BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

GRP PIPING SYSTEM

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Rev.No	**Date**	**Prepared**	**Checked**	**Approved**	**Remarks**

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1. GENERAL

1.1. Scope

This specification is intended for the specific requirement of Glass Reinforced Plastic (GRP) piping system. The scope of the vendor/vendor shall include but not limited to, the design, manufacture / fabrication, supply, inspection & testing, transportation, handling, lowering, laying & joining, pipe component assembly, hydro-testing and comprehensive Annual Maintenance Contract (AMC) of GRP pipes, joints, fittings and specials.

1.2. Project Information

Project title : Ultrafiltration Plant Package for NTECL-Vallur 3x500 MW TPP
Owner : NTPC -TAMILNADU ENERGY COMPANY LTD
Item : GRP piping system
Application : Conveying of seawater, at low pressure in Ultrafiltration plant.
Surrounding : Hot, dusty & humid atmosphere
Installation : Indoor/Outdoor
Ambient Temp : 55 °C Maximum & 5 °C Minimum
Operation : Continuous/Intermittent

1.3. Applicable Codes & Standards

The design, manufacture, inspection and testing of GRP water pipes shall comply with the latest ASTM D-3517 (Standard Specification for Fiberglass (Glass Fibre Reinforced Thermosetting Resin) Pressure Pipe in the case of pressure pipes) or AWWA C 950 (Standard for fibre glass pressure pipe) & AWWA M 45 (Fiberglass Pipe design) unless otherwise specified in this Technical Specification. The various codes used in the design, manufacture and testing of GRP pipes are as follows:

Code No.	Code Title
AWWA C950	Standard for fibre glass pressure pipe
AWWA M 45	Fiberglass Pipe design
ASTM C 33	Standard specification for Concrete aggregates
ASTM D 638	Standard Test Method for Tensile Properties of Plastics
ASTM D 695	Standard test method for compressive properties of rigid plastics.
ASTM D 1599	Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 2105	Standard Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe and Tube
ASTM D 2290	Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 2563	Standard practice clarifying visual defects in glass reinforced

	plastic laminated parts
ASTM D 2583	Standard Test Method for Indentation Hardness of Rigid Plastics by means of a Barcol Impressor
ASTM D 2992	Standard practice for obtaining hydrostatic or pressure design basis for Fiberglass Pipe and Fittings
ASTM D 2996	Standard specification for Filament-Wound Fiberglass (Glass-Fibre-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3262	Standard Specification for Fiberglass (Glass-Fibre Reinforced Thermosetting Resin) Sewer Pipe, in the case of gravity sewer pipes.
ASTM D 3517	Standard Specification for Fiberglass (Glass Fibre Reinforced Thermosetting Resin) Pressure Pipe
ASTM D 3567	Standard practice for determining dimensions of Fiberglass (Glass Fibre Reinforced Thermosetting Resin) Pipe and Fittings
ASTM D 3681	Standard Test Method for Chemical Resistance of Fiberglass (Glass-Fibre-Reinforced Thermosetting -Resin) Pipe in a Deflected Condition
ASTM D 3754	Standard Specification for Fiberglass (Glass Fibre Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe.
ASTM D 3839	Standard guide for underground installation of Fiberglass Pipes.
ASTM D 4161	Standard Specification for Fiberglass (Glass Fibre Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D 5365	Standard Test Method for Long-Term Ring-Bending Strain of Fiberglass (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe
ASTM D 5421	Standard specification for contact moulded "Fibre glass" flanges.
ASTM F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
BS 5480	British Standard Specification for Glass reinforced plastics (GRP) pipes, joints and fittings for use for water supply or sewerage
BS 8010-2.5	Code of practice for pipelines – pipelines on land: design, construction and installation; glass reinforced thermosetting plastics
ISO 1172	Textile-glass-reinforced plastics - Prepregs, moulding compounds and laminates - Determination of the textile-glass and mineral-filler content - Calcination methods
IS 12709	Glass Fibre Reinforced Plastics (GRP) Pipes, Joints And Fittings For Use For Potable Water Supply - Specification

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PART-A:

Design, Manufacture and Supply of GRP Pipes & Fittings

2. DESIGN REQUIREMENTS

2.1. General

Pipe type : ID series pipe
Outer surface finish : Smooth and glassy finish
Inner surface finish : Hazen-William flow coefficient, C = 150
Pressure rating : 10 bar (PN10 rating)
Pipe pigment colour : Will be finalized after ordering (inclusive of field joints)

2.2. Nominal Diameter

The nominal diameter of the pipe shall be as specified in the data sheet. The inside diameters and tolerances on diameters for the specified nominal diameter shall conform to the requirements stated in AWWA C 950 / ASTM D3517.

2.3. Length

Pipes shall be supplied in nominal lengths of 6m/9m/12m as per requirements. The tolerances on nominal lengths shall be as per relevant AWWA / ASTM standards to which they are supplied.

2.4. Wall Thickness

The average Wall thickness of the pipe shall not be less than the minimum wall thickness published in latest manufacturer's catalogue. However, minimum wall thickness in these published wall thicknesses of manufacturer shall conform to the tolerance limit as given in relevant AWWA / ASTM standards to which GRP pipes are supplied.

Vendor shall submit design calculations as per AWWA M 45 & AWWA C 950 to establish the adequacy of pipe size, pressure class and stiffness class selected for the GRP pipes.

2.5. Stiffness Class

The pipe shall be stiff enough to meet the design requirement with particular regard to installation method, burial depths, deflection limits, buckling and vacuum requirements.

2.6. Hoop and Longitudinal tensile strength

GRP pipe system shall meet the minimum hoop tensile strength and minimum longitudinal tensile strength requirements specified in AWWA C 950 / ASTM D3517 for the pressure class specified in the data sheet attached at the end of this subsection.

3. MATERIAL REQUIREMENTS

3.1. Resin

A thermosetting polyester resin (isopthalic resin) to be used and quality parameters shall be as per relevant AWWA / ASTM standards. The resin used for the internal liner of the pipes and fittings shall be of an unsaturated resin (vinyl ester) that can provide the required corrosive resistance. The resin in the structural wall of the pipes and fittings is of the unsaturated Polyester type incorporating styrene as the polymer monomer, but other resins may be used depending on the application.

3.2. Glass Fibre

Glass fibre reinforcement shall be of commercial grade ‘E’ type and shall conform to relevant ASTM standards.

3.3. Other Materials

Other materials used in the manufacturing of pipe like aggregates, fillers and additives shall be in accordance with the relevant AWWA / ASTM standards.

The vendor shall use only reputed makes of resin, fibre, aggregates, fillers, additives, etc. Vendor shall furnish the make of each of the above in the technical offer stage itself along with documented performance in this particular application.

3.4. Wall composition

Structure of pipe shall have chemical resistant liner, reinforced structural layer and outer surface layer. GRP Pipes shall be provided with UV stabilizers in the resin coat of outer surface layer. Overground GRP pipes (as applicable) shall be provided with flame retardant in the resin coat of outer surface layer.

a) The inner surface of GRP Pipe shall have a resin rich chemical resistant barrier with a thickness of minimum 2.5 mm vinyl ester resin of ratio 90 % suitably reinforced with “C” glass fibre of 10%.
b) Structural layer is made by filament winding of angle 54.7° consists of E-Glass Chopped roving strand Mat of 60% by weight.
c) The outer surface of the GRP pipes shall be provided with UV stabilized barrier made of 70% of resin & outer surface of the GRP pipe shall be glassy finish.

4. MANUFACTURING REQUIREMENTS

4.1. Pipes

The pipe shall be manufactured through Filament winding process (Continuous Filament Winding process using advancing mandrel method or Helical Filament Winding process) by winding continuous glass fibre filaments saturated with liquid resin or pre-impregnated with partially cured resin (subsequent heating may be required to polymerize the resin system) onto the outside of a mandrel in a predetermined pattern under controlled tension as described in ASTM D 2996 to result in a corrosion resistant, composite structure to meet the operating conditions.

4.2. Fittings

All fittings such as Bends, TEE's, etc. are to be manufactured using the same materials as that of pipe by contact moulding process. Standard GRP bends can be supplied factory made. Only swept design shall be used for bends. All GRP fittings, such as bend / elbows, ends, tees, flanges and reducers etc. shall be equal to or superior in performance to pipe of the same classifications and shall be smoothly finished internally in line with the pipe.

Generally, all GRP fittings are to be manufactured in factory. Dimensions of the fittings shall be as per relevant standards and drawings shall be submitted for BHEL approval. Only in exceptional circumstances, specific required fittings may be permitted (subjected to BHEL's approval) to be fabricated / laminated at site. However, such site fabricated / lapped fitting / branch off shall be hydro tested at pressure no less than 2.0 times the pressure class along-with the pipes.

All fittings shall have sufficient end length of pipe to accommodate over wrapped length of fitting and pipe. Moulded GRP fittings shall be made by hand lay-up, contact moulding, hot or cold press moulding or tape winding with internal liner. The internal and external surfaces of all pipes & fittings shall be clean and free from defects such as protruding fibres, voids, bubbles, pin holes, cracks, blisters, tackiness and foreign matters. Cut laminate surfaces are coated with liner resin and have a smooth finish.

4.3. Pipe Joints

The pipeline shall have a jointing system that shall provide for fluid tightness for the intended service condition. GRP pipes & fittings for above ground applications shall be joined by butt & wrap joint.

Vendor shall furnish the necessary calculations, drawings & other details pertaining to thrust blocks (which are to be provided at bends of buried as well as over ground GRP piping). For over ground piping, anchors are to be provided at reducers, branch offs, Tee offs, expanders and terminal points of other vendor apart from at points in straight run separated by an interval of ~90 meters. as per AWWA- M45 (for pipes up to 400 NB dia.) and as per system requirements for large sizes.

4.4. Flanged Joints

Flanged joints shall be used for connecting GRP pipes with valves, bellows, other piping components, equipment, etc. Flanged joints shall be used with gasket and fasteners. The flanged joint is made from the same material as the pipe.

For instrumentation, air vent, drain, dosing connections etc., flanged stubs are to be used. GRP flanges shall be contact moulded in accordance with ASTM D 5421. Flange face shall be flat, smooth, perpendicular to the pipe axis and drilled as per ANSI B 16.5 # 150.

Flange face ID corner shall be suitably chamfered (if required) so as to ensure full opening/closing of inline butterfly valves.

4.5. Material Inspection & Testing

The type tests shall be carried out in presence of the BHEL / BHEL approved representative, for which minimum 15 days' notice shall be given by the vendor. The vendor shall obtain the BHEL 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. The Long term type tests stipulated below should have been conducted by the manufacturer or its technology provider on GRP pipes at an independent laboratory or duly approved by accredited third party agency. Vendor shall submit these type test reports to BHEL. The manufacturer shall however carry out the short term / reconfirmation/ requalification tests as stipulated below. Further, BHEL reserves the right to waive conducting of any or all type tests (short term/ reconfirmation tests based on the reports/certificates) under this contract.

All the stage checks shall be offered to BHEL for inspection. Each pipe shall be tested hydrostatically at Vendor's works. Necessary test certificates for all pipes to be presented to BHEL for review. If the sample fails in the test, the entire lot is liable for rejection.

The following tests shall be carried out:

a. **Long term hydrostatic strength / Long term hydrostatic pressure:** Manufacturer or its technology provider should have already carried out the full type testing as described in Procedure-B of ASTM 2992, duly approved by accredited third party agency. Further, the manufacturer shall carry out the requalification test as described in reconfirmation test of ASTM 2992 on the same pressure class & stiffness class as specified for the pipes.

b. **Chemical resistance of pipe in a deflected condition:**
Manufacturer or its technology provider should have already carried out the full type testing as described in Procedure-A or Procedure-B of ASTM 3681, duly approved by accredited third party agency. Further, the manufacturer shall carry out the requalification test as described in reconfirmation test of

ASTM 3681 on the same pressure class & stiffness class as specified for the pipes under this package.

c. **Joint testing:**
All joints shall meet the laboratory performance requirements of section 7 of ASTM D4161. It shall be conducted on joint prototypes of elastomeric gasket sealed couplings in accordance with section 7 of ASTM D4161 on the pipes supplied under this package.

d. **Long term Stiffness – Material creep:**
Manufacturer or his technology provider should have already carried out the full type testing following the guidelines of ISO 10468 and analysed according to ISO 10928, method B. Further, the manufacturer shall carry out the reconfirmation test for 1000hrs on the same pressure class & stiffness class as specified for the pipes under this package. The test procedure for this reconfirmation test shall remain same as the Long Term Stiffness test stipulated above. The acceptance criteria for this test shall be as given in Clause 11 of ASTM D 5365 or as per alternative method proposed by manufacturer subject to BHEL approval.

e. **Long term Ring bending strain test:**
Manufacturer or his technology provider should have already carried out the full type testing using guidelines of ASTM D5365. Further, the manufacturer shall carry out the short term reconfirmation test in accordance with ASTM D5365 on the same pressure class & stiffness class as specified for the pipes under this package.

f. **Axial tensile strength** (ASTM D 2105/ ASTM D 638 / BS 5480)

g. **Hoop tensile strength** (ASTM D 2290 / BS 5480 / IS 12709)

h. **Structural integrity at deflected condition** (ASTM D 2412 / BS 5480 / IS 12709)

i. **Stiffness & flexural modulus** (ASTM D 2412 / BS 5480 / IS 12709)

In addition, product sample test report from a reputed / accredited test lab shall be furnished to BHEL. No material shall be dispatched without obtaining written clearance from BHEL. During inspection, the internal inspection reports shall be submitted to BHEL for info.

4.6. QA requirements for GRP pipes, fittings & specials

Following tests / inspections to be carried out on the finished pipes as per relevant IS/AWWA/ASTM standard:

a. Pipes produced are subject to following checks on 100% basis:
    1. Visual inspection for workmanship, marking, visual defect etc.
    2. BARCOL hardness
    3. Dimension: ID, OD, thickness, squareness of pipe ends, length of pipes
    4. Hydrostatic leak tightness to be carried out at 2 times of rated pressure class

b. Following control checks to be performed on representative samples (minimum one sample / 100 pipes for each type, size, grade etc.) taken from the finished products of each class & size on a random basis:
    1. Pipe stiffness
    2. Ring deflection test without damage / structural failure for Level A & B
    3. Hoop tensile strength
    4. Axial/longitudinal tensile strength
    5. Beam strength test as per relevant standards

c. UV exposure test to be carried out as per relevant standard

4.7. Marking

The marking on pipe shall include the following:

- Standard mark for the pipes conforming to AWWA / ASTM standards to which they are supplied.
- The manufacturer's name or trademark
- The nominal pipe diameter
- Class of pipe (Pressure & Stiffness)
- Batch no. or date of manufacture
- Colour bands for over ground piping

4.8. Packing & Transportation Requirements

All pipe and pipe fittings shall be suitably protected, coated, covered or boxed to prevent damage or deterioration during transit, handling and storage at site, till the time of erection. Each packing shall have necessary handling marks. Each packing shall contain a packing slip indicating the details of item like item description, quantity, weight etc. Packing slip shall be submitted for BHEL approval for giving dispatch clearance by BHEL.

Details of handling & Storage instruction shall also be provided in each packing. Vendor shall submit a write up for safe handling and stacking of pipes during transportation and at site.

All items shall be properly packed with adequate cushioning material to prevent rough handling and inland transport. Special care shall be given to prevent damage to the fragile components.

All pipes & fittings fabricated in the factory shall be transported to 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.

Props of proven 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.

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

The material being delivered at site shall be jointly inspected by BHEL and vendor. Defective or damaged pipe shall be rejected by BHEL and vendor is liable to replace the same with new ones without any commercial implications. In case of minor damage, the BHEL may allow repair of the pipe by the Vendor to the satisfaction of the BHEL.

PART-B:

Erection, Commissioning & Testing of GRP Pipes & Fittings

5. PIPE INSTALLATION & TESTING

Vendor shall carry out the installation and testing of GRP piping as per the BHEL erection drawings and manuals / documents. The vendor's scope of work includes but not limited to:

- Collection of vendor supplied GRP pipes & pipe fittings from stores.
- Collection of BHEL supplied valves, bellows, fasteners, rubber gaskets, etc. from stores.
- Safe custody of above drawn materials
- Laying, joining of GRP pipes and fittings as per the enclosed preliminary tender drawing no: 0-WT-240-00047. Final erection drawings shall be provided after order.
- All consumables like resin, fibre, mat etc. for joining of pipes & fittings.
- All tools, tackles, material handling equipment (cranes, hoists, chain pulleys, etc.), consumables, hydro-testing equipment, etc.
- Hydro-testing & leakage rectification of piping system.
- Handing over of piping system after commissioning and trial operation.
- Reconciliation of drawn material from the store.

All pipe and pipe fittings shall be installed and tested as per the specification, relevant national / international standards & statutory codes.

6. PIPING ERECTION

6.1. Details

a. Installation (laying and joining) of GRP pipes & fittings shall be carried out as per BHEL erection drawing. A preliminary isometric piping is enclosed along with the specification for the information of the Vendor. Vendor is advised to go through the drawing to understand the scope of work. The drawing gives only tentative work content and any minor addition/deletion to the installation is to be carried-out by the vendor without any additional commercial implication to BHEL. Further any minor modification / alteration required to suit the system is also to be carried-out by the vendor without any additional commercial implication.

b. Assembly of BHEL supplied components like valves, bellows, flanges gaskets & fasteners etc. (as per **Annexure-C**) in the pipeline are under the vendor's scope. The alignment, checking & ensuring the operation of the assembled components are also in the vendor's scope.

c. Alignment of the pipe support, fixing of rubber sheet (as per erection drawings), etc. at the pipe support location is under vendor's scope.

d. Temporary joints of pipes segments to be made as per erection drawing and shall be offered for stage inspection to BHEL. Final joining of piping shall be done after getting approval from BHEL.

e. The piping system shall be installed at site as per the erection drawing provided by BHEL after ordering. After the completion of pipe installation at site, entire piping, including air vent, drain & instrument tapings will be cleaned and flushed with water and tested for hydrostatic testing with water. All pipe joints shall be watertight. Joints that are found to leak by observation or during testing shall be repaired and retested. Protocol for hydro-test shall be obtained from the customer by the vendor.

6.2. Butt & Wrap Joining

The pipe / fittings ends shall be prepared, aligned & laminated with reinforcing fibres and resin. Before work on laminated joint is started, all necessary equipment for completing the work shall be made available. It shall be ensured that the pipes are maintained with joint faces held tightly together without offset. The pipe must be held securely in place to prevent any movement during the butt and wrap procedure. This may be accomplished by clamping the pipe into its hangers or by using stationary blocks to prevent any pipe movement.

The ends of the pipe are chamfered to leave a root face square to the axis of the pipe and 2mm to 3mm thick. Pipe ends are held rigidly in position with a maximum gap of 3mm. The chamfered, abraded and cut surfaces should be coated with the specified resin and the gap between the ends filled with resin paste.

Gaps between pipe sections should not exceed 3 mm. Therefore, a wrap-around should be used to ensure square cuts.

The glossy resin surface must be removed prior to making the joint. The sanded areas should be slightly greater than the width of the last layer of mat to be applied and equal in distance on both sides of the butt joint.

Vendor shall ensure that the pipe joining surface shall be free of grease, oil, dirt, paper, tape, moisture, solvents, grinding rust residue, etc. The joining surfaces must be protected from subsequent contamination if bonding operation is interrupted. Sanded joints left for extended periods, such as overnight, should be re-sanded. All surfaces must be free from water or other solvents prior to over wrapping.

Raw pipe edges shall be coated with catalysed resin. For severe chemical applications, fill any gaps between the pipe sections with a paste or putty. It shall be ensured that, the putty is smooth during throughout the application process.

The resin used shall be of the same type or compatible with the resin used in the manufacturing of the pipes. The curing agent or hardener shall be mixed with resin strictly following the recommendation of the resin manufacture regarding weighing, metering, mixing and temperature. Resins are temperature sensitive, and the amount of catalyst required increases as the temperature decreases. The resin and catalyst should be measured, mixed in proper proportions.

Apply a thin coat of catalysed resin to the cleaned, sanded surface where the mat will be applied. Layers of chopped strand mat and/or woven roving impregnated by resin shall be applied as per layer sequence. Each layer must be completely saturated and free from voids or air bubbles. Laminates over 6mm thick (2 or 3 layers) often have to be done in two operations to prevent exothermic and weak joints.

6.3. Checking The Installed Pipe

Initial diametrical deflection shall not exceed 3% of diameter. Bulges, flat areas, or other abrupt changes of pipe wall curvature are not permitted. Deflection checks shall be done when the first installed pipes have been backfilled to grade and continued periodically throughout the entire project. Laying shall not get too far ahead before verifying the installation quality. Pipes over 3% deflection shall be replaced completely. No attempt to jack or wedge the installed over deflected pipe into a round condition shall be made to avoid damage the pipe.

6.4. Correcting Over Deflected Pipe

Pipes installed with initial diametrical deflections exceeding the approved values shall be corrected to ensure the long term performance of the pipe. Damaged pipe shall be repaired or replaced as directed by the BHEL. Re-compact/ backfill to grade and check the pipe deflections to verify they have not exceeded the values to the satisfaction of BHEL.

6.5. Misalignment of the Joint

When for reasons of the lay-out of the line the joint has to be misaligned (but such misalignment must remain within the limits provided by the supplier of the pipes), such misalignment at the predetermined angle should be applied only after having inserted the pipe and the joint is thoroughly checked for its water tightness.

6.6. Exclusions

The following are excluded from the scope of vendor and will be arranged by BHEL

a. Storage of supplied items at BHEL store as of received condition
b. All civil works pertaining to GRP piping system
c. Service water at one point near UF Plant
d. Free Power supply at one point near UF Plant
e. Supply of service air at one point
   The requirement shall be specified by the vendor in their technical offer and the supply shall be limited to the specified quantities.

7. TESTING

7.1. Flushing

a. Completed piping systems shall be flushed by vendor with fresh water to clean the pipe of all dirt, debris, and foreign material. Vendor shall prepare a procedure for flushing of the system for approval of BHEL. Flushing shall not be commenced without approval of flushing procedure.

b. Vendor shall perform all activities like dismantling and reinstalling of all strainers, in line instruments etc. before and after completion of flushing.

c. Flushing shall be considered as complete only after inspection and approval by purchaser/consultant.

d. Disposal of muck and flushing media shall be arranged by vendor as directed by BHEL, in such a manner that it does not spoil the adjacent installations. Vendor shall obtain BHEL regarding the place and method to be adopted for disposal of debris.

e. Record of flushing giving following details shall be submitted by vendor to BHEL for approval and records:
    a. Date of flushing
    b. Identification of line: flushed line number

7.2. Inspection

All the stage checks shall be offered to BHEL / Customer for inspection.

7.3. Hydrostatic Testing

a. Completed piping system as approved by BHEL/customer/consultant shall be hydrostatically tested in the presence of customer/consultant. The general requirement for hydrostatic test shall be accordance with design requirement of this specification and standard codes applicable.

b. Vendor shall prepare hydrostatic test procedure based on specified codes. The hydrostatic test shall commence only after approval of procedure by customer/consultant.

c. The pipeline shall be hydro tested in stretches of suitable length at 1.5 times the working pressure (as per BS8010-2.5). Water and other facilities as required for such hydro testing shall be arranged by the vendor.

d. Necessary test certificate for all pipes to be presented to BHEL for review. Finally, entire pipeline system shall be tested at system working pressure during operation of the Make-up water pumps.

e. All the joints, which remain untested during sectional hydro tests shall be

exposed and inspected for leakage. All the leakage/ defects observed shall be rectified by the vendor and it shall be ensured that there is no visible leakage during continuous eight hours of operation.

f. After successful testing/ commissioning of entire pipelines, the area around exposed joints shall be restored. The detailed Filed Hydrostatic Testing Procedure based on International standard shall be submitted to BHEL for Approval.

g. All equipment and instrument used for hydrostatic test shall be approved by customer/consultant before start of test.

h. Pressure gauge shall be installed on line to measure test pressure. In case of longer lines two are more pressure gauge shall be installed as directed by customer/consultant. One gauge shall be installed at the discharge of the pressuring pump. Pressure gauge used for hydrostatic testing shall be calibrated with dead weight tester in the presence of engineer-in-charge. Range of pressure gauge shall generally be 1.5 times the test pressure.

i. Orifice plates and restriction orifices shall not be installed until hydrostatic test completed. Temporary gasket shall be used during testing which is in vendor's scope.

j. All equipment, lines instruments, relief valves, etc. shall be disconnected from piping system by means of blinds during testing (under vendor's scope). Control valves shall be replaced by spool pieces during testing, which is in the scope of vendor.

k. High point vent and low point drain required for testing in addition to those marked in the drawings shall be provided by vendor at his own cost. Smooth glassy finish to be maintained for all field joints with the parent colour of the pipes and fittings.

l. All field joints shall be kept clean for detecting leaks during testing. Test pressure shall be maintained long enough to facilitate complete inspection of system. Minimum duration of test shall be 6 hrs unless otherwise specified. Pressurizing equipment shall be isolated immediately after the test pressure is attained.

m. The records in duplicate shall be prepared, maintained and submitted by vendor. It shall include the information like date of test, identification of pipe tested / line number, test pressure, test result, etc.

8. GENERAL INSTRUCTIONS ON E&C, FIELD TESTING

a. Vendor shall post experienced site engineers with skilled/adequate man power for execution of piping system.

b. Adequate lighting facilities such as low volt hand lamps shall be arranged by the vendor at the site of construction etc. at his cost.

c. All the lifting tackles including wire ropes, slings, shackles and electrically operated equipment shall be got approved by BHEL before they are actually put on use. Test certificate obtained from the statutory authority should be submitted before their usage.

d. All valves mounted on GRP pipelines shall be checked and ensured for full open & hindrance free operation by the vendor during the erection stage itself.

e. All equipment so used by vendor shall be of proven quality and safe in operation as approved by BHEL site Engineers from time to time.

f. At periodic intervals of work, complete and detailed account of the equipment so erected shall be submitted to the BHEL.

g. All equipment shall be handled very carefully to prevent any damage and loss. No bare wire ropes, slings etc., shall be used for unloading and / or handling for equipment without the specific written permission of the engineer. The equipment from the storage yard shall be moved to the actual site of erection / location at the appropriate time as per the direction of BHEL so as to avoid damage for such equipment at site.

h. The work covered under this scope of work is of highly sophisticated nature requiring best quality / precision workmanship engineering and construction management. Vendor should also ensure successful and timely commercial operation of equipment installed. The vendor must have adequate quantity of precision tools, construction aids in possession. Vendor must also have adequate trained qualified and experienced supervisory staff and skilled personnel.

i. All the necessary certificates and licenses required to carry out his scope of work are to be arranged by the vendor then and there at no extra cost.

j. When the work is temporarily suspended he shall protect all construction materials equipment and facilities from causing damage to existing property interfering with the operations of the station when it goes into services. The vendor shall comply with all applicable provisions of the safety regulations clean – up programme and other precautionary measures which the BHEL has in effect at the site.

k. It will be the responsibility of the vendor to ensure the safe lifting of the piping

system taking due precautions to avoid any accidents and damage to other piping system and personnel. All piping shall be adequately supported and protected to prevent damage during handling and erection.

l. Sometimes it may become necessary for the vendor to handle certain un-required components in order to install the required materials. The vendor has to take this contingency also into account. No extra payment is payable for such contingencies.

m. There can be some variations in the dimensions and level appearing in the arrangement drawings and those actually occurring at site due to minor variations in the location of equipment, structures, cut out etc. adequate field joint shall be provided, permitting assembly and erection of pipe work without major modification.

n. GRP pipes shall cross road through Hume pipes. When buried GRP pipes are crossing roads, sand bags shall be put around GRP pipes within Hume pipe.

o. At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt, water or other foreign matter by means of approved plugs or end caps.

p. Site lapping of last joint during erection shall be done at a de-humidified condition by skilled worker to ensure correct curing.

q. All the tools, tackles, equipment, etc. required for the complete erection, commissioning & testing of piping system shall be arranged by the vendor at his cost. The vendor shall have & own a complete set of special tools and tackles required erection. The vendor shall also supply any special tools and tackles that may be required additionally during testing. All tools & tackles shall be reputed make acceptable to the Customer.

PART-C:

AMC, Legal & Other Requirements

9. ANNUAL MAINTENANCE CONTRACT (AMC)

The Vendor shall provide Comprehensive Annual Maintenance Contract (AMC) for 3 years after completion of the warranty period. The following services shall be included under AMC:

1. Round the clock monitoring of GRP pipe installation for any leakage / rupture / damage of the pipeline.

2. 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 piping system.

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

4. Recharging, testing and re-commissioning the entire GRP pipe installation to the satisfaction of the Employer within 24 hours of the reporting of leakage / rupture / damage of the pipeline.

AMC shall be quoted as a lump-sum amount only inclusive of repair, material & man-power.

10. LEGAL REQUIREMENTS

10.1. Statutory Requirements:

a. The vendor shall submit a copy of labour license obtained from the licensing Officer (Form VI) u/r 25 read with u/s 12 of contract labour (R&A) Act 1970 & rules and valid WC Insurance copy or ESI Code (if applicable) and PF code no along with the first running bill.

b. The vendor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r 78 (1) (a) (1) of contract labour rules, copies of monthly return of PF contribution with remittance challans under EPF Act 1952 and copy of renewed WC insurance policy or copies of monthly return of ESI contribution with challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

c. The vendor should ensure compliance of Sec 21 of Contract Labour (R&A) act 1970 regarding responsibility of payment of wages. In case of “Non-compliance of sec21 or non-payment of wages” to the workmen before the expiry of wage period by the vendor, BHEL reserves the right to pay the workmen under the orders of appropriate authority at the risk and cost of vendor.

10.2. Engagement of Labour

a. The vendor will be directly responsible for provision of health and sanitary arrangements more particularly described in contract labour (regulations & Abolition) Act, safety precautions etc., as may be required for safe and satisfactory execution of the contract.
b. The vendor shall be responsible for proper accommodation including adequate medical facilities & transportation to the work spot and back for the personnel employed by him.

10.3. Compliances with Labour Laws & Rules

Vendor shall comply with all state and central Laws, statutory rules, regulation etc., relating to labour in respect of following acts and also as amended by the Government during the tenure of the contract and having in force or jurisdiction at site.

a. Payment of wages act, 1936
b. Minimum wages act, 1948
c. Workmen's Compensation act, 1923
d. Industrial dispute act, 1947
e. Employees Provident fund scheme, 1952
f. Payment of Bonus act, 1965
g. Payment of Gratuity act, 1972
h. Contract Labour (Regulation & Abolition) Act, 1970

11. OTHER REQUIREMENTS

11.1. Time of Completion

The time schedule as prescribed in the contract is the essence of the contract. The time for completion shall always be reckoned from the date of commencement of work as certified by the BHEL Engineers. The entire work shall be completed by the vendor within the time schedule or within the such extended time as may be allowed under relevant clause.

11.2. Site Cleanliness and Safety Requirements

a. Vendor shall strictly follow all safety regulations / conditions as per general conditions of contract booklet enclosed with this tender.

b. Non – conformity of safety rules and safety appliances will be viewed seriously.

c. Vendor shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.

d. Vendor shall ensure that all Inspection, Measuring and Testing equipment that are used, whether owned by the vendor or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by vendor

at site with its calibration status is to be submitted to BHEL Engineer for control.

e. Vendor shall arrange for the inspection of the works at various stages as required by BHEL. Immediate corrective action shall be taken by the vendor for the non-conformances if any, observed and pointed out by BHEL.

11.3. Disposal of Scraps / Unused Items:

All the pipe scraps & materials are to be removed from the working area and transported to BHEL scrap area / as per the direction of customer. Un-used balance GRP pipes & materials, BHEL supplied materials are to be handed over at BHEL stores with acknowledgement.

11.4. Additional Requirements

During execution at site, pipe routing is susceptible to change. If any additional requirement of pipes & fittings occurs, the vendor shall supply these additional requirements (up to 10%) at the final unit rate agreed. No additional cost is applicable for the installation (laying and joining) for these additional items.

11.5. Other Instructions / General Clauses

- Vendor shall quote for complete work specified in the document. Vendor shall contact BHEL and obtain additional details/data if any required to submit proper quotation.

- The BHEL reserves the right to omit any one or more items of work at any time of the contact without assigning any reason what so ever.

- Details furnished in this specification are indicative only and cannot be considered as exhaustive. Vendor shall make all efforts to carry out piping works in total as per the specific requirements and as per the good engineering practice. All testing requirements as per the relevant and applicable standards are to be ensured by the Vendor.

- The Intent of this specification is to provide design, manufacture / fabricate, supply, erection, commissioning services for execution of projects according to most modern and proven techniques and codes. It is not the intent to specify completely herein, all aspects of the entire system. Nevertheless, the entire system shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The contract services towards installation of the plant shall not relieve the vendor of the responsibility of providing such services, facilities to complete the project of portion of project awarded to him. The quoted rate shall deem to be inclusive of all such contingencies.

- The vendor shall carry out the work in accordance with instructions/ drawings/

specification/ standard practices supplied / approved by BHEL from time to time.

- Modification / Rectification / repair / replacement of defective components if any shall be under vendor's scope within specified time during execution.

- Vendor to submit the erection schedule along with stage checks list. For each and every stage, the vendor shall get clearance from the BHEL Engineer / Customer.

- All the supplied materials will be issued from BHEL stores and it shall be the responsibility of the vendor for identification of the consignment and to take delivery from BHEL stores, transport the same to site & kept in their safe custody for erection.

- Necessary site co-ordination and clearance for stage check, hydraulic test, leak check from the customer engineer & pre-commissioning tests shall be carried out by the vendor.

- All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of about 25 years and shall withstand the operating parameter fluctuations and cyclic fluctuation which can be normally expected during this period.

- All pipes & fittings shall be properly designed to take care of hydraulic shocks and pressure surges which may arise in the system during operation.

- All low points in the pipe lines shall be provided with suitable draining arrangement and all high points shall be provided with air vent connections where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test.

- Drain shall be provided at low points and at pockets in piping such that complete drainage of all system is possible.

- All pipe work shall be designed to provide sufficient flexibility and to prevent development of undesirable forces or moment at points of connection to equipment.

- Extensive use of templates, gauges, plumb lines shall be made for laying, cutting fitting up of various piping components for fabrication.

- On completion of both shop and field fabrication, all subassemblies shall be cleaned for the inside and outside by suitable mechanical means ensuring that they are free from all loose foreign materials such as scales, sand, oil grease, cutting chips etc.

- Stub flanges are to be provided for all air vents, dosing, drain, instrument connections on the process pipe line as indicated. Exact location will be decided during detailed engineering.

- Adequate reinforcements / padding shall be provided at all pipe to pipe pull-out branch & stub flange joints.

- Pre-fabrication of pipe spools / segments shall be carried out by the vendor after getting prior approval from BHEL.

- Field joints may be suitably decided by the piping system supplier by keeping the view of transportation of prefabricated pipe segment to site.

- Erection of valves, including alignment, rubber bellows and other acc. required for piping are in the scope of the vendor.

- Entire piping including stub flange and valves shall be hydro tested as per the relevant specifications/standards. Pump, pressure gauges, dummy flanges, etc. Required for hydro test shall be in the scope of vendor.

- Piping support will be provided by BHEL, however, vendor shall provide all necessary input details for pipe supports, thrust blocks etc. well in advance to BHEL.

- Pipe laying, joining, clamping / U-bolt fixing of pipes, fastening of flanged connections, carrying out rework / modifications in piping & supports, etc. Are in the scope of the vendor.

- Piping & support erection shall be carried out in conjunction and jointly at site.

PART-D:

Documentation & Annexures

12. DOCUMENTATION

12.1. General Requirements

The documentation during bid and post order stage shall meet the following requirements.

a. All documents and drawings shall be submitted in English.
b. Hard copies of all documents and drawings during bid stage to be submitted in duplicate.
c. Hard copies of all documents for approval to be submitted in triplicate.
d. Hard copies of all final documents, drawings, manual etc., shall be submitted in bound folder in duplicate.
e. Soft copies of all final documents in MS office in the form of CD-1 set.
f. Soft copies of all fitting drawings in AutoCAD, latest version in the form of CD-1 set.

12.2. Documents to Be Submitted Along with The Bid

a. Duly filled up data sheet **Annexure-A** in the enclosed format.
b. Schedule for completion of Installation & testing of the above piping system
c. Pipe, fittings thickness calculations.
d. Pipe cross-sectional structural details & fitting dimensional detail drawing.
e. List of applicable standards for shop test.
f. Applicable Quality plan for supply of the above piping system.
g. Pipes & fittings Catalogues.
h. Any deviation to this specification shall be specifically mentioned in the enclosed deviation format **Annexure-B**.
i. Make & details of resin, fibre, mat, etc.
j. In case of any deviation, to this specification the Vendor shall indicate the deviation, clause by clause in the deviation format attached in **Annexure-B**. If there is no deviation "**NIL**" statement shall be furnished. In the absence of **Annexure-B**, it will be construed that the bid confirms strictly to this specification. Acceptance or rejection of the offer with or without deviations (either fully or partially) is sole discretion of the purchaser without seeking further clarification from the vendor.

NOTE: Failing to submit the above documents, the bid shall be considered as incomplete and may be liable for rejection. If required, vendor may visit BAP, Ranipet before the submission of their techno commercial bid for a technical discussion.

12.3. Documents to Be Submitted After Order

The following documents are to be submitted for BHEL's approval.

- Duly filled up data sheet
- Dimensional drawing for pipes and fittings
- Cross-sectional drawing for pipe structure
- GRP piping joining procedure, repair procedure, hydro-test procedure
- Pipe support span requirements for each size
- Pipe support requirements, drawings & details
- Thrust block requirements, drawings & details

The following are to be submitted to BHEL's review and acceptance for the manufactured GRP items.

- Material test certificate
- Dimensional report for pipes and fittings
- Hydraulic test certificates
- Performance guarantee certificate
- Final product laboratory test certificates

All records/documents called for herein the specification under various clauses

13. ANNEXURES

13.1. Annexure-A (Design Datasheet for GRP pipes & fittings)

Description	BHEL Requirement	Vendor Compliance / to specify
Piping Material	Glass Fibre Reinforced Plastic	
Applicable standards	As listed in the technical specification	
Vacuum pressure (kg/cm^2)	(-) 0.8	
Max. service temperature (°C)	36	
Hazen William's Constant	150	
Pressure class	PN 10	
Stiffness class & value	C, 248 kPA (min) @ 5% deflection	
Interior layer resin	Vinyl ester	
Interior layer glass	C-glass fibre	
Interior layer resin thickness (mm)	2.5 (minimum)	
Interior layer surface ratio (Mat: Resin)	10:90	
Structural layer glass	E-glass fibre	
structural layer ratio (Glass: Resin)	60:40	
Exterior layer resin	Isophthalic resin	
Exterior surface ratio (Mat: Resin)	30:70	
Exterior surface	UV stabilized resin	
Winding method	Filament wound (Helical)	
Winding angle	54.7°	
Additives	Pigment / Dyes / Colouring Agent	
Pipe thickness	Vendor to provide calculation	
Hoop tensile modulus Mpa	Vendor to specify	
Axial tensile stress Mpa	Vendor to specify	
Axial tensile modulus	Vendor to specify	

Mpa		
Hoop bending modulus Mpa	Vendor to specify	
Coefficient of linear expansion mm/m°C	Vendor to specify	
Barcol hardness	Vendor to specify	
Bend design	Swept	
Flange drilling standard	ANSI B16.5#150	
Medium	Chlorinated sea water	

13.2. Annexure-B (Technical Deviations)

Sl.No	Sec/Clause No	Specification	Statement Of Deviation/Variations	Reason For Deviation	Cost Of Withdrawal

Date: Signature & Seal of the Vendor

13.3. Annexure-C (List of BHEL supplied components to be assembled in the pipeline)

Sl. No	Item Description	Sze	Unit	Qty	Approx. Unit Wt (kg)	Approx. Total Wt (kg)
Valves						
1	Butterfly valve (Manual + OCLS) - Wafer	DN 250	No	2	33	66
2		DN 200	No	2	23	46
3	Butterfly valve (POV) - Wafer	DN 300	No	16	47	752
4		DN 250	No	8	37	296
5		DN 200	No	8	27	216
6		DN 150	No	28	24	912
7	Butterfly valve (FCV) - Wafer	DN 300	No	8	48	384
8	Butterfly valve (Manual) - Wafer	DN 400	No	8	83	664
9		DN 300	No	8	42	336
10		DN 200	No	2	22	44
11		DN 150	No	2	19	38
12	Non-return valve - Wafer	DN 200	No	3	10	30
13		DN 150	No	2	6	12
Approx. Sub-Total Weight (kg)						**3796**
Bellows						
1	Concentric rubber expansion bellows	DN 250	No	2	14	28
2		DN 200	No	4	10	40
3		DN 150	No	2	7	14
Approx. Sub-Total Weight (kg)						**82**
Other items						
1	Fasteners	-	Lot	1	-	1530

Sl. No	Item Description	Sze	Unit	Qty	Approx. Unit Wt (kg)	Approx. Total Wt (kg)
2	Gaskets & rubber sheets	-	Lot	1	-	680
Approx. Sub-Total Weight (kg)						**2210**

Note: The above list is tentative and not exhaustive.