work in all respects to the full satisfaction of the Owner / Owner's Representative. The entire coating operation starting from cleaning and surface preparation till coating shall be performed under the supervision of skilled personnel who are well conversant with the work. Pipes which have been cleaned and primed, or cleaned,

primed and coated, without having been inspected and approved shall be rejected.

This specification is not intended to be all inclusive and the use of guidelines set forth here does not relieve the Contractor of his responsibility for the quality and performance of the applied coating system, and to supply coating material capable of performing its intended service.

16.2 Referenced Standards:
The following standards (latest revision) referenced below are a part of this specification. In case of conflict between this specification and the referenced standards, this specification shall apply.

(a) ANSI/AWWA C209 - Standard for Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

(b) ANSI/AWWA C214 - Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines

(c) SSPC-SP I - Solvent Cleaning

(d) SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning

16.3 General:
The buried steel pipeline special sections shall be protected with hand or manual machine applied cold applied tape protective coating conforming to AWWA C209 - 00 (Cold Applied Tape Coating Systems for Exterior of Steel Water Pipelines).
Protective coating shall consist of a coating system consisting of primer, inner - layer tape and outer-layer tape.
Work or material that fails to conform to this standard may be rejected at any time before final acceptance

16.4 Coating system:

The pre-fabricated polyolefin tape coating system shall consist of the following layers to provide an applied coating system thickness of 100 mils (2.5mm) on the exterior of the special sections of steel pipes.

1. A liquid adhesive layer.

2. An inner-layer tape for corrosion protection having thickness of 30mils and applied with 50% overlap

3. An outer-layer tape for mechanical and UV protection having thickness of 20mils and applied with 50% overlap.

16.5 Liquid Adhesive layer:

The liquid adhesive layer shall consist of a mixture of suitable rubber and synthetic compounds and solvent. The liquid adhesive layer shall be brush applied to the abrasive blasted prepared

pipe surface before application of the inner-layer tape.
The function of the liquid adhesive is to provide a bonding medium between the pipe surface and the inner-layer tape.

The liquid adhesive shall be supplied by the manufacturer that supplies the innerlayer tape. The liquid adhesive shall not settle in the container forming a cake or sludge that cannot be easily mixed by hand or mechanical agitation and it shall have good machine-application properties.

Table I - Physical Properties of the Liquid Adhesive

Color	Base		Weight	Flash Point
Black	Rubber and Synthetic Resins	Flammable	6-8 lb/gal (0.72 – 0.965g/l)	-10oF (-17oC) or greater
		Non flammable	10 – 12 lb/gal (1.20– 1.44 kg/l)	None

16.6 Inner-layer tape:

The inner-layer tape shall be a two-layer tape consisting of a polyolefin backing layer with a laminated butyl-based adhesive layer. The inner tape shall be compatible with the liquid adhesive. The manufacturer shall certify that the backing material shall be polyolefin only,containing not more than 3.5 percent, by weight, of non-polyolefin material consisting of carbon black and antioxidants. The inner-layer tape shall be applied after the liquid adhesive and before the outer-layer tape.

The backing and adhesive shall be made from materials that provide high electrical resistivity, resistance to corrosive environments, low moisture absorption and permeability, and shall provide an effective bond to a primed steel surface. The inner-layer tape shall be of material that will resist excessive mechanical damage during normal application operations and shall be sufficiently pliable for the intended use. The inner-layer tape shall withstand, without tearing, the tensile force necessary to obtain a tightly wrapped inner coating free of voids. The inner-layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of 38mm.

The thickness of the inner tape shall be 30mils.

To ensure a proper smooth coating by hand or by manual hand wrapping machine, the inner-layer tape shall be provided in standard widths of 4” or 6” as per manufacturer recommendations consistent with the pipe diameter.

16.7 Outer-layer tape:

The outer-layer tape shall be a two-layer tape consisting of a polyolefin backing layer with a laminated butyl adhesive layer. The manufacturer shall certify that the backing material shall be polyolefin only containing not more than 3.5 percent, by weight, of non-polyolefinic material consisting of pigments, antioxidants and stabilizers. Theouter layer shall be compatible with the inner-layer tape The primary function of the outer tape layer is to provide mechanical protection to mechanical and outdoor weathering (UV) protection to the tape system, and secondarily, to contribute to the overall corrosion-protection properties of the system. The outer-layer tape backing shall be compounded so that it will be resistant to outdoor weathering.

The outer-layer should be of suitable quality for the local environment, as follows:

Storage Temperature : 0 to 500C.
Over-ground Condition : 0 to 600C.
Under-ground Condition : 70C to 350C.
Ultraviolet-ray Protection : Required in outer layer.

Materials used in the outer-layer tape shall have high electrical resistivity, low moisture absorption and permeability, and shall provide mechanical protection during handling and outdoor storage. The outer-layer tape shall be sufficiently pliable for normal application operations by hand or by manual hand wrapping machine and shall form an effective bond to the inner-layer tape. The outer-layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of38mm.

The thickness of the outer-layer tape shall be 20mils.

To ensure a proper smooth coating by hand or by manual hand wrapping machine, the outer-layer tape shall be provided in standard widths of 4” or 6” as per manufacturer recommendations consistent with the pipe diameter.

16.8 Coating-system Thickness:

The installed coating system thickness shall not be less than 100 mils (2.5mm) and shall comprise of the following.

1. A liquid adhesive layer (50-75 microns)

2. An inner-layer tape (Nominal 30 mils i.e. 0.75mm) applied with 50% overlap

3. An outer-layer tape (Nominal 20 mils i.e. 0.50mm) applied with 50% overlap

The properties of the tape & coating system shall conform to the following requirements.

Table – I - Physical Properties of Total System

Property	Requirement	
	Minimum	Maximum
Thickness		
100 mil, nominal	95 mil	105 mil
Dielectric breakdown	400v/mil	
Water-vapor transmission, max.	0.25 perms [1.44ng/ (Pa.s.m2)]	
Insulation resistance	500,000 mega ohms (min)	
Adhesion to Primed Steel	20 ozf/inch	

16.9 Coating Application:

General:

The coating application shall be a manual operation starting with properly abrasive blasted pipe surface. Longitudinal & spiral welds of the pipe shall not exceed a height of 3/32 inch (2.4mm) above the pipe surface and shall be ground flush a full 18 inch (450mm) along the length of the pipe from both ends prior to the coating process.

Steps, which shall be performed consecutively, shall consist of (1) liquid adhesive application by brush; (2) application of the inner-layer tape directly onto the prepared pipe surface with 50% overlap; and (3) application of the outer-layer tape directly on top of inner-layer tape with 50% overlap.

Pipe preparation:

Metal surface condition:

Bare pipe shall be free from mud, mill scale, mill lacquer, wax, coal tar, asphalt, oil, grease, or any other foreign material. Before blast cleaning, surfaces shall be inspected and pre- cleaned according to SSPC-SP 1 to remove oil, grease, and loosely adhering deposits.
Visible oil and grease spots shall be removed using a solvent. Only solvents that do not leave a residue shall be used. Preheating to remove oil, grease, and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

After drying and removing all loosely adhering foreign materials, the pipe surface shall be cleaned by blasting with grit or sand to achieve a surface preparation at least equal to that specified in SSPC:SP6/NACE3. The blast anchor pattern or profile depth shall be 1 mil to 3 mils (25 µm to 75 µm) measured in accordance with ASTM D-4417.

The cleaned exterior pipe surface shall be inspected for adequate surface preparation.

Surface imperfections, such as slivers, scabs, burrs, weld spatter, and gouges, shall be removed by hand filing or grinding if necessary to prevent holidays.

Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture. No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid adhesive application, the minimum steel substrate temperature shall be 21°C and at least 3°C above the dew point.

Coating Application:

a). Liquid adhesive application:

The liquid adhesive shall be applied in a uniform thin film at the coverage rate recommended by the manufacturer. The liquid adhesive shall be thoroughly and continuously mixed and agitated during application to prevent settling. The liquid adhesive shall be applied to the entire exterior surface of the pipe by brush to cover the entire exterior surface of the pipe.

The liquid adhesive coat shall be uniform and free from floods, runs, sags, drips, or bare spots. The liquid-adhesive-coated pipe surface shall be free of any foreign substances, such as sand, grease, oil, grit, rust particles, or dirt.

Before applying the inner-layer tape, the liquid adhesive layer shall be allowed to touch dry in accordance with the manufacturer's recommendation.

b). Application of inner-layer tape:

The inner-layer tape shall be applied directly onto the prepared pipe surface by manual tape coating machine. When applied to spirally welded pipe, the direction of the tape spiral shall be generally parallel to the weld spiral. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

c). Application of outer-layer tape:

The outer-layer tape shall be applied over the inner-layer tape using the same type of manual tape coating machine used to apply the inner layer tape. The overlap of the outer-layer tape shall not coincide with the overlap of the inner-layer tape. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

Material acceptance

Acceptance of the proposed coating materials shall be approved by the Owner / Owner's representative.

17.0 Coating repair in field:

All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by peeling back and removing the outer and inner layers from the damaged

area. The exposed areas shall then be coated with liquid adhesive and either (1) a length of inner-layer tapes shall be wrapped around the pipe to cover the defective area; or (2) a patch of inner-layer tape shall be applied directly to the defective area as specified by the Owner's Representative. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specifications after the repair is completed. If holidays are not found, the repaired area shall be covered with the outer-layer tape with a minimum over-lap of 100 mm beyond the inner-tape patch.

18.0 Hoisting:

Special sections, fittings, miter bends etc. shall be hoisted using only wide-belt nylon slings or the equivalent. The use of caliper clamps, metal chains, cables, tongs, or other equipment likely to cause damage to the coating shall not be acceptable, nor shall dragging of the pipe be permitted. The Contractor shall allow inspection of the coating on the underside of the pipe while the pipe is suspended from the slings.

19.0 Shipping, handling and storage:

Coated pipe sections shall be handled, stored and transported in a manner that will prevent damage to the coating.

Pipe sections, fittings also shall be handled and stored in a manner to prevent damage to pipe walls and ends.

Pipe sections or coating damaged in handling or other operations shall be repaired. Handling during the period of coating also shall be such as to avoid damage to the coating. Thermal expansion is a characteristic of the coating that may cause uneven areas on the coated pipe surface, but does not adversely affect the coating system's performance. These areas do not require any repair.

Stacking: Sufficient spacers or padding shall be .used to prevent damage to the pipe sections and coating.

Shipping: Pipe sections, fittings etc shall be transported from the coating yard to the jobsite using sufficient shoring or tonnage, padding and banding to adequately protect the pipe and its coating.

Trench-side Storage: Pipe sections, fittings stored along the trench side shall be suitably supported off the ground to avoid damage to the coating.

20.0 SPECIFICATION FOR FIELD JOINT ANTI-CORROSION COATING OF BURIED 3LPE COATED PIPELINES (MAKE UP WATER SYSTEM)

SCOPE

This specification establishes the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of buried pipelines factory coated with three layer polyethylene coating, by heat shrink wraparound sleeves conforming to EN 12068 –

"Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection – Tapes and Shrinkable Materials" and the requirements of this specification. Unless modified/replaced by this specification, all the requirements of EN 12068 shall remain fully applicable and complied with.

This specification shall be read in conjunction with the conditions of all specifications and documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

REFERENCE DOCUMENTS

Reference has also been made to the latest edition (edition enforce at the time of issue of enquiry) of the following standards, codes and specifications:

a) 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)

b) ISO 8503-1 : Part 1: Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces.

c) ISO 8503-4 : Part 4: Methods for calibration of ISO surface profile comparator and for the determination of surface profile Stylus instrument procedure.

d) SIS 055900 : Pictorial Surface Preparation Standard for Painting Steel Surfaces.

e) SSPC-SP1 : Steel Structure Painting Council.

In case of conflict between the requirements of this specification and that of above referred documents, the requirements of this specification shall govern.

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

20.1 MATERIALS AND EQUIPMENT

Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve suitable for a maximum operating temperature of (+) 60oC (Tmax) and shall conform to designation EN 12068-C-HT-60 UV.

a).Heat shrinkable wraparound sleeves:

Heat shrinkable wraparound sleeve shall consist of radiation cross-linked, thermally stabilized, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/co-polymer hot melt adhesive. The joint coating system shall consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be provided with suitable means (thermochrome paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The sleeve shall be supplied in pre-cut sizes to suit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve in the "As Applied" condition shall be as follows:

Pipe Size (Specified outside Diameter)	Thickness (mm)		
	On Pipe Body		On Weld Bead
	Average	Min.	(Min.)
<30" (762.0mm)	2.0	1.8	1.6
>32" (813.0mm)	2.4	2.2	2.0

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

Functional Requirements of Field Joint Coating

Properties of the PE backing shall be as follows:

S.No	Properties	Unit	Requirement
a.	Tensile Strength @ +25 deg C	N/mm2	>12
b.	Ultimate Elongation @ +25 deg C	%	>250
c.	Dielectric withstand with 1000 Volts/sec	KV	>30
d.	Water absorption @ +25 deg. C For 24 hours	%	<0.05
e.	Volume Resistivity @ +25 deg. C	Ohm-cm	>1015

Functional Properties of Joint Coating System (As supplied)

As applied field joint coating system shall comply the requirements of DIN EN 12068, Table 1 & 2 corresponding to designation EN 12068 – C HT 60 UV, except as modified below:

a) Cathodic Disbondment Resistance at Tmax i.e. 60oC shall be 20mm when tested as per Annexure K of EN 12068. Test shall be carried out at (+) 60oC.

a) Peel Strength shall be as follows:

Peel Strength		Unit	Requirement for Mech.Resistanc-e Class-C (minimum)
Inner to Inner (+)	@ 23 deg.C	N/mm	1.5
Outer to Inner	@ Tmax	N/mm	0.3
Outer to Outer	@ 23deg.C	N/mm	1.5
	@ Tmax	N/mm	0.3
To Pipe Surface	@ 23deg.C	N/mm	3.5
	@ Tmax	N/mm	0.5
To Factory coating	@ 23deg.C	N/mm	3.5
	@ Tmax	N/mm	0.5

Contractor shall obtain prior approval from Employer regarding the Manufacturer of the joint coating material and the specific grade of the joint coating system.
Complete technical details along with test certificates complying with the requirements of relevant clause of the specification shall be submitted to Employer for this purpose. The Contractor shall furnish test certificates from an independentDIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification.

Field joint coating system shall be of suitable width considering an overlap to the factory coated pipe coating by minimum 50 mm on each side of 3 LPE coated pipes.

20.2 APPLICATION PROCEDURE

General

1. The application procedure shall be in accordance with manufacturer's instructions and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the Employer.
   Manufacturer's expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at Contractor's cost.

2. Operators for coating application shall be given necessary instructions and training before start of work, by the Contractor. To verify and qualify the application procedures, all coating applied during the qualification test, shall be removed for destructive testing as detailed subsequently in this specification.

Contractor shall only utilize those operators who have been approved/prequalified by the field joint coating manufacturer.

3. Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose. Solvent cleaning procedure according to SSPC-SP1 shall be followed.

4.0 Each field joint shall be blast cleaned using a closed cycle blasting unit or an open expendable blasting equipment. With the first equipment type, steel or chilled shot and iron grit shall be used and Garnet material with the second one.
During blast cleaning the pipe surface temperature shall be simultaneously more than 5oC above ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surfaces shall be completely dry. The surface shall be cleaned to a grade Sa 2½ in accordance with Swedish Standard SIS-055900with a roughness profile of 50-70 microns.
Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO 8503 or ISO 8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.

Dust, grit or foreign matter shall be removed from the cleaned surface by an industrial vacuum cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO 8502-3. The frequency of checking for dust contamination shall be 1 every 10 joints.

Blast cleaned field joint shall be coated with 2-4 hours according to the conditions below:
- Relative Humidity (RH) >80% - 2 hours
- Relative Humidity (RH) 70-80% - 3 hours
- Relative Humidity (RH) <70% - 4 hours

Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleaned again.

4. The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity, made visible during blast cleaning, shall be reported to the Employer Representative and on permission from Employer Representative, such defects shall be removed by filling or grinding. Pipes affected in this manner shall be then re-blast cleaned if the defective area is larger than 50mm in diameter.

6. The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

7. All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures

herein described.

8. Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

20.3 Application Procedure for Heat Shrink Wraparound/Sleeves

1. In addition to the requirements stated above, following shall be complied with:

2. The wraparound sleeve shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.

3. Before centering the wraparound sleeve, the bare steel surface shall be preheated either with a torch moved back and forth over the surface or by induction heating. The minimum pre-heat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature-recording thermometer (Digital Pyrometer with flat probe type contact). Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

4.Upon pre-heating, the pipe surface shall be applied with two pack epoxy primer of wet film thickness 150 microns or as per manufacturer's recommendation whichever is higher, to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating if recommended by the manufacturer. The wet film thickness of the primer shall be checked on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

5. Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe when the epoxy is still wet. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

6. A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the centre of the sleeve and heat circumferentially around the pipe. Continue heating from the centre towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

7. The complete shrinking of the entire sleeves shall be obtained without undue heating of the existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

8. The joint coating application shall be done under supervision of the manufacturer's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and bidder's are required to furnish specific commitment to this. Minimum 50 (fifty) field joint coating to be carried out under

supervision of the joint coating supplier's representative. Application procedure and environment protection methodology demonstrated at the time of field trial shall be strictly followedduring the entire work.

20.4 REPAIRS

a). If a field joint is detected to be unacceptable after testing as per relevant QA section of this specification the Contractor shall, at his own cost:

(i) Determine the cause of the faulty results of the field coating.
(ii) Mobilise the expert of manufacturer, if required.
(iii) Test to the complete satisfaction of Employer, already completed field coatings.
(iv) Stop the field coating works until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Employer.

b). Contractor shall replace all joint coating found or expected to be unacceptable as per relevant section of this specification.

c). Contractor shall, at his own cost, repair all areas where the coating has been removed for testing by the Employer.

d). After the coating work on welded joints and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

e). Employer shall be entitled to check the coating on buried pipelines or parts of pipelines with equipment such as the "Pearson Meter" and the resistance meter. If coating defects are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

21.0 SPECIFIC TECHNICAL REQUIREMENT OF LAYING BURIED 3LPE COATED PIPES (MAKE UP WATER SYSTEM)

21.1 Handling and supporting coated pipes

a). The coated pipes should be carefully handled so as to not damage the pipe coating in any way. The coated pipe shall be handled at all times with wide non-abrasive slings or belts such as canvass or rubber belts of minimum 300mm width of sufficient strength, or other equipment designed to prevent damage to the coating and all such equipment shall be kept in such condition that its continued use is not injurious to the coating. The use of tong, bare pinch, bare bars, chain slings, rope slings without canvass covers, belt slings with protruding rivets, pipe hooks without proper padding or any other handling equipment which the ProjectManager claim to be injurious to the coating shall not be permitted.

b). The lorries/trucks used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of lorries/trucks used for transportation shall be covered by nonabrasive 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 pointswith the pipe.

(Pipes shall be stored in the field under covered protection during rains. Pipes shall be kept on clean square cut padded wooden skids, protected with Kraft paper, felt or straw until ready to be lowered in the trench).

21.2 Repairs

If any damage is caused to the coating of adjacent pipes or any other existing structure during excavation or subsequent work or during coating of field joints, the Contractor shall carry out necessary repairs at his own cost in a manner as directed by the Project Manager.

All the damaged area shall be repaired by applying specified anticorrosive coating with a thickness greater than that of the parent coating. If the thickness is found insufficient, the Bidder shall have to modify the same to the satisfaction of the Project Manager without any extra cost.

21.3 Lowering and laying

The pipe shall be lowered either by mechanical method or by hand when the trench is ready and bottom of the trench has been graded as per required pipe laying conditions of the specification and codes and standards approved by the Project Manager.

21.4 Method and time of lowering pipe

Under favourable temperature conditions and using methods which will not damage coating, the pipe may be rolled into the trench.

Pipe previously set on skids, shall be lowered into the trench normally in the cool atmosphere of the morning and only when the temperature of the pipe is below the softening point of the coating materials.

All skid marks and other places of damage shall be thoroughly examined to ensure proper patching, wherever necessary, before the pipe is finally lowered into the trench.

Before making joints, the pipe shall be carefully laid so as to be perfectly aligned in both plane and profile. The ends of the pipeline shall be kept closed to prevent entry of any foreign material.

General

The Contractor shall place soil over the trench to such a height which, in the opinion of the Project Manager, shall be adequate for future settlement of the trench backfill.

Surplus excavated soil or rubbish material shall be removed by the Bidder//Contractor at his own cost to a place designated by the Project Manager beyond the initial lead of 30M but upto a lead of 2Km without any extra cost to the Employer.

After the roads, dykes, rail embankments etc. are constructed and if they are trenched or otherwise disturbed by the Bidder during erection of the pipe lines, the Bidder shall restore the structures to its original level and condition. In the event the Bidder is required to place backfill extra fill, gravel or other special material, it shall be done by him without any extracost to the Employer.

Where there are long sections of pipe between field joints, the trench may be back filled immediately after the pipe is laid and accepted for alignment, except for a distance of one meter on each side of the centre of each field joint. The two metric sections of the trench at the field joint shall not be back filled until the piping has been tested and approved.

22. SPECIFIC TECHNICAL REQUIREMENT – ERECTION

22.1 GENERAL

a). Erection shall include welding, bolting, preheating, stress relieving, cleaning and painting of the piping systems as specified in this specification. Hydrostatic testing shall be performed as per relevant chapter/ clauses of this specification. The Contractor shall also make all temporary closures and connections as required for hydrostatic testing and cleaning operations and remove the closures/ connections after the successful completion of hydrotest operation.

b).The Contractor shall coordinate the erection of the piping systems as required with the erection schedule of other equipment suppliers. The sequence of work shall be carefully planned to minimise interference with other groups working in the same area. The actual sequence to be followed shall be to the approval of the Employer/ Project Manager and the Employer may at any time, direct the Contractor to reschedule his work as per the status of work at site.

c). Prior to making interface connections with equipment supplied by others, the Contractor shall obtain the approval of the construction managers and the concerned equipment manufacturer's field engineering representatives.

d). All workmanship shall be accomplished using accepted methods and procedures of the highest recognized fabrication and erection standards. Workmanship not conforming to the intent of this specification shall be liable to rejection by the Project Manager at any time, during the progress of work. The Contractor shall correct the workmanship immediately at no extra cost to the Employer.

e). The Contractor shall make all interface joints of the piping system, covered under this specification at the connecting points with equipment/ piping supplied by others.

f). It is the responsibility of the Contractor to ensure correct orientation of all valves, instrument stubs etc. in line with final piping drawings. Where sufficient information regarding such orientation is not available on the piping drawings, the same shall be obtained from the Employer/ Project anager.

g). During the erection, the Contractor shall take into account the following even though these might have been taken care during design and layout drawing finalisation stage:

(i) Piping are routed to avoid interferences with other pipes, hangers, structures, equipment, electrical trays, ventilation ducts etc., with sufficient clearance to accommodate thermal insulation and/ or piping movements as required. In case any interference is observed during actual erection at site, suitable modifications shall be proposed by the bidder and approval of Project Manager shall be obtained for implementing modifications.

(ii) The pipe routing also provides sufficient clearance removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping does not encroach on the withdrawal space of the various equipment.
(iii) The tap offs on main lines are suitably located by the Contractor to suit the layout prepared by him.
(iv) The Contractor shall utilise the existing structures to support the piping as far as practicable. All auxiliary steel required shall be supplied by the Contractor.
(v) Field run piping shall be erected only after completion of all other piping systems, structures and equipment unless otherwise approved/ directed by the Employer/Project Manager.
(vi) Before performing any welding, all corrosion products, dust, grease and other foreign material shall be cleaned from the surfaces to be joined and all valves shall be opened fully and cleaned thoroughly.
(vii) Piping on both sides of the joint shall be adequately supported during all welding. Temporary supports, if used, shall be so designed that no stress due to pipe weight shall act on the joints during the joining.
(viii) All pipes shall be located and laid in accordance with the approved layout drgs. No deviation will be allowed except by written authorisation of the Project Manager.

(ix) Before laying the pipes, the coordinates and levels of the pipes shall be checked by the Contractor. Any discrepancies between the execution and approved drawings shall be brought to the notice of the Project Manager and corrections shall be carried out as per his instructions.
(x) Unless otherwise indicated on the drawings pipelines for various services shall be sloped as indicated in the specification.

All vents and drains shall be provided by Contractor as part of piping erection work. Vents shall be provided at high points in piping where air or gas pockets may occur (vents for use during hydrostatic test shall be plugged after the completion of the test). Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Valves/ cocks/ pipe work/ fittings/ hangers and supports required for vent/ drainsystem shall be supplied by Contractor.

22.2 BOLTS AND NUTS

During erection of piping system, the Contractor shall provide proper number and size of bolts and nuts as per drawings and specifications. The Contractor shall provide approved quality of grease mixed with graphite powder thoroughly on all the bolts, nuts and washers during storage in his store,

immediately after erection and when the flange joints are dismantled for flushing, testing and alignment of equipment etc. to prevent rusting of nuts, bolts and gaskets. The grease and graphite powder shall be supplied by the Bidder and the
cost of the same are deemed to be included in erection prices.

22.3 CLEANING, FLUSHING AND BLOW OUT

All piping shall be cleaned by the Contractor before and after erection to remove grease, dirt, dust, scale and welding slag.

Before erection all pipe work, assemblies, sub-assemblies, fittings and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brush and followed by air blowing. The brushes shall be of the same or similar materialas the metal being cleaned.

After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.

22.4 DISMANTLING OF PIPING

To facilitate dismantling of piping near the valves and equipment, Suitable measures as recommended by the project manager shall be adopted by the Contractor.

22.5 SPECIFIC TECHNICAL REQUIREMENT – WELDING

GENERAL

This specification shall apply to all welded pipe joints of carbon and alloy/ stainless steel piping systems. The welded joints shall include:

(a) All the line joints of the longitudinal and circumferential butt welded and socket welded type.

(b) The attachment of castings, forgings and flanges to pipe.

(c) Welded manifold headers and all other sub-assemblies.

(d) Welded branch connections with or without saddles and reinforcement rings.

(e) Attachment like drips, drains, instruments, branch lines, weldolets, sockolets, thermo wells, couplings, etc.

(f) Closure of joints for valve bonnets, inspection plugs and similar joints.

(g) Any other similar joints not specified above but encountered during fabrication and/ or erection stage. It is imperative that the Contractor makes every effort to provide the same high degree of component supervision and workmanship during fielderection as is intended for shop fabrication.

Welding shall be made by manual shielded metallic arc process. Electrodes used shall be of approved make. Flux coated rods shall be kept dry and electrode containers shall be protected against moisture. Electrodes that show sign of deterioration or damage shall not be used. Automatic or semi-automatic welding shall be done with the specific approval of Employer.

Details of welding techniques such as number of beads and layers, weld gap at base, use of backing ring, weld electrodes diameter and average current values etc. are subject to Project Manager's approval. However, Contractor shall submit welding procedure as per ASME Section IX to Employer for his approval.

The Contractor shall furnish each welder with a steel stencil for making the weld so that the work of each welder may be identified. Each welder shall stencil each weld made by him with the stencil assigned. Each welder's certificate of qualification not older than 6 months shall be on fire at the work site and shall be made available to the Project Manager. In the event of a welder leaving the job his stencil will be void and not duplicated if another welder is employed. This shall be done in addition to stamping of welds. Welders working close to inflammable materials shall be provided with fire extinguishers and shall observe all necessary fire prevention precautions, such as using shields as required, to avoid fire hazard and heat damage to adjacent structure.
Various requirements of welding both for erection and fabrication activity shall be as given in this specification.

22.6 CODES AND STANDARDS

The welding of fusion welded piping system shall comply with all currently applicable statutes, regulations and safety codes in the locality where it will be installed. It shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the Contractor of his responsibility. In particular all welding activity shall conform to the latest editions of the following codes and standards.
- ANSI codes for pressure piping.
- ASME Boiler and Pressure Vessel Code Section-IX. "Qualification

Standard for Welding and Brazing Procedures, Welders, Brazers and Welding and Brazing Operators".
- Specifications of the American Welding Society.
- Standards of Pipe Fabrication Institute.
- Any other codes/ standards specified in the Technical Specification.

22.7 END PREPARATION AND CUTTING

(a) End preparation for welding shall be as per the codes and standards indicated in the specification. Before welding, the ends shall be cleaned by wirebrushing, filing of grinding. For tees, laterals, mitre bends and other irregular details, cutting template shall be used for accurate cutting and cutting shall follow the outline of the template.

(b) Piping for socket welded connection shall be saw / machine cut, square to the axis of the pipe and reamed. Individual lengths of the pipes shall be jointed by couplings or unions. A minimum gap of 1/16" between the end of the pipe and the bottom of the socket shall be provided before welding. Piping for butt-welded run shall be supplied with ends bevelled by machining. Any pipe and fitting ends requiring bevelling for welding shall also be machined. If machining is impracticable, ends may be prepared by grinding or by flame cutting and consequent grinding back 2mm prior to welding.
Butt welding end preparation which meets the procedure qualification is acceptable.
Each joint shall be internally swabbed and be free from scale, surface cracks, oil,grease, oxides or other foreign matter before installation.

(c) Where backing rings are used, they shall be accurately fitted and welded to the upstream inside side of the pipe. Weld slag and splatter shall be removed prior to assembling the pipe.

(d) The ends of the pipe to pipe, pipe to fitting and fitting to fitting joints shall be aligned as accurately as is practical within the existing commercial tolerance on pipe diameters, wall thickness and out of roundness. Alignment shall be provided the most favourable conditions for the deposition of the root bead. This alignment must be preserved during welding. In cases, where ends of unequal internal diameter areabutted and the internal misalignment exceeds 2mm they shall be internally reamedto equal each other.

(e) Where pipe length must be erected before the circumferential joint is welded, the plates and these joints shall be bevelled so that the top half is welded mostly from outside and lower half mostly from inside of pipe.

22.8 WELDING TECHNIQUE

(a) Welding may be performed with the pipes in a fixed position by rolling, provided that proper alignment is maintained by the use of supports, skids, welding rolls or structural frame work. The entire root pass shall be made with the pipes in a stationary position and movement of the pipes during this time must be kept to theabsolute minimum.

(b) When using external clamps the root beads must be uniformly spaced around the circumference of the pipe and shall have an accumulated length of not less than 50% of the circumference before removal of the clamps.

(c) Tack welding for alignment of pipe joints shall be executed carefully. Defective tack welds shall be removed prior to welding of joints, number of tacks shall be 6.

(d) Root pass shall be made with electrode/ filler wire, size of which shall not be greaterthan 2mm. Welding shall be done with direct current with values recommended bythe electrode manufacturer.

(e) If the rolling technique is to be used after the root pass, the weld must consist of not less than two passes using the approved type and size of electrode and the weld puddle shall be maintained at or near the top centre of the pipe.

(f) Welds shall be full penetration, continuous and without defects. After deposition, each layer of weld shall be cleaned to remove slag and scale by wire brushing or grinding and chipped, where necessary, to prepare for proper deposition of the next layer. The weld reinforcement shall not be less than 2mm and not more than 4mm above the normal surface of the joined sections.

(g) The reinforcement shall be crowned at the centre and shall merge into the base material without excessive shoulder or undercut. All scale and slag shall be removed and the completed weld shall be thoroughly cleaned before final inspection.

(h) The welding process that are used in fabrication and welding are restricted to shielded metal arc welding. However, root pass welding should be done by tungsten argon- arc process for all stainless steels lines (when single side welding technique is employed).

(i) Welding shall not be carried out without adequate protection when the quality of the completed weld may be affected by the weather. The Project Manager shall decide if protection against the weather is adequate.

(j) For pipe wall thickness less than 3mm oxyacetylene welding is recommended.

(k) Upward technique shall be adopted for welding pipes in horizontally fixed position.

(l) The root pass of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 1.5mm inside the pipe.

(m) In case of deviation from the welding process and electrodes as specified, the Contractor shall seek the approval of the Employer before adopting them.

(n) During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.

(o) Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 2mm. At least two passes shall bemade on socket weld.

(p) Welding at any joint should be completed uninterrupted. If this procedure can not be followed for some reason, the weld shall be insulated for slow and uniform cooling.

(q) As far as possible welding shall be carried out in a flat position. If not possible welding shall be done in a position as close to flat position as possible.

(r) Downward technique is not allowed in welding pipes in horizontal position, unless permitted by the Employer.

(s) As a rule no backing ring shall be used for circumferential butt welds.

22.9 **FILLER MATERIAL**

Electrodes used for welding shall conform to IS:814 and IS:815 latest edition or equivalent international standard and shall be compatible with parent material. The electrodes to be used by the Contractor shall be approved by the Project Manager. The tests of electrodes shall be carried out by the Contractor at his own cost. Makes of electrodes/ filler materials shall be subject to Employer's approval.

The Contractor shall submit manufacturer's certificates for each batch of electrodes supplied and used by him for welding.

Electrodes shall be stored in sealed original containers. They shall be stored properly to prevent moisture absorption and shall be handled in such a manner so as to avoid the damage of coating. Electrodes when used shall be free from rust, oil, grease, soil or any other matter which could be harmful for the quality of welding.

The electrodes used shall be suitable for the welding process and the weld properties shall not be inferior to those of the base metal.

22.10 WELDING INSPECTION

The work shall at any time be available for inspection by the Project Manager. No weld shall be covered before the inspection has been carried out to the entire satisfaction of the Project

Manager and the Project Manager reserves the right to reject welds upon visual inspection and/ or upon evidence of defects detected by radiography/ ultrasonic tests.

22.11 REPAIR

(a) Any and all welds found to be poor or doubtful quality shall be cut out and replaced with satisfactory welds at Contractor's expense.

(b) Defective welds may be repaired after obtaining approval of the Project Manager but any weld that shows evidence of having been repaired without authorisation may be rejected. Repairs may be made on pin-holes and undercutting in the final bead without authorisation but must meet with final approval of the Project Manager.

(c) Before repairs are made, the defects shall be removed by chipping, grinding or flame gauging, slag and scale shall be removed by wire brushing. Repaired area shall be MPI/DP tested to ensure that the defect is completely removed.

22.12 WELDER QUALIFICATION

Welding/ tack welding of piping shall be done only by 'certified welders'. Welder qualification tests shall be as per ASME section-IX.

22.13 ALIGNMENT AND SPACING

(a) Components to be welded shall be properly aligned and spaced. Root opening shall be 2.0 mm

(b) Special care shall be taken for fitting and alignment in case of inert gas tungsten arc welding.

(c) A wire spacer of proper diameter may be used for the weld root opening but must be removed after tack welding and before weld deposite of the root pass.

22.14 SPECIFIC TECHNICAL REQUIREMENT – FABRICATION

GENERAL

(a) The Contractor shall prepare necessary fabrication drawings based on approved layout drawings for piping systems.. Contractor's fabrication drawings shall take into account the requirements of this specification as also all applicable codes and standards including statutory regulations. All pipes shall be routed and located in accordance with approved layout drawings. No deviation will be allowed except by written authorisation of the Project Manager. In case of systems requiring statutory clearance, fabrication and erection shall commence only after the necessary clearance have been obtained from the statutory authorities. Contractor's fabrication drawings shall carry all details of fabrication, welding etc. as may be required for obtaining the necessary statutory clearances.

(b) All workmanship shall be in accordance with the methods and procedures of the best, recognised pipe fabrication techniques and must be done in a neat and workman like manner conforming to the requirements of applicable codes andstandards and IBR, as applicable.

(c) Flanges and their contact surfaces shall be concentric with the pipe axis and shall be accurately machined and drilled true to template.

(d) Where welded pipe and fittings are used, the longitudinal weld seams of adjoining sections shall be staggered by 90 deg.

(e) No buttweld and branch joint shall be closer than twice the pipe diameter to any other joint except where weldolet type joints are to be used.

(f) Prefabrication shall be carried out in the fabrication shop to be established at the site by contractor to ensure quality of work and to minimise work on required machinery, templates, gauges, tools and tackles etc. Contractor shall indicate in his offer details of the facilities available at his works for fabrication of pipe work. The extent of fabrication at works shall be such as to restrict field welding to circumferential line joints alone. Further, the number of circumferential line joints to be performed in the field shall be held to a minimum. Such prefabrication/ preassembly of piping should be based on the approved piping arrangement/ fabrication drawings. The contractor shall provide for appropriate field joints and fit in sections permitting the preassembled pipe work to be installed without any modifications. In any case no extra claims shall be entertained on this account. In case of errors or omissions the bidder shall bring it to the notice of the Employer. The Contractor shall correct the errors/ ommissions and get the same approved by the Employer prior to fabrication.

(g) Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes above 350 the mitre bends shall conform to BS:534. The bend radius shall be used for all pipes 1.5 times the nominal pipe diameter.

(h) The pipe bends shall be true to angle and radius and shall maintain a true circular cross-section without deformity or undue stretching. Crimping of pipes to form bends is not acceptable.

(i) All welded branch connections shall be of suitable structural adequacy. It is the Contractor's responsibility to provide reinforcement wherever necessary for branch connections. Welded branch connections are not an acceptable alternative where tees have been specified.

(j) As far as possible machine bevelling shall be employed. If gas bevelling is carried out, edges shall be ground after gas bevelling.

(k) All welded attachments on pipelines shall be of same material as the parent pipeline and shall be subjected to the same fabrication and welding procedures as the associated piping.

Dimension & Tolerance for Fabrication

i. Internal misalignment: misalignment shall not exceed 3.0mm

ii. External misalignment: 3.0mm or less

iii. Length : +3mm

iv. Inclination of flange: 1/2 deg. (i.e. angle between pipe axis & flange face)

v. Perpendicularity : 2mm in 1000mm

vi. Horizontality : 2mm in 1000mm

vii. Misalignment between
pipe centre & flange Centre: +1.6mm
viii. Rotation of flange: +1.0mm

22.15 Painting / Anti-Corrosive Protection Schedule for over ground piping & fittings

a) External Painting and application procedures for over ground piping & fittings shall be as follows:

A) Surface preparation: Commercial blast clean

B) Primer: Conforming to BS:5493, Table-f.Part-2. Reference FP-3A IS:2074 for primer/ IS:2937 (for enamel)
Binder : Alkyd or modified alkyd.
Nominal Coating Thickness: 70 microns

C) Under Coats: Conforming to BS:5493, Table-4F.Part-3, Reference FU-2A IS:2074 / IS:2937
Binder :Alkyd or modified alkyd.
Main Pigment: Coloured Pigments (full colours) suitably extended
Nominal Coating Thickness: 70 to 80 microns

D) Finish Paints : Conforming to BS:5493, Table-4F.Part-3, Reference FU-2A IS:2074 / IS:2937
Binder :Alkyd or modified alkyd.
Main Pigment :Fade-resistant coloured pigments
Nominal Coating Thickness: 50 to 80 microns

E) Dry Film Thickness 190 to 230 microns

b) Where blast cleaning is not feasible at job site and subject to approval by Employer in writing, power tool cleaning may be substituted as follows:

A) Surface preparation : Power Tool clean

B) Primer: Conforming to BS:5493, Table-4F.Part-2 Reference FP-2A, IS:2074 / IS:2937
Binder :Drying Oil modified with phenolic or phenolic modified resin.
Nominal Coating Thickness: 70 microns

C)Under Coats :Conforming to BS:5493, Table-4F.Part-3, Reference FU-1A IS:2074 / IS:2937
Binder: Drying Oil modified with phenolic or phenolic modified resin.
Main Pigment: Coloured Pigments (full colours) suitably extended
Nominal Coating Thickness:25 to 40 microns

D)Finish Coats: Conforming to BS:5493, Table-4F.Part-4, Reference FF-1A IS:2074 / IS:2937
Binder :Drying Oil modified with Phenolic or Phenolic modified resin.
Main Pigment: Fade resistant coloured pigments
Nominal Coating Thickness:25 to 40 microns

E)Dry Film Thickness 120 to 150 microns

22.16 Drawings, Catalogues and Manuals

Bidder shall furnish all data called for in 'Technical Data Sheet' of the specification, with the bid and after the award of contract.

22.17 DOCUMENTS AND HANDBOOKS

The Contractor shall send all documents listed below as an integral part of his supply and will be responsible for the dispatch of these documents by his sub-contractors. Any change in these documents made by Project Manager or by the manufacturer will need revision of the documents and the Contractor shall send to the Project manager a copy of such revised documents.

The following documents shall be submitted:

(a) List of all components included in the supply.

(b) Quality control plan.

(c) Any document required as per the specifications.

(d) Test procedures.

(e) Inspection reports and certificates of tests.

(f) Cleaning procedures.

(g) Packing and preservation procedures.

(h) Handbook in compliance with the provision of this paragraph.

(1) The handbook shall be clear and contain all relevant information to familiarise the personnel in charge of operation and maintenance with the various components and to assist them in all erection, disassembly, repair work etc.

(2) The following chapters shall be at least included in this handbook.

(i) Erection of the components at the site;

(ii) Maintenance, repair, periodical testing (for instance, alignment checks, tightening of bolts etc.

(iii) Operation;

(iv) Storage and preservation of the machinery at the storehouse and after installation;

(v) Lubrication schedule, including characteristics of the suggested lubricant; lubricants amount and change periodicity.

(3) The handbook shall include all drawings and documents required for maintenance and operation, such as assembly drawings, section drawings,

(4) Special care shall be taken to include all information and precautions required for erection and safe operation. Furthermore, all information shall be given for procurement of spare parts, as well as the technical particulars and construction details for parts which can be manufactured or purchased at the site.

(5) Handbook shall be printed clearly and shall be bound.

(6) The handbooks shall also cover all necessary information pertaining to parts supplied alongwith various equipments/ components covered under the package.

23.0 CATHODIC PROTECTION SYSTEM (MAKE UP WATER SYSTEM)

23.1 GENERAL

This specification defines the requirements of system design, engineering, installation, testing and commissioning of Sacrificial anode and Impressed Current Cathodic Protection (CP) systems for underground cross-country pipelines/ structures and associated services. This specification defines the basic guidelines to develop a suitable CP system for the pipelines / structures require to be protected. The type of Cathodic Protection (CP) systems i.e., Sacrificial anode or Impressed Current or both to be provided for this package shall be as defined in the scope.

CODES AND STANDARDS

The system design, performance and materials to be supplied shall conform to the requirements of the latest revision of following standards as a minimum.

- NACE Standard RP-0169 : Standard recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping System.
- NACE Publication 10A190:Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RPO169-83).
- NACE Standard RP-0177: Standard Recommended Practice Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosing Control System.
- NACE Standard RP-0286: Standard Recommended Practice The Electrical isolation of Cathodically Protected Pipeliens.
- NACE Publication No. 54276 :Cathodic Protection Monitoring for Buried Pipelines

- NACE Standard RP-0572: Standard Recommended Practice Design, Installation, Operation and of Impresed Current Deep Ground beds.
- DNV RP-B403 :Recommended Practice Monitoring of Cathodic Protection systems.
- DNV RP-B401 :Recommended Practice Cathodic Protection Design.
- IS 8062 :Recommended Practice ICCP for Underground piping
- BS 7361 Part I land and :Code of practice for Cathodic Protection for marine application.
- VDE 0150 :Protection against Corrosion due to Stray Current from DC Installations.
- IS : 1554 Part I : PVC insulated (heavy duty) cables.

The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations.

23.2 SCOPE OF WORK

a) Carrying out required corrosion survey and collection of data for design and implementation of both Sacrificial anode and Impressed Current (ICCP) cathodic protection systems.

b). Implementation of CP system by Interpretation of survey data, basic engineering, detailed deign & engineering, getting approval of survey data/engineering documents from Employer, procurement /manufacture/ supply/ installation of various equipments, field testing & commissioning as per the approved commissioning procedure, periodic monitoring of the protection level of the pipelines/structures, interference testing & mitigation is required during post commissioning period and submission of complete documents to Employer for record.

c). Supply and installation of Sacrificial Anode CP system consisting of :

i) Required number of Sacrificial Zinc and or Magnesium anodes with pre-packed with special backfill.
ii) Required number of manual test stations (common for both Sacrificial & Impressed current type CP systems) and data retrieval computer.
iii) Required junction boxes, cables & cabling
iv) Associated civil, structural and electrical materials for installation of sacrificial type CP system as elaborated elsewhere.
v) Monitoring of the performance of the Sacrificial anode CP system and taking corrective actions till the commissioning of ICCP system.

d). Supply and installation of Impressed current type CP system consisting of:

i) Required number of transformers rectifier (TRU) units along the pipelines to be protected. Minimum two numbers of TRU shall be provided one to be installed in/near the makeup water pump house and one near the reservoir area of the Plant end at suitable locations. Bidder to note that Employer's AC supply for CP station is availableat above two points only. In case CP stations are required at location in between ofthese two points, bidder has to make suitable arrangement for

alternate power supply source (like solar power etc) for such CP stations. Solar powered electric supply or any other alternate source shall be provided with battery bank suitable for min. 100 hours backup at 100% load and other necessary accessories required to complete the system.

ii) Required number of anode (one anode ground bed near each TRU/CP unit location) ground beds with anodes with canisters and back fill materials. The anodes shall be of either High Silicon Cast Iron (HSCI) type or Mixed Metal Oxide (MMO) coated Titanium anode type.

iii) CP system at cased crossings

iv) Required insulation joints & neoprene wrap

v) Grounding anodes at required locations and additional test stations if any.

vi) Permanent reference cells

vii) Portable reference cells (2 numbers ; One at make up water pump house and one at Plant end)

viii) Electrical resistance probes & E/R resistance reading instrument.

ix) Surge diverters and Polarization cell

x) Polarization coupons

xi) Required junction boxes, cable & cabling

xii) Barbed wire fencing along with appropriate support and lockable gate to be provided around the anode bed and the TRU (if located outdoor) of ICCP system.

xiii) Associated Civil, structural and electrical works for installation of Impressed Current CP system.

xiv) Supply of required Monitoring instruments, monitoring of ICCP system (**till the system is handed over to Employer for a period of 6 months after commissioning of the complete ICCP System**) & training Employer's personnel for monitoring services.

23.3 Miscellaneous scope of work such as:

a) Suitable Markers with legible marking along with buried cabling work at anode locations of both Sacrificial & ICCP System, TLP etc. are to be provided by the Contractor. Support pipes/structures for junction boxes etc.

b) All other materials which may be necessary but not mentioned herein specifically to complete the Cathodic Protection System in all respects to the best engineering practices.

c) All tools and tackles, testing instruments and machines required for execution of the work.

d) All skilled, semi-skilled, unskilled supervisory and Managerial Manpower required for execution of the work. Contractor shall also be responsible for carting away all discarded or surplus material anywhere within the site boundaries as per instructions of the Engineer.

e) All tests required as per specification. Contractor shall be responsible for making all arrangements (including supply of materials) for all tests, performance of tests in presence of Employer/ Employer's representative.

f) Submission of results for approval & all rectification work if required. Contractor shall also be responsible for accurately recording and maintaining records of all tests as per requirement of Owner's representative.

g) Contractor shall mobilize at site adequate testing equipments/apparatus including skilled, unskilled, managerial manpower required at site for all testing. All instruments and consumable required during erection/pre commissioning, performance testing & monitoring shall be arranged by

the Contractor.

h) Maintaining records of all the works and inspections as per advice of the Engineer.

i) All other materials necessary but not mentioned herein specifically to complete the Cathodic Protection system in all respects to the best engineering practices shall be included by the Bidder.

Required Mandatory Spares as listed elsewhere.

21.4 DESCRIPTION OF CATHODIC PROTECTION SYSTEM

Cathodic protection is a method which protects the pipe reliably even at undetected coating/wrapping holidays. The protective current supplies electrons to the pipe which is to be protected. These electrons replace the electrons which would otherwise be produced by metal decomposition to cover the electron requirements for the reduction of oxygen at the metal surface. The potential of the metal surface is sufficiently reduced to prevent the dissociation of positive iron ions from the material. The anodic reaction is replaced by a cathodic reduction of the oxygen and the entire pipe surface protected is transformed into a safe cathode.

21.5 Sacrificial Cathodic Protection System

a). It is proposed to provide Sacrificial type Cathodic protection System for the buried pipeline by using the Zinc/Magnesium anodes packed in highly conductive backfill at regular intervals of 1 (one) Kilometer for the complete pipe length. However the actual anode installation location shall be decided as per design criteria in consultation with Owner.

b). This shall primarily protect the pipeline during the construction phase till the Permanent Impressed Current type Cathodic (ICCP) Protection System is commissioned. The Sacrificial anode CP System shall be supplied and installed concurrently along with the erection of every portion of buried pipe which is to be protected so that pipe gets protected against corrosion after the same is erected till the permanent CP system is commissioned along with the complete piping system.

c). A typical anode installation consist of conductive connection (through thermit welding) of cables of specified size to the metal (Cathode) structure to be protected, connection of the cabling from this joint to the terminal of test station, installation of pre-packed anode at suitable depth from the pipeline, connection of tail cable of anode to the terminal of test station. The protective current which flows due to the potential difference between pipe and anode metal shifts the corrosion from the metal structure to the anode.

d). The system shall include provision of required numbers of permanent Test Stations at regular intervals along the pipe line for monitoring the system parameters.

e). 6.04.01.05 The system shall be decommissioned after the successful commissioning of Permanent ICCP system.

21.6 Impressed current type Cathodic Protection system

a).In Impressed current system, the protective current required shall be supplied either by Transformer rectifier (TRU) units connected to the electrical main supply or by any alternate electric supply source as detailed elsewhere in specification and fed into the pipeline by buried impressed current anodes. The system consists of following main components:
i) Transformer rectifier stations feeding the Protective current.
ii) Impressed current anodes packed with backfill.
iii) Cables between rectifier/alternate source, pipeline and impressed current anodes.
iv) Alternate source of power as detailed in cl 3.04.00 a) of this sub section, feeding the protective current at location where AC Supply is not available.

b). The anodes may be of either High Silicon Cast Iron (HSCI) type or Mixed Metal Oxide (MMO) coated Titanium anode type.

c). The test stations proposed to be provided with the Sacrificial type CP system shall be utilized for this ICCP system also for system monitoring and testing along with additional test stations if required.

22.0 PERFFORMANCE CRITERIA FOR CATHODIC PROTECTION

To achieve a reliable and an easy check of the effectiveness of cathodic Protection System it is necessary to determine one or more parameters measured that serve as criteria for the protective effect achieved. Hence while monitoring cathodic protection effectiveness, following criteria shall be applied in principle.

a). **Sacrificial type Anode CP System**

i) The pipe to soil potential measurements shall be between (-) 0.95V (ON) and (-) 1.8 V (ON) for coal tar coated pipe lines with respect to a copper / copper sulphate reference electrode.
ii) At the locations of polarizations coupons, the coupon to soil potential measurement shall be between (-) 0.9 V (OFF) to (-) 1.18 V with respect to a copper / copper sulphate reference electrode.
iii) A positive potential swing of 100 millivolts or more shall be considered sufficient to indicate the presence of an interaction / interference situation requiring investigation and incorporation of mitigation measures by the Contractor.

b). **ICCP System**

i) The pipe to soil potential measurements shall be between (-) 0.9V (OFF) and (-) 1.18 V (OFF) with respect to a copper / copper sulphate reference electrode.
ii) In rare circumstances, a minimum polarisation shift of (-) 100 millivolts may be accepted as an adequate level of cathodic protection for the pipeline with the approval of Owner.

iii) A positive potential swing of 100 millivolts or more shall be considered sufficient to indicate the presence of an interaction / interference situation requiring investigation and incorporation of mitigation measures by the Contractor.

CP SYSTEM DESIGN PARAMETERS

a). Design Parameters for Sacrificial Anode CP system

i). The design life of system shall be minimum two (2) years. However those parts of sacrificial anode CP system which are to be integrated with permanent ICCP system shall be designed based on permanent CP paremeters / design basis as mentioned below.

ii). Under temporary CP design basis, the minimum protection current density shall be (i) 40 · A/m^2 for the pipeline surrounded by soil of resistivity more than 100 ohm.m (ii) 75 · A/m^2 for the pipeline surrounded by soil of resistivity of 10 ohm.m to 100 ohm.m and (iii)500 · A/m^2 for resistivity of soil less than 10 ohm.m. Under marshy conditions the protection density shall be 1000 · A/m^2 for temporary CP system design. **However the actual current density to be adopted shall be suitably increased by contractor based upon soil conditions, current drainage survey details, foreign pipe line / structures and other interference areas affecting the installation**.

iii). At horizontal crossings the pipe protection current density applicable for marshy area shall be considered.

iv) Safety factor for current density shall be minimum 1.3 for degradation of coating.
v). Anode utilisation factor shall be 0.8 (max) and 0.6 (max) for solid and ribbon anodes respectively.

b). Design Parameters for Impressed Current CP system

i) The design life of system shall be minimum twenty five (25) years.
ii). The minimum protection current density shall be (i) 200 · A/m^2 for the pipeline surrounded by soil of resistivity more than 100 ohm.m (ii) 300 · A/m^2 for the pipeline surrounded by soil of resistivity of 10 ohm.m to 100 ohm.m and (iii) 2000 · A/m^2 for resistivity of soil less than 10 ohm.m. Under marshy conditions the protection density shall be 5000 · A/m^2. **However the actual current density to be adopted shall be suitably increased by contractor based upon soil conditions, current drainage survey details, foreign pipe line / structures and other interference areas affecting the installation**.

iii). The minimum end of life pipe protection current requirement shall be considered as the current requirement indicated above or 4 times the current density value measured by the current drainage survey whichever is maximum.

iv). At horizontal crossings the pipe protection current density applicable for marshy area shall be considered.

v) Safety factor for current density shall be minimum 1.3 for degradation of coating.

vi). Anode utilisation factor shall be High Silicon Cast Iron (HSCI) anode 0.8 (max) and 0.6 (max) for solid center connected anodes and end connected anodes respectively.

vii). The maximum anode surface current density shall not be considered more than 10 Amp/Sq.M for HSCI anodes.

viii). The coating efficiency to be considered for design shall be 70% maximum throughout the design life.

ix). Anode consumption rate for HSCI anodes shall minimum 0.4 Kg/Amp/Year.

x). For mixed metal coated titanium anode (MMO type) the anode surface current density and anode consumption rate etc shall be as per the guranteed values published by the manufacturer and supported by the tests certficates / field proneness.

xi) The sizing of transformer rectifier or any alternate electric supply source shall be done considering an additional requirement of 25% power compared with the power required under normal operating condition.

The details of various equipments and other activities constituting CP system shall be executed/designed, manufactured, tested, supplied, commissioned as per the following Annexures enclosed with this sub-section.

Sl no.	Annexure No	Description
1)	Annexure-1	Data Collection & Survey
2)	Annexure-2	Anodes & Anode ground beds
3)	Annexure-3	CP Stations & TRU
4)	Annexure-4	Test Stations
5)	Annexure-5	Miscellaneous Equipments
6)	Annexure-6	Spares for CP System

For detail of Annexure 1 to 6 , refer section G of this technical specification.

Detailed Field Testing, Commissioning and Monitoring Procedure and as well as Interference Mitigation methodology to be adopted during the duration of CP system monitoring shall be prepared and the same shall be submitted for Approval of Employer.

SECTION - D

PROJECT COMPLETION SCHEDULE & MILESTONE SCHEDULE

1.00.00 PROJECT COMPLETION SCHEDULE

Bidder to complete the entire make-up water piping package work within ------ month.

Region /PSWR to fill in the blank according to their requirement or according to project completion schedule and instruct the bidder suitably.

2.00.00 MILE STONE SCHEDULE

Bidder shall have the overall responsibility for readiness of sub-system, achievement of critical milestones and commissioning of make-up water piping to meet the overall milestone and commissioning schedule and shall submit detailed work program in the bid inter-alia taking into consideration the milestone to be considered for progressive payment.

Region/PSWR to review and update milestone accordingly.

SECTION - F

DOCUMENTS TO BE FURNISHED BY BIDDER

1.0 Bidder to submit the following Documents along with the Bid.

i). Pipe size selected and combination of GRP/MS/DI pipes.
ii). Trench detail for laying of GRP/MS/DI pipe.
iii).Pipe sizing calculation for GRP/MS/DI pipes.
iv).Stamped copy of Quality Assurance Plan (QAP) for GRP/Di/MS pipe.
v).Compliance certificate.
vi).Deviation sheet
vii).Schedule of declaration
viii). Price Schedule format.

SECTION - G

ANNEXURE

ANNEXURE--1

DATA COLLECTION / SURVEY

1.0 The details of soil resistivity data if enclosed with this specification is for general guidance of the contractor and the accuracy, validity & adequacy of the data shall be verified by the Contractor.

2.0 The contractor shall carry out corrosion survey along the ROW of the pipeline and soil resistivity survey at anode ground bed locations (for both sacrificial & ICCP) for proper design of ground beds using Wenner's 4-pin method or approved equal shall be used for such measurements. One or more ground bed plots may be required to be selected and surveyed at each CP station to form a suitable ground bed for ICCP system.

3.0 The following additional data shall be collected to generate design data:

i) Design Data regarding of foreign service / pipelines in and around or crossing the right of way and diagram representing existing structure / pipe-to-soil potential records.

ii) Data regarding existing and proposed DC/AC power sources and systems using earth return path such as HVDC substations / earthing stations in the vicinity of the entire pipeline route.

iii) Crossing and parallel running of electrified and non-electrified traction.

iv) Crossing or parallel running of any existing or proposed EHV/HV AC/DC overhead power lines.
v) Data regarding Voltage rating, phases, sheathing details of underground power cables along ROW or in its vicinity.

vi) Topographic Survey for the ground plots of anode ground bed, CP stations etc if required.

4.0 On completion of all field work, a report incorporating all the results generated from surveys and details of additional data collected, detailed interpretation of survey results and resistivity (on semilog graph sheets) data, probable interference prone areas, selected locations for anode ground beds, etc. to form a design basis for the scheme of cathodic protection shall be prepared. This report shall also include various drawings prepared in connection with the above work.

ANNEXURE-2

ANODES & ANODE GROUND BEDS

1.00 Sacrificial type Anodes & anode beds

a) Anodes of type 1 as per ASTM-B-418 standard shall be used for seawater, brackish water or saline electrolyte application and anode of type II as per ASTM – B -418 standard shall be used for fresh water, back fill and soil applications

b) Zinc anodes where soil resistivity predominantly remains ranges from 0-10 ohm.m and pH value is within 9.

c) Low potential magnesium anodes where soil resistivity range is from 10 ohm.m to 30 ohm.m

d) High potential magnesium anodes along ROW where soil resistivity is in the range from 30 ohm.m to 50 ohm.m. In the area, where the resistivity is of the order of 50 ohm.m and above magnesium ribbon anodes shall be installed all along the pipelines by the side of the pipeline in the pipeline trench.

. e) Anodes shall be installed along the pipeline at suitable intervals (not more than 1000 m apart) as per pipeline protection voltage attenuation calculations and ground bed resistance/current output of anode installations. At high resistivity area the magnesium ribbon anodes shall be installed.

f) Selected sacrificial anodes shall be checked for its suitability for the soil conditions with particular attention to carbonates, bicarbonates, phosphates, nitrates etc in the soil.

g) The anodes shall be laid in proper type of back fill along with suitable safe guards against anode passivation in prevailing soil, such that the effect of soil is minimum on the anode effectiveness and life shall be taken by the contractor.

h) Single type of anode shall be protected totally each section of electrically continuous pipeline

i) The anode shall be installed at sufficient depth to reach moist soil.

j) The anode shall be separated from the pipeline by at least 5m in case of magnesium anodes and 2 m for zinc anodes. The magnesium ribbon anode shall be separated from the pipeline by at least one meter.

k) The anode connections to pipe line shall be routed through test stations.

l) In case of temporary CP anode ground bed, the leads of all the anodes shall be joined together in a junction box filled with epoxy and buried. A single cable shall be routed from the junction box to test station.

m) In case of sacrificial anode ground bed which is intended for permanent CP system and /or which is to be integrated with permanent CP system, the test leads of all the anodes shall be brought up to the test station and shall be terminated.

n) The quantity of anodes at each ground bed shall be sufficient for providing the required protection current density considering the ground bed resistance, cable resistance etc.

o) Any deficiency in the protection system if noticed during the commissioning or during the monitoring shall be corrected by the CP Contractor by suitably augmenting the system with additional anodes without any extra cost to Employer.

1.0 Anode Ground Beds of Impressed CP System

i) Each CP station shall have an independent anode ground bed, shallow or deep well construction type.

ii) Ground bed shall be located away from the pipeline and foreign pipeline / other buried metallic structures, at least by 100 meters away preferably in moist strata and as far as possible, horizontal ground beds shall be at right angles to the pipeline.

iii) Anodes shall be of high silicon cast iron type or mixed metal oxide coated titanium anodes.

iv) Sheet steel anode canisters of adequate size filled with petroleum coke breeze shall be provided for each anode. In case of deep well ground beds non-canistered anodes with petroleum coke breeze in the well surrounding the anodes shall be provided.

v) Each shallow anode-bed shall be positioned horizontally or vertically in the soil with suitable backfill. The depth of anodes shall be minimum 2 meter from grade level.

vi) Layout shall show anode installation details, anode grouping, anode wiring, anode cable routing, etc, the details of anodes, deep well casing, anode positioning, anode cable supporting, deep well gas venting, active, passive portions of the ground bed, etc.

vii) Anodes shall be supplied complete with tail cables, which shall be long enough for termination on without intermediate joints.

viii) In case of two parallel pipelines running in the same ROW, the anode ground beds of the respective pipelines shall be located on the respective sides of the pipelines.

3.0 CP for Cased Crossing

i) The carrier pipe inside the painted or coated casing shall be protected by zinc ribbon anodes weld connected to the outer surface of bottom of carrier pipe extending up to hour hand positions of 4 and 8 O'clock. The anodes shall be at close intervals with minimum one number of anode installed between every two supports provided between carrier and casing. The anodes shall be sized based on the permanent CP design parameters for marshy area and design life of permanent CP system.

ii) In case, casing is coated, the casing shall also be protected by sacrificial anode installations provided at both ends of casing based on the permanent C.P. design parameters and design life of permanent CP system.

iii) Where casing is uncoated or unpainted additional protection for carrier pipe may not be required.

4.0 Details of Sacrificial type Anodes

4.1 Magnesium Anodes

i) The anode shall conform to the requirements of ASTM-B 843 standard. The anode shall be of high manganese, magnesium alloy packed with special back fill. The metallurgical composition, potential and consumption rate of anode shall be as below:

a) Metallurgical Composition

Element	**Weight** (High potential type)	**Weight** (Low potential type)
Manganese	0.5 – 1.3%	0.15 – 0.7%
Copper	0.02% max	0.02% max
Silicon	0.05% max.	0.1% max.
Zinc	--	2.5% - 3.5%
Aluminium	0.01% max	5.3% - 6.7%
Iron	0.03%	0.003 % max
Nickel	0.001% max	0.002% max.
Calcium	--	--
Other metallic elements Each	0.05% max	--
Total	0.3% max.	0.3% max
Magnesium	Balance	Balance
b) Anode open circuit potential	1.75 volts	1.55 volts
c) Anode consumption rate	7.9 kg/(A yr) max	7.9 kg/(A yr)max

4.2 Zinc Anodes

The anode shall conform to the requirements of ASTM-B 418 standard. The metallurgical composition of anode, potential and consumption rate of anodes shall be as below. The anode shall be packaged with special backfill except ribbon type anodes. The type of ribbon anode at cased crossing shall suit the type of soil outside the casing

i) Composition:

Element	Weight (Type I)	Weight (Type II)
a) Aluminium	0.1% to 0.5%	0.005 % max
b) Cadmium	0.025-0.07%	0.003% max.
c) Copper	0.005% max.	0.002% max.
d) Iron	0.005% max.	0.0014% max.
e) Lead	0.006% max.	0.003% max.
f) Others	0.01% max.	–
g) Zinc	Balance	Balance
ii) Anode open circuit potential	1.1 volts	1.1 volts
iii) Anode consumption rate	11.24kg/(A yr)max.	11.24kg/(A yr) max.

4.3 Miscellaneous Requirements

a) The anodes shall be provided with cable tail of sufficient length to reach test station/buried junction box, without any intermediate joint in the cable and with minimum of 1 m cable slack provided at each anode and test station ends.

b) The anode shall be pre packaged with special backfill of composition given below adequately and the thickness of back fill shall not be less than 50 mm on all the sides of the anode.

The composition of special back fill for anodes shall be as below:
Gypsum 75%
Bentonite 20%
Sodium Suplhate 5%

c) The anodes for grounding of CP protected above ground pipelines at intermediate distribution portions etc, grounding of motor operated valves on CP protected portion pipeline, grounding of pipeline through polarisation cell at EHV/HV line crossings or running in parallel, etc, shall be minimum 20 kg net weight each of sacrificial anode of the same type as the one provided for the protection of the pipeline.

5.0 Anode for Impressed Current CP system

5.1 High Sillicon Cast Iron Anodes

a) High silicon cast iron type anodes shall be center-connected hollow type or end connected solid type. Composition shall be as below and shall also conform to ASTM A518-86 Gr.III

Element	Weight
Silicon	14.2 – 14.75%
Manganese	1.5% max.
Carbon	0.7% - 1.1%
Chromium	3.25 – 5.0%
Copper	0.5% max.
Molybdenum	0.2% max.
Iron	Balance

b) Surface current density rating of the anode shall not be less than 10A/sq.m. for continuous operation.

b) Anode consumption rate shall not be more than 0.2 kg/AmpYr.

d) Sheet steel anode canisters of adequate size shall be provided for each anode for shallow anode ground bed filled with petroleum coke breeze with following specification conforming to IS: 8502, Grade-A type.

Chemical composition of petroleum coke breeze.
Fixed carbon content by mass : 99% min.

Ash by mass : 0.5% max.

Moisture by mass : 0.1% max

Volatile matters by mass : 0.5% Max

Bulk density : 800 kg/M_3 to 1200 kg/M_3

Real density : 2.03 kg/litre min.

Particle size : 1 mm max. dust free

Resistivity : 0.1 ohm cm max at 150 PSI

For deep well ground beds, calcined petroleum coke breeze slurry conforming to above shall be supplied along with the anodes.

5.2 Mixed Metal Oxide Coated Titanium Anode.

i) Mixed metal oxide coated titanium anodes shall be of pure titanium having substrate composition of titanium of ASTM B 338, Grade II, over laid with mixed oxide of noble metals (MMO coated) and shall be dimensionally stable. The anodes shall be centre connected sealed

tubular type.

ii) The design life of anode under burial condition, at the design operating current in minimum be the design life of the CP system specified.

iii) The guaranteed design parameters of anode regarding current density, consumption rate, design life, rated current output, dimensions, shape, noble metal oxide coating thickness (gm/square meter), their physical and mechanical properties shall be substantiated by manufacturer's published catalogues and backed up by type test reports.

iv) The anodes shall be provided with sheet steel canisters and coke breeze as described for HSCI anodes above.

5.3 Each anode shall be supplied with anode tail cable connected to it, which shall be long enough for termination on anode lead junction box without intermediate joint and joint of anode and cable shall be carried out at shop before dispatch of anode and and the joint insulated.

5.4 For deep well ground beds steel pipe casing for active portion of the ground bed and non metallic pipe casing for the tope inactive portion of the ground bed shall be provided. Anode supporting pipe, anode centralisers and gas venting pipes shall be provided for the ground bed.

5.5 Heat Shrunk Anode Cap : Each Anode shall be provided with anode Cap to prevent from any environmental degradation. The Caps shall be moulded out of radiation cross-linked Polyethylene material which shall be heat shrinkable and matching with the anode size.

6.0 Testing

6.1 In addition to the requirements specified elsewhere in this Technical Specification, following shall also apply. Inspection, routine tests and final acceptance tests shall be carried out at manufacturer's works.

6.3 **Sacrificial type Anodes & HSCI anodes**
a) Visual inspection on all the anodes regarding surface finish excessive shrinkage, cracks, cable joint to anode cone, etc.

b) Dimensional weight check of minimum 10% of number of anodes from each heat.

c) One anode per heat shall be subjected to radiographic test completely to evaluate cracks, voids, slag inclusion, etc.

d) At least one anode per heat shall be subject to destructive testing for slag inclusions, bond between the anode material and steel inserts.

e) One anode sample per heat shall be subject to chemical analysis by spectrographic method.

f) Type test certificate for electrochemical test such as open circuit potential, anode consumption rate, Visual examination of corrosion pattern (uneven consumption, inter granular attack, etc) shall be submitted to Employer. The test should have been conducted within the last two years otherwise fresh electrochemical test on One anode from the lot to be supplied shall be conducted for this project.

6.4 **Mixed Metal Oxide Coated Titanium Anode**

All the tests listed above under Cl 6.3 above shall generally applicable and the Contractor shall furnish list / details of the tests that will be conducted by manufacturer of anode and their acceptance criteria and the same shall be discussed and mutually agreed to.

6.5 **Petroleum coke breeze and special back fill**

The petroleum coke breeze material shall be tested for chemical composition, bulk density, real density, particle size and resistivity and test certificate shall be furnished. The special back fill material for the sacrificial anodes shall be tested for composition and test reports shall be submitted.

ANNEXURE-3

CP STATIONS AND CP TRANSFORMER / RECTIFIER UNITS

1.0 CATHODIC PROTECTION STATIONS

i) Minimum two numbers of CP stations shall be provided one each at the either end of the pipelines. The number and exact locations shall be based on the corrosion survey data to be collected and as per the guidelines below.

ii) Availability of nearby low resistivity areas for location of associated ground beds may be ensured, as far as possible, for selection of CP stations.

iii) The requisite current drainage tests / survey shall be conducted by the contractor to establish the adequacy of CP current requirement, adequacy of number, ratings of CP stations for permanent CP system indicated in the data sheet.

2.0 CP TRANSFORMER RECTIFIER UNIT

i) Cathodic protection power supply module and Cathodic Protection Transformer Rectifier Unit (TRU) shall be located indoor inside a permanent enclosure and the same shall be provided by the Contractor. One TRU shall be provided for each CP station.

3.0 SPECIFICATION FOR TRANSFORMER RECTIFIERS

3.1 **Scope**

This specification covers the manufacture, testing and inspection of transformer rectifiers for Cathodic Protection System.

3.2 The transformer rectifier units shall be a standard product of a manufacturer regularly engaged in production of Cathodic Protection power supplies. The units shall be supplied in accordance with the following specifications and data sheets.

3.3 **Applicable Standards**

If not otherwise indicated on "Data Sheet", transformer rectifier shall meet the requirement of IEC Recommendations.

IEC 76 Power Transformer

IEC 404-2 Methods of measuring magnetic and electrical properties of magnetic sheet and strip for transformers.

IEC 287 Calculation of the continuous current rating of cables.

IEC 144 Degree of protection of enclosures for low voltage switchgear and control gear.

IEC 146 Semiconductors convertors

IEC 296 Insulating oils for transformers and switchgear.

a) When no. IEC standard exists,, the standards of the country of origin shall be used but the bidder must state this in his offer and be prepared to submit copies of said standards in the English language.

b) NEMA Pub. No. MR-20-1953,, Reaffirmed by NEMA 1971,, 1975. Semiconductor rectifiers. Cathodic Protection Units.

c) NEMA Standard Publication/No. 250-1979,, including Rev. No. 1 December 1980 enclosures for electrical equipment (100 volts maximum).

d) ANSI 342 Practice and Requirements for Semiconductor Power Rectifiers.

e) NEPA-70-1981 National Electrical Code.

f) MIL-C-45662- Calibration systems requirements.

Transformer

The transformer will be the isolation type having separate primary and secondary windings. An electrostatic shield, composed of heavy copper foil, shall be placed between the two windings and grounded to the rectifier cabinet. The transformer core and windings shall be dipped in insulating materials to withstand 2,000 volts (RMS value at 50 hertz) applied for one minute between the windings and between each winding and the transformer core. Magnet wire insulation and transformer interlayer insulation shall be of class H type. Transformer lead wires will be not less than 500 circular mils of cross section area per ampere of A.C. Current carried at full load. The transformer will be dipped in thermo-setting varnish and baked. Transformer varnish will meet the standard for 155 degree C. operation. Actual transformer hot spot temperature rise will not exceed 85 degree C at full load in ambient temperature of 55oC.

Transformer regulation will not exceed 3% from full load to 1/4 rated load. Transformer efficiency will not be less than 95%. Magnetic core losses at full rated output will not exceed 0.83 watts per pound.

3.5 **Rectifying Elements**

The power rectifier units will be Silicon Controlled Rectifier (SCR's) mounted on heat sinks of sufficient size to prevent the temperature rise from exceeding 100oC at rated ambient temperature 55 $_{o}$ C. The peak inverse voltage ratio of the SCR's will be 2. The SCR's will be sized for 200% full load current rating of T/R unit.

3.6 **A.C. Input**

The transformer rectifier units shall operate on 230 Volts AC(+ 20%) single phase, 50 Hz power.

3.7 **DC Output**

The rectifier shall be capable of operating continuously at rated load at any output voltage from zero to 100% without damaging any rectifier components. Silicon Controlled Rectifier (SCR's) shall be used in the power circuit for control of the output voltage in automode.
The SCR's of the rectifiers will be controlled by commands from electronic circuit cards. These cards shall be the plug-in type printed circuit cards mounted on the front panel of the rectifier for easy field replacement. The printed circuit card contact pads will be gold plated to provide easy conduction and to eliminate contact corrosion.
Completed printed circuit controllers will be sealed with a circuit card sealant to prevent atmospheric corrosion and fungus contamination. Separate fast fuse shall be provided for protection of each SCR/DIODE.

3.8 **DC Output Adjustments / Control**

i) The DC output control shall be capable of operating in any of the following modes, with the help of a selector switch

ii) Manual Mode:
Output voltage control at 2 volt steps from 0 V shall be available by means of coarse and fine tap changing switches.

ii) Auto Mode :

A constant current control will be provided to set the output current to any value up to the rectifier rating. The output current shall not vary more than 1% while the output voltage may vary from zero to 100% depending upon the setting of the voltage control potentiometer. In the constant current mode, the voltage control potentiometer may be used to set the output voltage limit to a desired value.

3.9 **DC Output Ripple**

The single phase rectifiers shall have an output ripple not to exceed 5%

3.10 **Input Over Load Protection**

Protection from over loads on the input will be provided by moulded case, magnetic circuit breakers on the input side. These circuit breakers will hold at 100% of rated load. They may trip between 101% and 125% of the rated load and must trip at 125% and above. The trip point will be unaffected by ambient temperature. Circuit breakers will be the manually reset type. The trip handles of individual pole circuit breakers will be mechanically linked so all lines are opened when an overload occurs.

3.11 **Output Overload Protection**

Protection from overload on the output will be provided by an electronic current limiting feature. The current limit is to be set by current limit switches marked "coarse" & "fine". The coarse switch shall give limit of 0, 15A, 30A, 45A, 60A, 75A and so on upto required current level in steps of 15 A, while fine switch shall give limit of 0. 3A, 6A, 9A, 12A, 15A. The limit of the two switches shall be algebraically additive and shall give required steps of 3A each. The maximum current limit can be set by operator at any desired value in 3A step and in any circumstances

even in case of short circuit the output current should not exceed the maximum set current limit. In addition to above current limiting feature HRC fuse of suitable ratings to be used at positive and negative terminals to disconnect T/R unit quickly in case of over loads in the output circuit.

3.12 **Voltage Surge Protection**

Each silicon controlled rectifier (SCR) shall be protected from voltage surges by means of R-C circuitry. These devices will be rated such that they will conduct heavily before the peak inverse voltage rating of the SCR's is exceeded. In addition, lightning arrestors shall be provided in the AC input and DC output circuit of the rectifier.

3.11 Cooling

The rectifiers will be natural air cooled capable of operating simultaneously at rated output in ambient temperature of 55 degrees C.

3.12 Input and Output Terminals

DC terminals shall be located convenient to the cable entrance and shall be solderless pressure type terminals of tin plated copper. Output terminals shall be suitable for 50mm square cable cross section. Two negative and one positive output terminals shall be provided. AC terminals shall be insulated to withstand 2000 volts 50 Hz to the enclosure, shall be shielded to prevent accidental contact and shall be sized to take cable sizes of 25mm^2.

3.13 Meters

The transformer rectifier units shall be equipped with a separate continuous reading voltmeter and ammeter for the DC output and for the AC input voltage and current. These meters shall have a full scale capacity at least 10% above the output rating of the unit.

The transformer rectifier units shall also be supplied with a 0 to + 2.5 volt corrosion voltmeter with a 10 megaohm input impedance. This meter shall be connected to a two-way on and off selector switch to allow structure to electrolyte potential measurements to be taken with respect to either of two reference electrodes. This meter is not intended to control the output of the transformer rectifier. All meters shall be electronic digital type with LED display arrangement and should be able to indicate the current and voltage ranges as per data sheet upto three decimals. Digit size should be 15mm x 10mm (minimum). Meters shall be rectangular in shape and accurate to within + 2% of full scale at 55 ^{o} C. They shall be temperature compensated to vary no more than 1% per 10% temperature changes. All ammeters and voltmeters shall be provided with separate fuse and toggle switch.

3.13 **Annunciation**

Each transformer rectifier shall be supplied with a continuous signal light which will go out at loss of AC input. This light will be mounted on the top of the transformer rectifier unit.

3.15 Enclosures

All transformer rectifier units shall be located in non-classified area, shall be housed in air cooled enclosure vermin proof and shall be in IP 55 as per IEC or ISIS standards. Minimum cabinet thickness shall be 12 SWG. Accessibility shall be provided by hinged and removable front and sides or by hinged doors and removable chassis. A Plexiglas viewing window shall be provided to allow the meters to be read without opening the transformer rectifier unit. The enclosure shall be supplied with an engraved warning label with the words "DANGER". Transformer rectifier enclosure shall be furnished with gland plate mounted with double compression cable glands for the AC input, DC output and potential measurement cables as per the data sheet.

After fabrication the entire enclosure shall be sand blasted to Sa 2 1/2 SURFACE. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be a dark Grey shade of polyamide cured epoxy in three coats to achieve total thickness of 15 mils. 3.16 Enclosure Earthing All normally dead metallic parts shall be electrically continuous, one earthing

terminal suitable for 25mm square cable connection shall allow their connection to power supply earthing and two earthing terminals suitable for 35mm square cable connection shall allow an electrical connection to the local earthing pit.

3.17 NAME PLATE

A permanently stamped metal plate shall be attached to the outside of the case with the following information:

(a.) Manufacturer's name
(b.) Year of manufacture
(c.) AC input voltage and current rating
(d.) AC frequency
(e.) Phase
(f.) Maximum output DC Volts and Amps rating
(g.) Weight in Kg of T/R unit
(h.) Model number
(i.) Serial number

3.14 **Data Sheet of T/R Units**

The parameters for which the TR set is to be sized is given below. These represent a minimum requirement:-

Description Data

a) AC Input Voltage : 415/230 volts + 10%. 50 Hz three/single phase.
b) DC Power Output : As per system requirement
c) DC Output Voltage : As per system requirement
d) DC Output Current : As per system requirement
e) Current rating for Diodes/SCR's : 100% excess current capacity of T/R unit.
f) Full load Efficiency of Transformer Rectifier Assembly : More than 75%

g) Full load Efficiency of Transformer alone : More than 95%

h) Power Factor : 0.9 lagging
i) Insulation level : 2 KV
j) Peak Inverse Voltage of diodes/SCR's : 2 KV

k) Filtering Circuit : L.C. Filter
l) Ripple & Hum at rated output : Less than 5%
m) Surge Diverters fo Diodes/SCR's : R-C circuitry
n) Lightning Arrestor : At both input and output side of the T/R unit of voltage rating 280 V RMS, Max. Spark over voltage 3.0 KV Current discharge capacity 10 KA.

o) Protection : MCB having thermal over load and magnetic short circuit protection for input in addition to separate HRC fuse protection for each SCR/diodes and at output positive(+), Negative terminals.

p) Meters/Instruments : As per Sec. 3.1.13
1 No. DC Voltmeter

1 No. DC Ammeter
1 No. AC Voltmeter
1 No. Corrosion Meter : + 25000 MV
voltmeter with 10 megohm input resistance.

q) Enclosure : As per Specification.
r) Construction : Floor mounted indoor type
s) Cooling : Air cooled
t) Cable Entry : Through double compression gland for required sizes of cables
u) Enclosure painting : As per Specification
v) Fabrication, Schematic : Contractor to furnish prior to and
wiring diagram fabrication of T/R units.
w) Spare Parts : Supply as per Specification.

3.15 Required drawings & design documents and Instruction/Operation and maintenance manual submitted as per Employer's requirement after award of Contract.

ANNEXURE-4

TEST STATIONS
(COMMON FOR SACRIFICIAL & ICCP SYSTEM)

1.0 For monitoring the performance of the CP system, Test stations shall be provided along the ROW considering the following design criteria.

a) At sacrificial anode ground beds and at all insulating joints.
b) At both sides of metalled road crossings, major river crossings, cased crossings and at crossings of other pipelines / structures.
c) At locations with drastic changes in soil resistivity.
d) At railway line crossings and along lines running parallel to the pipeline.
f) At EHV/HV, AC/DC overhead line crossings, at locations where EHV/HV overhead line is in the vicinity of the pipeline, at EHV/HV cable crossings or along routes where EHV/HV cables are running in parallel.
g) At locations where interference problems are suspected.
h) At locations of pipe distribution valve stations.
i) At locations of surge diverters, polarization coupons, pipeline grounding through polarisation cells, zinc and magnesium anodes, reference cell, and electrical resistance probe installation etc.
j) At any other locations required by Employer during commissioning & testing period.

2.0 Test stations used for sacrificial anodes shall have shunt for measurement of anode current, provision for resistance insertion to limit the anode current output and anode disconnecting link. Test stations for bonding shall be provided with shunt and resistor as a means to monitor and control current flow between the pipeline and foreign pipelines or structures thatmay exist in common ROW.

3.0 Current measuring facility shall be provided at interference prone areas, on both sides of major river crossings, near marshy areas and minimum one for every 5 Km maximum along the pipeline and at each CP station drainage point.

4.0 Test stations, facing the pipeline shall be provided with nameplate of anodised aluminium with black back ground and white letters fixed to the inner side, with the information such as chainage in km, connection scheme, distance from pipeline in meter, direction of water flow etc.

5.0 Minimum two cables from the pipeline shall be provided at any test station and twenty percent spare terminals shall be provided. A detailed test-station schedule shall be prepared before implementation and got approved from Employer.

6.0 Test station enclosure shall be made of sheet steel of at least 3 mm thickness and shall be suitable for GI pipe post mounting. Test stations shall have weatherproof enclosure having degree of protection IP-55 or better and hinged locked shutter. The inner and outer surface of test stations shall be epoxy painted.

6.1 The resistors for control of current provided in the test stations, anode/cathode junction box. etc shall be of variable, grind coil type. The resistors shall be suitable for operation over the design life for the permanent CP system specified in the project specification/data sheet. At the locations of solid state polarisation cells the test station size be suitable for mounting the polarisation cell inside the test station.

ANNEXURE-5

MISCELLANEOUS EQUIPMENTS

1.0 POLARISATION COUPONS

1.1 To monitor the adequacy of the CP system to polarize / protect coating holidays steel coupons of pipeline material shall be provided along the pipeline at CP station drainage points, predicted cathodic protection mid points along the pipeline, at locations where the pipeline is bonded, interference prone areas, at locations such that minimum one coupon is installed for every 10 km approximate. The coupons shall be constructed from the pipeline material and shall have uncoated surface of 100 mm x 100mm exposed to soil. Two cables one for connection to pipeline for protection and other for potential measurement shall be provided for each coupon. The protection cable shall be connected through a magnetic reed switch inside the test station to enable measurement of coupon 'OFF' potential. A permanent reference electrode shall be installed adjacent to the coupon in a manner so as to measure the representative potential of the coupon. Magnets for operation of reed switch shall also be provided.

1.2 The polarisation Couposn shall be made from the material of the pipeline. The coupon shall have one side exposed area of 100 mm x 100 mm. Cable connection of 10mm^2 and 4 mm^2 shall be provided to the coupon for connecting it to pipeline for cathodic protection and potential measurements respectively. Connection of coupon to pipeline shall be through a vacuum sealed magnetic reed switch housed inside the test station. The magnetic reed switch shall be rated to carry and break minimum 50mA at 50 V DC.

2.0 SURGE DIVERTER AND POLARISATION CELL

1.1 Surge Diverter

i) Explosion proof spark gap surge diverter shall be provided across each insulating joint to protect it from high voltage surges. coming across it due to lightning strikes, electrical faults, etc. on the above ground portion of the pipeline. The surge diverter shall be of spark gap type. The device shall have weatherproof enclosure suitable for out door mounting. The surge diverters shall be of explosion proof type.

ii) The minimum ratings of the device shall be as below:-
a) Type : Spark gap, explosion proof type.
b) Current, 8/20 micro second wave : 100 Kilo Amp.
c) Spark – over AC voltage - 50 Hz : 1 KV
- Impulse (1.2/50 microsecond) : 2.2 KV

2.2 **Polarisation Cell**

i) At each crossing or parallel run of pipeline and overhead 66 KV and above EHV lines, the pipeline shall be grounded through polarisation cell with zinc galvanic anodes of minimum 20 kg net each. In case transmission lines are running parallel within 25 meters of the pipeline, the Grounding shall be done at regular intervals of maximum 1 km to control any surges.

ii) The Polarisation cell shall be installed inside test station. The minimum ratings of the device shall be as below:-

iii) Polarisation cell shall be a soilid state device designed to simultaneously provide isolation for

DC current and low resistance path for AC current. The device shall have weather proof enclosure and shall be suitable for mounting inside a test station. the DC blocking voltage shall not be less than 1.2 volts. The DC leakage current at 1.2 volt shall not be more than 0.5 mA. The minimum ratings of the device shall be as below:-

DESCRIPTION	RATING
- 50Hz steady state current	35A min at 65^{0}C and min 2V DC
- AC fault current	6 kA min for 1 cycle, 3.5kA min for 30 cycles
-AC voltage under maximum rated AC fault current	Less than 10 V peak to peak

2.3 The surge diverter and polarisation cell system shall be suitable for the design life of permanent CP system.

2.4 Motor operated valves (MOV) where located on the cathodically protected portion of the pipeline shall be grounded by a zinc anode of 20 kg net where the type of anode provided for the CP system of the pipeline is zinc or magnesium respectively.

2.5 The above ground cathodically un-protectd pipeline at terminals, intermediate distribution stations , etc. shall be earthed with GI earth electrodes and resistance to earth of grounding shall be limited to 5 ohms max.. Each electrodes shall be 100 mm dia, 3000 mm long, and 13 mm thick conformity to IS 3043.

3.0 PERMANENT REFERENCE CELLS

i) High purity copper / copper sulphate reference cells (Silver/Silver Chloride type in place of copper / copper sulphate cells at marshy area locations, where water table is high and chloride concentration is more than 300 ppm) shall be provided for potential measurement of stable coupon to soil at the locations of polarization coupons and at CP stations of Impressed Current CP System.

ii) The test station connection scheme shall clearly indicate the type of the reference electrode (Cu CuSO4/Ag AgCl).

iii) The permanent reference cells shall have a required design life under installed / buried condition and in high resistivity area, the same shall be suitable for the prevailing dry soil conditions.

iv) The permanent reference cells shall be installed in natural soil conditions as per the recommendations of the cell manufacturer.

v) The reference cells shall be provided with cable tail long enough for connection to without any joint in between up to CP power source at CP stations and up to test stations at the locations of polarization coupons. The cable up to CP power source shall be routed through test stations near pipelines.

4.0 ELECTRICAL RESISTANCE PROBE

i) At the bottom portion of pipeline, Electrical resistance probes (E/R probes) utilising the electrical resistance technique shall be provided along the pipeline at marshy areas (if applicable) and at vulnerable location to monitor the external corrosion activity on the pipeline.

ii) The material of the E/R probe element shall be of the same alloy as of the pipeline material.

iii) The lead-wires of the probe shall be connected to pipeline through test station and terminated inside test station enabling periodic resistance measurement of the probe using a portable probe measuring instrument.

iv) One number Portable E/R probe reading instrument shall be supplied and the same shall be suitable for use in field and shall have IP 55, weatherproof enclosure. The probe reading instrument shall be of digital type with 3.5 digit display. The instrument shall run on rechargeable batteries. The instrument shall be able to directly read out the resistance of probes.

5.0 REFERENCE CELL ACCESS POINTS

Reference cell access points near insulating joint locations wherever the ground is paved, for measurement of pipe to soil potentials shall be provided. A perforated PVC pipe filled with native soil and buried at the location shall be provided for the purpose. The length of the PVC pipe shall be adequate to reach the native soil below the paving.

6.0 ANODE JUNCTION BOX

i) Each ground bed shall be provided with one or more anode junction boxes depending on the size of anode ground beds,. All tail cable from individual anodes shall be terminated onto the respective anode junction boxes, which shall be further connected to the main anode junction box (where applicable) which in turn shall be connected to the cable coming from CP power source.

ii) Junction boxes shall have sheet steel enclosure of minimum 3 mm thickness and hinged lockable shutters and shall be weatherproof with degree of protection IP – 55. It shall be epoxy painted on inside and outside surface.

iii) Junction boxes shall have anode bus of copper with nickel/ silver plated or tinned.

iv) Provision shall be made for measurement and control of individual out going circuit /anode current by providing suitable shunt and resistors of grid coil type and each outgoing citcuit shall be labeled.

v) Disconnecting links shall be provided for each out going / anode circuit. 30% spare out going circuits shall be provided in each anode junction box.

vi) A nameplate of anodised aluminium with black back ground and white letters shall be fixed to the inner side of the junction box shall be provided with the information such as Ground bed current rating, Ground bed resistance, Connection scheme, Distance from pipeline and CP station in metres.

7.0 CATHODE JUNCTION BOX

i) A cathode junction box shall be provided near the pipelines - wherever output of the CP power supply unit is connected to multiple pipelines-at the location of connection of the negative drainage cable to the pipelines.

ii) The negative of the CP power source shall be connected to the incoming circuit of the cathode junction box. The junction box shall have separate out-going circuit one for each pipeline to collect the negative drainage currents from each of the parallel pipelines.

iii) The incoming circuit shall have a current measurement shunt. Each out going circuits shall have isolation link, variable resistance of grid coil type and a current measurement shunt. One number spare outgoing circuit shall be provided.

iv) Junction boxes shall have sheet steel enclosure of minimum 3 mm thickness and hinged lockable shutters and shall be weatherproof with degree of protection IP – 55. It shall be epoxy painted on inside and outside surface. Identification labelling shall be provided for each terminal and shall clearly indicate the size and identification of the pipeline to which it is connected.

v) A nameplate of anodised aluminium with black back ground and white letters shall be fixed to the inner side of the junction box shall be provided with the information such as Chainage in KM, Connection scheme, Direction of flow in pipeline, Distance from pipeline and CP station in metres.

9.0 CABLES

i) Cables shall be with annealed high conductivity stranded copper conductor, PVC insulated, 650/1100 V grade, armoured, PVC sheathed conforming to IS 1554 Part – I, except for the cables for anode tail, reference cells and pipeline for potential measurements.

ii) The minimum size of the copper conductor shall be:

a) 6 sq.mm (minimum) for anode tail cable from anode to buried junction box or test station (in case of permanent CP anode ground bed).

b) 10 sq.mm (minimum) from buried junction box to test station and from test station to pipeline.

c) 10 sq.mm (minimum) for polarisation coupon protection cable.

d) 25 sq.mm(minimum) for bonding, polarisation cell, grounding anodes and surge diverter connections or shall be suitable for the maximum fault current.

e) 35 sq.mm (minimum) for positive & negative drainage cables and 10 sq.mm for anode tail cables of ICCP System

f) 6 sq.mm for current measurement.

g) 4 sq.mm (minimum) copper conductor, 650/1100V grade, PVC insulated, armoured, PVC sheathed for the TRU incomer cable. The cable shall be of 3 core type for single phase units and of 4 core type for 3 phase TRU.

iii) The length of anode tail cable shall be sufficient for routing from anode to buried junction box or test station for anode for temporary CP or permanent CP
respectively.

iv) The cables for reference cells, coupon and pipeline potential measurements shall be of 4 sq.mm copper conductor, PVC insulated, Aluminium backed by mylar / polyster tape shielded, PVC sheathed, armoured, PVC over all sheathed type.

v) The anode tail cables shall be PE insulated, 650V grade, unarmoured, PVC sheathed and length shall be sufficient without any joint in between.

vi) Cable conductor sizes indicated above are minimum only and higher sized cables shall be provided for proper operation of the CP system.

vii) **Cable Laying**

a) Cables shall be laid in accordance with layout drawings. No straight through joint shall be permitted. Cable route shall be carefully measured and cables cut to required length. Minimum one meter cable slack shall be provided near anodes, anode junction box, pipeline and test stations to account for any settling.

b) All cables inside station / plant area shall be laid at a depth of 1. 0 metre. Cables outside station / plant area shall be laid at a depth of minimum 1.5 metres.

c) Cables shall be laid in sand under brick cover and back filled with normal soil. For cables laid outside the station /plant area, polyethylene warning mats shall be placed at a depth of 0.9 metre from the finished grade, to mark the route.

d) In case of above ground cables, all unarmoured CP cables shall be laid in GI conduits for protecting against the mechanical damage.

e) All underground unarmoured cables including anode tail cables shall run through PE sleeves. Permanent reference cell cables routed along the pipeline shall be carried at the top of the carrier pipe by securely strapping it at intervals.

f) PVC pipes of proper class & size shall be provided for all underground cables for road crossings.

g) The cables for reference cells and pipeline potential measurement shall be routed in a separate trench other than the trench provided for the rest of the CP system cables, AC cables for TRU units etc.

h) The armour of the cables from CP station to test station (potential measurement, reference cell & drainage cables etc.), CP station to ground bed (anode cable) and test station to pipeline shall be earthed only at CP station end and test station end respectively of the cables. The cable armour shall be insulated to avoid armour carrying
CP current.

vi) **Cable to Pipe Connections**

a) Connections of all cables other than cathode drainage cables to the pipeline or to charged pipelines shall be made by low temperature thermit welding as per the established procedure and anode cap shall be filled up with Epoxy hardener. The strength of the joint shall be tested by striking with hammer. The resistance of the cable to pipe at the pin brazing connection point shall not exceed 0.1 ohm.

b) The cathode drainage cable shall be connected to a bolt welded to a metal plate, which is weld connected to the pipeline. The material of the plate shall be same as that of the material of the pipeline.

c) Pipe coating shall be repaired after connection of cable to pipeline. The coating repair material shall be compatible with the original coating and shall prevent ingress of water along the cable surface and at the interface of coating repair with the original pipe coating.

	QUALITY PLAN	CUSTOMER: NTPC	PROJECT: 2X660MW NTPC KHARGONE STPP (PROPOSAL)	PO No.:	-
		BIDDER/VENDOR: -	SPEC. NO :	QP No.:	Rev-00
		SYSTEM: GRP PIPING SYSTEM	ITEM: GRP PIPES & FITTINGS	Issue Date :	27.08.2014

S.No	Component/ Operation	Characteristics Checked	Category	Type/ Method of Check	Extent of Check	Reference Document/ Standard	Acceptance Norms	Format of Records	Agency			Remarks
									P	W	V	
1.0	2	3	4	5	6	7	8	9	10			11
1.0	**GRP PIPES**											
1.1	Acceptance Tests	Dimensions (OD)	MA	Measurement	100%	IS 14402 :1996 & BS - EN 14364 : 2006 & also Technical data sheet of vendor	$	INSPECTION REPORT	2	1	-	Two Sample from every 100 Pipes to be witnessed by BHEL +Test certificates of 100% pipes tested by Vender to be verified by BHEL/BHEL Authorised Representative.
1.2		Wall Thickness	MA	Measurement			$	INSPECTION REPORT	2	1	-	
1.3		Workmanship	MA	Visual			IS 14402:1996;Cl.9	INSPECTION REPORT	2	1	-	
1.4		Soundness of Pipe (Hydrotest)	CR	Annex C,IS 14402			IS 14402:1996;Cl.12.2 (Two times Pressure Class)	INSPECTION REPORT	2	1, 4	-	
1.5		Nominal Length	MA	Measurement			As per Customer requirements	INSPECTION REPORT	2	1	-	
1.6		Marking	MA	Visual			As per Customer requirements	INSPECTION REPORT	2	1	-	
1.7		Barcol Hardness	MA	ASTM D - 2583			Min 40	INSPECTION REPORT	2	1	-	
1.8	Destructive Tests	Pipe Stiffness & Deflection	CR	Annex B,IS 14402	One sample from every 100 Pipes. (Min Two samples per Lot)		IS 14402:1996;Cl.10	INSPECTION REPORT	2	1, 4	-	One sample from every 100 Pipes. (Min Two samples per Lot)
1.9		Longitudinal Tensile Strength	CR	Annex D,IS 14402			IS 14402:1996; Cl.13 Table-06	INSPECTION REPORT	2	1, 4	-	
1.10		Hoop Tensile Strength	CR	Annex E,IS 14402			IS 14402:1996; Cl.14 Table-07	INSPECTION REPORT	2	1, 4	-	
1.11		Composition	CR	ISO 1172, ASTM D-2584			% Resin, Glass & Sand	INSPECTION REPORT	2	1	-	
1.12	Type Tests / Long term Tests	Hydrostatic Design Basis (HDB)	MA	Annex F,IS 12709	6 Samples (3Samples for 100Hrs and 3Samples for 1000Hrs)		IS 14402:1996;Cl.15	INSPECTION REPORT	2	1	4	Vendor to submit valid TEST Certificate to be vetted by BHEL . However if the conductance of test is found necessary by BHEL , material to meet delivery requirement will be supplied by vendor to site at his risk and cost till successful conductance of test.
1.13		Chemical Resistance of Pipe (Strain Corrosion test)	MA	Annex F,IS 14402			IS 14402:1996;Cl.16	INSPECTION REPORT	2	1	4	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURES		
	DATE		BIDDER/VENDERS COMPANY SEAL

	QUALITY PLAN	CUSTOMER: NTPC	PROJECT: 2X660MW NTPC KHARGONE STPP (PROPOSAL)	PO No.:	-
		BIDDER/VENDOR: -	SPEC. NO :	QP No.:	Rev-00
		SYSTEM: GRP PIPING SYSTEM	ITEM: GRP PIPES & FITTINGS	Issue Date :	27.08.2014

S.No	Component/ Operation	Characteristics Checked	Category	Type/ Method of Check	Extent of Check	Reference Document/ Standard	Acceptance Norms	Format of Records	Agency			Remarks
									P	W	V	
1.0	2	3	4	5	6	7	8	9	10			11
2.0	**GRP PUSHFIT GASKETED COUPLING**											
2.1	Acceptance Tests	Hydrotest	CR	Annex C,IS 14402	100%	IS 14402 :1996	IS 14402:1996;Cl.12.2 (Two times Pressure Class)	INSPECTION REPORT	2	1, 4	-	Two Sample from every 100 Coupling to be witnessed by BHEL +Test certificates of 100% couplings tested by Vender to be verified by BHEL/BHEL Authorised Representative.
3.0	**GRP FITTINGS**											
3.1	Acceptance Tests	Workmanship	MA	Visual	100%	IS:14402 :1996	As per Vendor SPEC/STD/APPD DWGS	INSPECTION REPORT	2	1	-	One Sample per Type & Lot to be witnessed by BHEL +Test certificates of 100% fittings by Vender to be verified by BHEL/BHEL Authorised Representative.
3.2		Dimensions	MA	Measurement			As per Approved Drawings	INSPECTION REPORT	2	1	-	
3.3		Hydrotest	MA	Visual	For Bends, Lamination joint strength may be alternatively checked at shop by hydrotesting of straight pipe (One number per size) with lamination joint at pressure twice pressure class. For other fittings, One number of fitting each type & size shall be hydro tested at shop at pressure twice pressure class.		Fittings shall not show any leakage or Burst when tested at twice pressure class for 1 min at room temperature.	INSPECTION REPORT	2	1	-	Lamination joint shall be as per manufacturer standards and Pipe will be offered for testing after completion of lamination joint. Samples as per Col.6 to be selected by BHEL/BHEL Authorised Representative.
4.0	**PACKING**											
4.1	Acceptance Tests	Workmanship	MA	Visual	**100%**	IS 14402 :1996	As per SPEC/STD/ARPPD DWGS	INSPECTION REPORT	2	-	-	Compliance certificates for packing to be submitted by Vendor.
		Dimensions	MA	Measurement			As per Approved Drawings	INSPECTION REPORT	2	-	-	

Notes :

1. In case of Long Term tests are requried to be carried out as per IS14402, the dispatches to be made pending the test results to meet delivery requirement.
2. Factory Hydro Test for Pipes, Couplings & Fittings will be done at pressure Twice the pressure class & Holding Time of One Minute as per IS:14402.
3. P = Performed by,W = Witnessed by,V = Verified by,1= BHEL /BHEL Authorised Representative, 2 = Vendor , 3 = sub vendor , 4= Customer / Customer Representative; MA = Major , CR = Critical , IS - Indian Standard
4. BHEL /Customer or Authorised Representative may witness at any stage as deemed necessary during the contract execution.
5. Samples selected by BHEL for HYDRO test will only be identified by marking.
6. Lot size is the quantity offered in one inspection call/one inspection visit.

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURES		
	DATE		BIDDER/VENDERS COMPANY SEAL

Technical Delivery Conditions for IS 3589 Pipes

1.0 SCOPE

1.1 This Technical Delivery Conditions specify the requirements in addition to IS:3589 for electrically welded (ERW \ SAW) steel pipes.

1.2 The pipes are intended for water services (under Non-IBR Piping system only).

1.3 The pipes shall conform to the size, grade and quantity as specified in the purchase order.

2.0 MATERIAL

2.1 The plates / coils used for pipe shall meet the requirements as per IS: 3589 Grade Fe 410 MPa including mechanical test requirements.

3.0 DIMENSIONAL TOLERANCES

3.1 The tolerances limits are:

a) OD:- Upto NB 1600 mm: $\pm$ 4 mm; Above NB 1600 mm: $\pm$ 6mm

b) Thickness:- Upto 14mm : +1.3mm / -0.8mm; Above 14 mm : +1.4mm / - 0.8mm.

c) Ovality (Difference between major and minor inside diameter): 0.5% maximum

d) Squareness of ends: The ends of pipe section shall not vary by more than 3mm at any point from a true plane perpendicular to the axis of the pipe and passing through the center of the pipe at the end.

e) Length and quantity tolerance as per P.O.

3.2 Other tolerances shall be as per IS: 3589

4.0 MANUFACTURING

4.1 The pipe shall be of longitudinally welded or spirally welded as indicated in the P.O.

4.2 The ends shall be edge prepared as indicated in the purchase order.

4.3 Circumferential seams shall be minimum 1500 mm apart from each other and from ends.

4.4 All pipes shall be completely finished and free from surface, sub surface defects such as pits, cracks, weld spatters & laminations etc..

5.0 NDE

5.1 For Pipe dia less than 1000mm:- 100 % Hydro test on each pipe + Radiography test for 100mm weld length at both the ends for 10% of the pipes.

5.2 For Pipe dia 1000 mm & above :-The NDT for each pipe shall be done by any one of the following options. The vendor shall indicate their choice in the offer.

a) 100 % Hydro test along with Radiography test for 100mm weld length on both the ends of each pipe.

b) 100 % Ultrasonic test + 10 % Radiography test on weld length (including all T- joints and 100mm weld length at both the ends) for each pipe.

c) 100 % Radiography test on weld length of each pipe.

5.3 The Ultrasonic test / Radiography test shall be carried out as per ASME Sec-V and shall be accepted as per ASME B31.1 Cl:136.4.6 / Cl:136.4.5.

6.0 INSPECTION

6.1 All pipes shall be inspected by the vendor prior to BHEL / Customers' Inspection. BHEL or BHEL authorized inspector / Customer will select the pipes at random and carryout the inspection. The necessary Material Despatch Clearance Certificate is to be obtained by the vendor prior to the despatch of material.

7.0 PAINTING AND PACKING

7.1 The pipes if dispatched to BHEL Stores shall be coated with resin type translucent rust preventive on the outside unless otherwise specified in the P.O. Pipes of diameter above NB 450 mm, shall be coated inside also.

7.2 The pipes if dispatched to project site directly shall be coated outside & inside as indicated in P.O.

7.3 In case of any special coating like PU, Glass Flake etc.. the vendor shall get BHEL approval for their QP and Procedure for application of coating.

7.4 Internal coating shall not be applied for 100mm length from each end to facilitate site joints.

7.5 Spiders are to be provided on both ends of the pipes as per the drawing indicated in the enquiry / Purchase Order.

8.0 MARKING

8.1 The pipes dispatched to **BHEL Stores** shall be **paint stencilled & hard punched** with the following details.

1) PO Number 2) Supplier's emblem/code 3) Size & Specification 4) Heat number 5) Pipe number 6) Inspector's seal

8.2 The pipes despatched directly to project site as **DTS**, the following details (furnished in the P.O. or separately) shall be **paint stencilled & hard punched** on both ends of the pipes in addition to the above.

- Work order No
- DU No
- Project name
- Quantity
- Weight

8.3 For the pipe dia 1000mm and above marking shall be done on internal surface in the uncoated area (i.e) within 100mm from pipe ends. The hard punching shall be done at one end and paint stencilling at other end. In case of pipes of dia less than 1000mm the marking shall be done on outside surface.

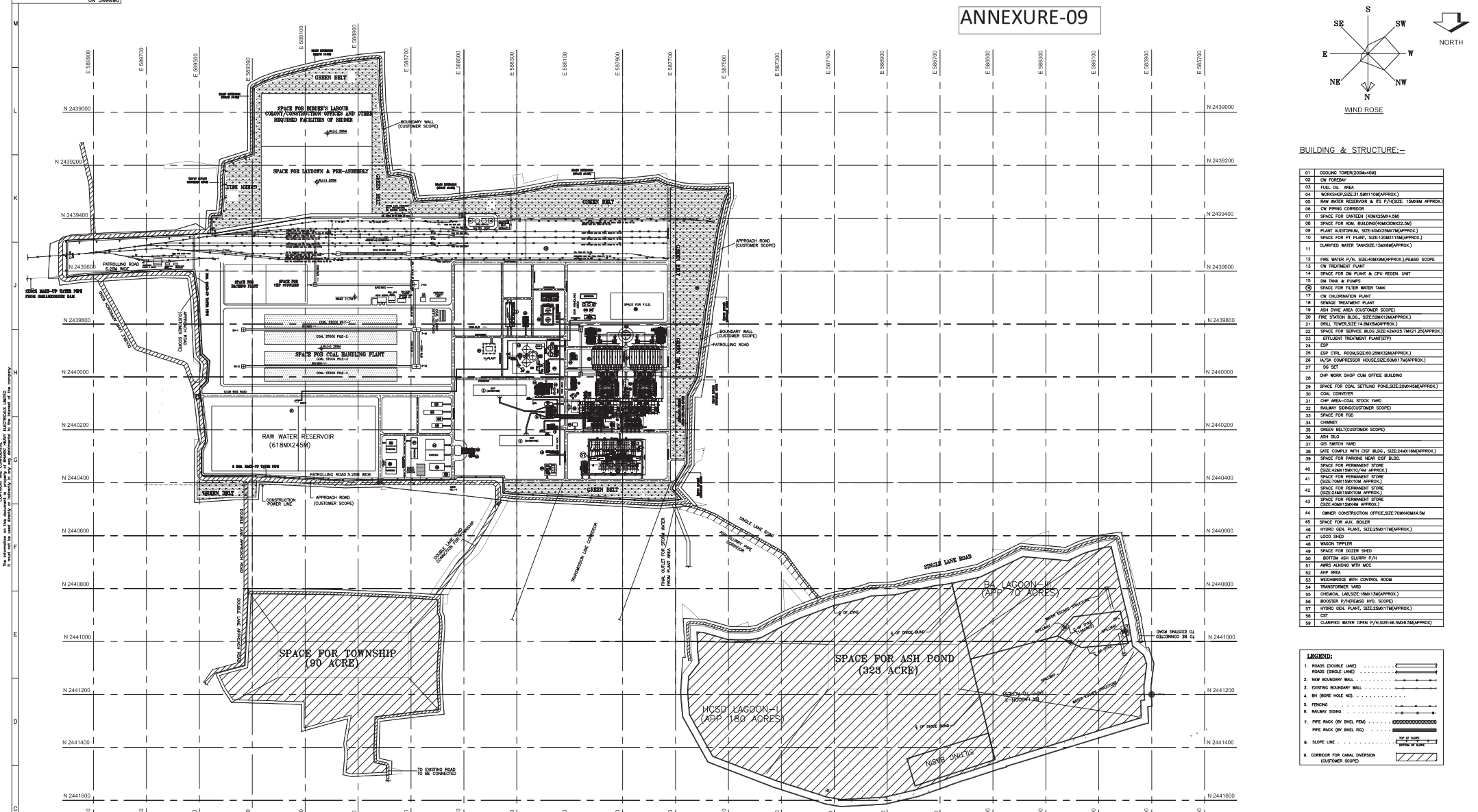
9.0 CERTIFICATES

9.1 Three original test certificates typed in English shall be submitted along with the inspection report.

9.2 The test certificate shall furnish the following details.

a. BHEL P.O Number & Amendment Number(if any)
b. BHEL P.O. Serial Number
c. Test Certificate number.
d. Specification, grade, size, quantity
e. Heat number of plate (or pipe number with traceability to heat number)
f. Chemical composition and Mechanical properties
g. Hydrostatic test, UT, RT reports as applicable.
h. Dimensional report
i. Painting details

ANNEXURE-09



BUILDING & STRUCTURE:–

01	COOLING TOWER(200Mx40M)
02	CW FOREBAY
03	FUEL OIL AREA
04	WORKSHOP,SIZE:31.5MX110M(APPROX.)
05	RAW WATER RESERVOIR & ITS P/H(SIZE: 15MX6M APPROX.)
06	CW PIPING CORRIDOR
07	SPACE FOR CANTEEN (40MX25MX4.5M)
08	SPACE FOR ADM. BUILDING(40MX30MX22.5M)
09	PLANT AUDITORIUM, SIZE:40MX25MX7M(APPROX.)
10	SPACE FOR PT PLANT, SIZE:120MX115M(APPROX.)
11	CLARIFIED WATER TANKSIZE:15MX6M(APPROX.)
12	FIRE WATER P/H, SIZE:40MX9M(APPROX.),PE&SD SCOPE
13	CW TREATMENT PLANT
14	SPACE FOR DM PLANT & CPU REGEN. UNIT
15	DM TANK & PUMPS
16	SPACE FOR FILTER WATER TANK
17	CW CHLORINATION PLANT
18	SEWAGE TREATMENT PLANT
19	ASH DYKE AREA (CUSTOMER SCOPE)
20	FIRE STATION BLDG., SIZE:52MX12M(APPROX.)
21	DRILL TOWER,SIZE:14.8MX5M(APPROX.)
22	SPACE FOR SERVICE BLDG.,SIZE:42MX25.7MX21.25M(APPROX.)
23	EFFLUENT TREATMENT PLANT(ETP)
24	ESP
25	ESP CTRL. ROOM,SIZE:60.25MX32M(APPROX.)
26	IA/SA COMPRESSOR HOUSE,SIZE:50MX17M(APPROX.)
27	DG SET
28	CHP WORK SHOP CUM OFFICE BUILDING
29	SPACE FOR COAL SETTLING POND,SIZE:20MX45M(APPROX.)
30	COAL CONVEYER
31	CHP AREA–COAL STOCK YARD
32	RAILWAY SIDING(CUSTOMER SCOPE)
33	SPACE FOR FSD
34	CHIMNEY
35	GREEN BELT(CUSTOMER SCOPE)
36	ASH SILO
37	GIS SWITCH YARD
38	GATE COMPLX WITH CISF BLDG., SIZE:24MX16M(APPROX.)
39	SPACE FOR PARKING NEAR CISF BLDG.
40	SPACE FOR PERMANENT STORE (SIZE:42MX15MX10/4M APPROX.)
41	SPACE FOR PERMANENT STORE (SIZE:70MX15MX10M APPROX.)
42	SPACE FOR PERMANENT STORE (SIZE:24MX15MX10M APPROX.)
43	SPACE FOR PERMANENT STORE (SIZE:40MX15MX4M APPROX.)
44	OWNER CONSTRUCTION OFFICE,SIZE:70MX40MX4.5M
45	SPACE FOR AUX. BOILER
46	HYDRO GEN. PLANT, SIZE:25MX17M(APPROX.)
47	LOCO SHED
48	WAGON TIPPLER
49	SPACE FOR DOZER SHED
50	BOTTOM ASH SLURRY P/H
51	AWRS ALNDING WITH MCC
52	AHP AREA
53	WEIGHBRIDGE WITH CONTROL ROOM
54	TRANSFORMER YARD
55	CHEMICAL LAB,SIZE:18MX13M(APPROX.)
56	BOOSTER P/H(PE&SD HYD. SCOPE)
57	HYDRO GEN. PLANT, SIZE:25MX17M(APPROX.)
58	CST
59	CLARIFIED WATER OPEN P/H,SIZE:46.5MX6.5M(APPROX)

LEGEND:

1. ROADS (DOUBLE LANE)
   ROADS (SINGLE LANE)
2. NEW BOUNDARY WALL
3. EXISTING BOUNDARY WALL
4. BH (BORE HOLE NO).
5. FENCING
6. RAILWAY SIDING
7. PIPE RACK (BY BHEL PEM)
   PIPE RACK (BY BHEL ISG)
8. SLOPE LINE (TOP OF SLOPE / BOTTOM OF SLOPE)
9. CORRIDOR FOR CANAL DIVERSION (CUSTOMER SCOPE)

NOTES

1. FINISH GROUND LEVEL: RL(+) 254.0M
2. ALL ELEVATIONS ARE REFERRED TO POWER HOUSE FINISHED GROUND FLOOR ELEVATION ± 0.00M WHICH CORRESPONDS TO RL(+) 254.5M
3. BOILER AREA FINISHED GRADED LEVEL IS 200MM BELOW 0.0M i.e. RL 254.3M
4. TRANSFORMER YARD FINISHED GRADED LEVEL IS 100MM BELOW 0.0M i.e. RL 254.4M
5. LOCAL SHEDS SHALL BE REMOVED AND AREA CLEARED AFTER VACATION OF SHEDS BY CONCERNED AGENCY.
6. COOLING TOWER ORIENTATION MODIFIED AS PER WIND DIRECTION.

PROGRESSIVE PRINT,DT.13.08.14

FOR TENDER PURPOSE ONLY

THE DRAWING IS TYPICAL FOR TENDER PURPOSE AND NOT BINDING FOR EXECUTION. HOWEVER BASED ON FINAL TURBINE CONFIGURATION,ESP & ELECTRICAL SCHEME (STATION TRANSFORMER/GCB) BEING OFFERRED, THE DRAWING SHALL BE SUITABLY MODIFIED.

REV.	DATE	ALTD	CHD	APPD
02				
01				

CUSTOMER

JOB NO. K13
STATUS PROPOSAL
DISTRIBUTION
TO
No. OF

NATIONAL THERMAL POWER CORPORATION LTD.

KHARGONE SUPER THERMAL POWER PROJECT (2X660 MW)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE	NAME	SIGN	DATE
DRN	GKM		13.08.2014
DESN	SKM		13.08.2014
CHD	SK		13.08.2014
APPD	J. JAMES		13.08.2014

TITLE

PLOT PLAN

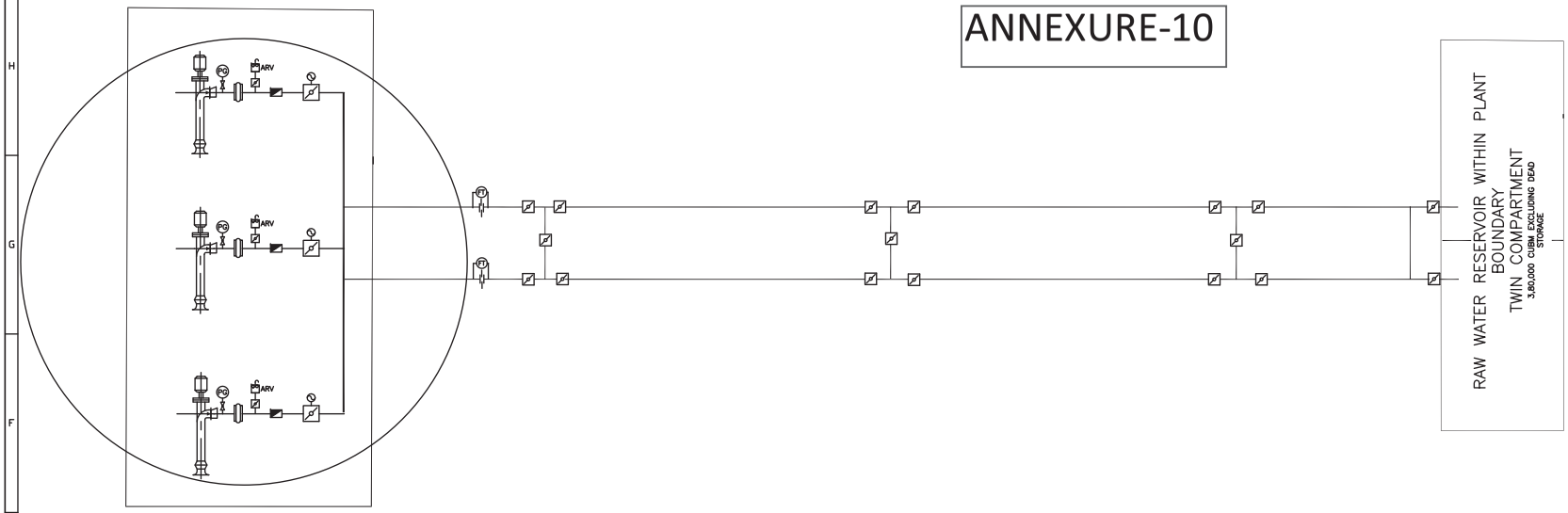
DEPT. SCALE: 1:4850 DRAWING NO. PE-DG-K13-100-M001
SIGN
DATE
SHEET 1 OF 1 REV. 00

FORMAT SIZE A0

DRAWING NO. PE-DG-K13-100-M001

ELECTRONIC FILE NAME PE-DG-K13-100-M001

ANNEXURE-10



MAKE UP WATER
PUMP HOUSE
AT OMKESHWAR DAM

LEGEND

- VERTICAL PUMP
- RE JOINT
- AIR RELEASE VALVE
- NON RETURN VALVE
- MOTOR OPERATED BUTTERFLY VALVE
- MANUAL BUTTERFLY VALVE
- (PG) PRESSURE GAUGE
- (FT) FLOW TRANSMITTER
- (LT) LEVEL TRANSMITTER (SHALL BE INDIACTED DDE).
- (PT) PRESSURE TRANSMITTER (SHALL BE INDIACTED DDE).

NOTES:–

For scope of supply & services for Make-up water Piping from Omkeshwar dam to Raw Water Reservoir within Plant boundary, Please refer attached technical specification.(refer Section C ,sub, sec-I)

For Material, Coating & other details for Make-up water Piping, please refer sub-sections as mentioned below:

1) MS PIPE, Coating, Laying & other details - Sub section A-09, Make-up Water Piping, Section VI Part B of Customer specification.
2) GRP and DI PIPE: Sub section A-08, Low Pressure Piping, Section VI Part B of Customer specification.

OWNER	NTPC LIMITED
CONSULTANT	
PROJECT	2X660MW KHARGONE STPP

JOB NO. K-13
STATUS PROPOSAL
DISTRIBUTION (INTERNAL)

TO				
NO.				
REV.	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NOIDA

	NAME	SIGN	DATE
DRN.	KS/TM		
CHD.	AJ		
APPD	AS/IJ		

TITLE: MAKE–UP WATER SYSTEM P&ID

MAUX	MPL	C&I	DEPT.	SCALE 1:1	DRAWING NO.
			SIGN		PE–DG–K13–172–N101
			DATE		SHEET 1 OF 1 REV. 00

SECTION - H

FORMATS TO BE FILLED BY BIDDER

SECTION - H

COMPLIANCE CERTIFICATE
SCHEDULE OF DEVIATION
SCHEDULE OF DECLARATION
PRICE SCHEDULE FORMAT

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnish the same with the offer.

a) The scope of supply, technical details construction features, design parameters etc. shall be as per Technical specification and there are no exclusions with regard to same.

b) There is no other deviation w.r.t. specification other than those furnished in the "schedule of deviations". Any other deviation stated or implied taken elsewhere in the offer stands withdrawn unless specifically brought out in the schedule of deviations.

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification and QP enclosed therein. QP will be subject to NTPC approval & NTPC hold points for inspection/testing shall be marked in the QP at the contract stage. Inspection/testing shall be witness as per the same apart from review of various test certificates/Inspection records etc.

d) All drawings/data sheets/calculations etc. submitted along with the offer shall be considered for reference only, same shall be subjected to NTPC approval in the event of order.

e) The offered materials shall be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' wherever not specified & prices for the same included in the base price itself. Prices for special tools & tackles, if any, shall also be included in the base price.

g) All bidder shall be subject to NTPC approval in the event of order.

h) The hydrostatic testing of piping shall be carried out as specified i.e. at 1.5 times the design pressure.

i) Any other Drawing/document required during detail engineering shall be provided in line with NTPC requirement by bidder without any commercial/ technical implication o the employer.

j) All minor Civil Works like making opening to suit/ finishing of opening sealing of duct opening, grouting of inserts, foundation bolts, base plates etc. is included in the scope of the bidder.

k) In case of any contradiction between the Sections/Sub-Sections of Specifications, the latter shall be final and binding on the bidder without any financial implication.

FORM NO PEM 6036-1

	TITLE	SPECIFICATION NO
BHEL	* SCHEDULE OF DEVIATIONS ( ) From Conditions of Contract (Volume – 1) ( ) From General Technical Conditions (Volume – II A) ( ) From Technical Specifications (Volume –II B)	PE-DC-K13-100-M001 VOL III PART 'A' SHEET…….. OF……

We the undersigned hereby certify that the above mentioned are the only deviations.

FORM NO PEM 6040-1

	TITLE	SPECIFICATION NO PE-TS-308-100-M042
	*SCHEDULE OF DECLARATIONS	VOL III PART 'A'
		SHEET…….. OF……

* **Bidder shall include this schedule both in technical and Price offers**

DECLARATION

I ……..……certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated …….. and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidder's Company Name …….

Authorised representative's Signature ……..

Name …….

Bidder's Name with seal

The bidder hereby agrees to fully comply the requirements and intent of this specification for the price indicated

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

2x660MW KHARGONE STPP

PRICE SCHEDULE FOR CROSS COUNTRY MAKE UP WATER PIPE LINE

SL. NO.	TYPE OF PIPE		Measurement Unit Length(M)/Nos/ Tonnes	UNIT RATE (Rs.)	TOTAL COST (Rs.)	EXCISE DUTY (Rs.)	CST @2% (Rs.)	FREIGHT CHARGES INCLUDING SERVICE TAX(Rs.)	TOTAL FOR SITE PRICE(Rs.)
[A]	**MECHANICAL SCOPE**								
1	Piping material cost								
	Pipe NB	Mild Steel(MS) pipe							
		GRP pipe							
		DI pipe							
	Bends	Mild Steel(MS) pipe							
		GRP pipe							
		DI pipe							
	Eq Tee	Mild Steel(MS) pipe							
		GRP pipe							
		DI pipe							
	Manhole arrangement	Mild Steel(MS) pipe							
		GRP pipe							
		DI pipe							
	Connecting flanges	MS pipe							
		GRP pipe							
		DI pipe							
	Pipe Jointing material	Lamination for GRP							
		Coupling for GRP							
		Coupling for DI							
2	Valves cost								
	BFV								
	ARV with isolating valves								
	Drain valves								
3	Surface Protection for MS pipe								
	3LPE coating								
	Cathodic protection (Mechannical work)								
	Cathodic protection (Electrical work)								
4	Pipe, fittings & valves Laying cost								
		MS Pipe							
		GRP Pipe							
		DI pipe							
5	Commissioning spares	MS Pipe							
		GRP Pipe							
		DI pipe							
6	Hydrotesting charges including all necessary tools & tackles								
7	Administrative charges								
	Total cost of Mechanical scope:								
[B]	**CIVIL SCOPE**								
1	Topgraphical survey								
2	Geotechnical investigation								
3	Site levelling & grading cutting/filling & disposal of earth								
4	Trench excavation								
5	Backfilling includinf bed preparation	MS piping							
		GRP Piping							
		DI Piping							
6	Thrust Block	MS piping							
		GRP Piping							
		DI Piping							
7	Other concrete work	for Manholes							
		For cathodic protection							
		Rail/road crossing							
		river/canal crossing							
		Pipe pedestals							
		Misc work							
8	Structural work	For bridges							
		Misc work							
9	Administrative charges								
	Total cost of Civil scope:								
[C]	**Annual maintenance contract for 2Years**								
	Total cost for Turnkey execution:								