BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

GRP PIPING (CONCRETE ENCASED) DESALINATION & CHLORINATION PIPING

00	05.08.20	SS	GR	KMS	Fresh issue
Rev.No	Date	Prepared	Checked	Approved	Remarks

TABLE OF CONTENTS

1.0 SCOPE OF SUPPLY & SERVICES

1) Scope

i) Bidder's scope covers Detailed Design, Engineering, Manufacturing, Transportation, Site-Storage, Erection and Hydro-testing of Glass Reinforced Plastic (GRP) piping for 2x660 MW Udangudi Supercritical Thermal Power Project Stage-I with respect to Desalination plant piping and chlorination piping in this specification. For all other piping, Bidder to refer to Specification PE-TS-435-100-M042.

ii) Following piping are covered in scope of supply of this specification

1. Hypochlorite dosing line from Electro chlorination plant to Intake Pump house.
2. Hypochlorite dosing line from Electro chlorination plant to Intake well.
3. Hypochlorite dosing line from Electro chlorination plant to CW fore-bay.
4. Sea water backwash line from Backwash sump to CW blowdown pipeline leading to outfall
5. Sea water from CW make up line (leading to CW fore-bay) to Electro chlorination plant
6. PT plant sludge pipeline from sludge sump to Ash pond
7. Air vents as applicable for the above pipelines

iii) Bidder's scope also covers to provide civil design inputs e.g.: Thrust blocks etc. requirement along with loading details.

iv) Complete piping system with fittings (Tees, elbows, expander, end caps etc.) along with flanged tapping (for main/branch pipe connections, drains, vents, manholes etc.) shall be in bidder's scope. Isolation valves drain and vents, measuring instruments shall be supplied by BHEL with flanged ends, as free supply items.

v) GRP pipelines shall be mainly underground with RCC encasement of 150mm for the pipes described in this specification. Also refer External piping layout drawing 1-WT-040-01850. Top of the buried pipe shall be at least 1.5 meters below the ground level. Based on the Bidder's civil design inputs, civil works i.e. excavation, bed preparation, laying/joining, RCC encasement, backfilling, installation of thrust blocks etc. shall be done by BHEL during project execution. Hydro-testing of piping (segments as well as full system) shall be done by Bidder. It shall be Bidder's responsibility to supervise and ensure correct installation of GRP piping (including supervision of pipe trench and PCC/ RCC beds) by coordinating with BHEL's civil execution agency.

vi) Bidder to note that the following Annexures are attached as a part of this specification

a) Annexure-I – Estimated BOM based on BHEL External piping Layout drawing attached with this specification as Annexure-II. Bidder to note that his scope includes supply of all items required for complete erection and Hydro-testing of piping (other than those mentioned as free supply by BHEL) including tools /tackles. Detailed layout drawing shall be prepared by the successful bidder after award of contract for BHEL approval and site reference.

b) Annexure-II – External Piping layout drawing (1-WT-040-01850) showing the routing details of GRP piping for this project.

c) Annexure-III comprises of Technical Datasheet for Below Ground GRP piping which shall be duly filled by Bidder and submitted to BHEL for approval.

2) It is not the intent to specify herein all the details of design, manufacture, installation, testing etc. Bidder shall quote his standard, proven product, which shall conform in all respects to high standards of design, engineering, installation, inspection and workmanship and shall be capable of performing the required duties in a manner acceptable to the Engineer/Owner who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.

3) The omission of specific reference to any component / accessory/ design data necessary for the intended performance of the piping system shall not relieve the supplier of the responsibility of providing such facilities to complete the supply within the quoted prices.

4) General Arrangement drawings/ Material Specification/ Design Calculations/ Layout drawings/ Installation procedures/ Joining procedures/ Hydro test procedures/ Pipe support details/ Materials test certificates etc. for complete GRP piping shall be approved by BHEL/ Customer.

5) BHEL's / CUSTOMER'S representatives shall be given access to the shop in which the products are being manufactured or tested and all test records shall be made available to them. Pipe and fittings shall be tested as per approved Quality Plan.

6) BHEL/ CUSTOMER shall provide statutory approvals/ clearances to the successful bidder during contract stage. However, the responsibility to generate all the documents related to statutory approval shall be on the Bidder.

7) In case of any deviation from this Technical Specification and Technical Requirements, Bidder shall indicate the same in the Schedule of Deviations. In the absence of duly filled schedules, it will be assumed that the bid strictly conforms to the specification.

8) The bids shall be in English language and in SI Units.

2.0 PROJECT INFORMATION

2.1	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
2.2	Project Title	:	2x660MW Udangudi Supercritical Thermal Power Project Stage-1
2.3	Location	:	Udangudi, Thoothukudi District, Tamil Nadu - 628215
2.4	Nearest Railway Station / Access Road	:	Tiruchendur, Thoothukudi Dist./ East Coast Road – State highway 176

Bidder to refer to Specification PE-TS-435-100-M042 for further details.

3.0 TECHNICAL REQUIREMENTS

1) Technical requirements
   Technical specification document are minimum requirements, which the bidder should follow. However, the bidder shall also include & provide any additional requirements, if so warranted to meet tender requirements including guarantees as well as those required for smooth & trouble free operation of the system/ plant.

2) CODES & STANDARDS
   The latest revision/ version of the following or equivalent standards shall be complied as a minimum requirement. It shall be responsibility of the Bidder to comply all the applicable Indian/ International codes, best practices for complete Design, Engineering, Manufacturing, Delivery, Erection & Hydro-testing.

1)	IS 14402	GRP pipes, joints, and fittings for use for sewerage, industrial waste and water
2)	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
3)	IS 13916	Installation of GRP Piping system – code of practice
4)	IS 6746	Unsaturated polyester resin systems - specification
5)	IS 11273	Woven roving fabrics of ‘E’ glass fiber
6)	IS 11320	Glass Fiber roving for the reinforcement of Polyester and of epoxide resin system
7)	IS 11551	Glass fiber chopped strand mat for the reinforcement of epoxy, phenolic and polyester resin system
8)	AWWA C950	AWWA Standard for fiberglass pressure pipe
9)	AWWA M45	Fiberglass pipe design
10)	ASTM D3517	Standard Specification for “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Pressure Pipe
11)	ASTM D 3567	Standard practice for determining dimension of “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Pipe & fittings
12)	ASTM D3839	Standard guide for underground installation of “Fiberglass” pipe

3) Design Requirements

   a) Nominal Diameter

The nominal diameter of the pipe shall be as specified in the specification. The inside diameters and tolerances on diameters for the specified nominal diameter shall conform to the requirements stated in IS: 14402 / AWWA C950 / ASTM D3517.

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

c) Wall Thickness
The minimum Wall thickness of pipe at any point shall not be less than the wall thickness specified in the approved drawings. Minimum wall thickness in these published wall thicknesses of manufacturer shall conform to the tolerance limit as given in relevant IS / AWWA / ASTM standards to which GRP pipes are supplied. Contractor shall submit design calculations as per AWWA M45 & AWWA C950 to establish the adequacy of pipe size, pressure class and stiffness class selected for the GRP pipes.

d) Pressure Class
Design Pressure of piping system is mentioned in Annexure-I. GRP pipes shall have adequate pressure class based on the given design pressure of pipes.

e) Stiffness Class
GRP pipes specified should have a minimum Stiffness Class of SN5000 (248Kpa) to take care of the uncertainties of various loading conditions in different terrains. However, the actual stiffness class calculations as per AWWA M45/ relevant code shall be submitted to BHEL for approval and stiffness class to be selected.

f) Hoop and Longitudinal tensile strength
GRP pipe system shall meet the minimum hoop tensile strength and minimum longitudinal tensile strength requirements specified in IS 14402 / AWWA C 950 / ASTM D3517 for the considered pressure class based on the design pressure requirements mentioned in Annexure-I.

4) Material Requirements

a) Resin
Premium grade Vinylester resin type (compatible with Sodium hypochlorite & sea water) shall be used for inner liner and isopthalic resin type shall be used for outer liner. Quality parameters shall be as per relevant IS/ AWWA/ ASTM standards.

b) Glass Fiber Reinforcement
Glass fiber reinforcement shall be of 'E-CR' type and shall conform to IS 11273, IS11320 or IS11551, as appropriate or relevant ASTM standards.

c) Wall Composition

GRP pipes must be provided with UV (ultraviolet) stabilizers in the resin system so that there should not be any degeneration during storage in the pipe surface due to ultraviolet light. Structure of pipe shall have chemical resistant liner, reinforced structural layer and outer surface layer. Sand as a filler is not permitted.

The thickness of resin layer shall be

S.No.	Application	Corrosion barrier layer thickness	Exterior resin layer thickness
1	Sea water	Min. 1.6mm	Min. 1.6mm
2	Sodium Hypochlorite (0.2% conc)	**Min. 3.0mm**	Min. 1.6mm

d) Other materials

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

GRP pipes and fittings minimum design requirement:

S.No	Design parameter	Requirement for sea water application	Requirement for sodium hypochlorite application
1.	Stiffness class	5000	5000
2.	Vacuum	760 mm Hg	760 mm Hg
3.	Inner liner thickness	**1. 6mm**	**3mm**
4.	Resin type for inner liner	Vinyl ester	Vinyl ester / equivalent resin compatible with sodium hypochlorite (0.2% conc.)
5.	Glass type	E-CR	E-CR
6.	Resin type for exterior liner	Isopthalic	Isopthalic
7.	Aggregate type	Silica sand	Silica sand
8.	Exterior layer thickness	1.6mm	1.6mm
9.	Minimum initial specific stiffeners STIS	5000 N/m^2	5000 N/m^2
10.	Ring bending strain	1.3	1.3
11.	Pressure Rating	PN10	PN10
12.	`O' rings in pipe joints	Compatible with sea water	Compatible with sodium hypochlorite (0.2% conc.)

5) Manufacturing Requirements

GRP pipe shall be machine-made either with a Continuous Filament Winding process using advancing mandrel method or with a Helical Filament Winding process with full automation

6) GRP fittings & specials

All GRP fittings, such as bends/ elbows, ends, tees, spools, flanges and reducers etc. shall be equal to or superior in performance to pipe of the same classifications and shall be smoothly finished internally.
All GRP fittings are to be manufactured in factory. Dimensions of the fittings shall be as per relevant standards, and drawings shall be submitted by Bidder to BHEL for approval.

Complete pipes/ fittings to be installed by Bidder must be new & unused.

(a) Fittings made from straight pipe

Fittings shall be fabricated from complete pipes or portions of straight pipe complying with IS 14402 / ASTM standards, as applicable for the pipe classifications. The fitting shall comply with the declared design requirement and be suitably mitred. The mitre shall be over wrapped externally and internally with liner, woven roving and/or chopped strand mat to ensure the longitudinal and circumferential tensile strength is at least equal by design to that of the pipe with which the fittings are to be used. All fittings shall have sufficient end length of pipe to accommodate over wrapped length of fitting and pipe.

(b) Fittings made by Moulding

Moulded GRP fittings shall be made by hand lay-up, contact moulding, hot or cold press moulding or tape winding with internal liner.

7) JOINTING & INSTALLATION

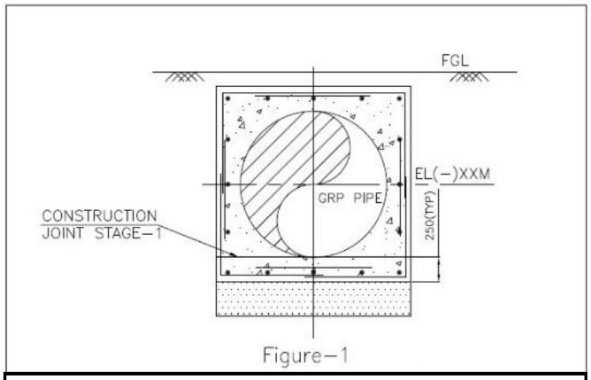
GRP pipeline shall have a jointing & installation system that shall provide for fluid tightness for the intended service condition in line with relevant AWWA/ ASTM/ IS code mentioned above.
As per scope, Bidder has to provide Civil design/ Technical inputs to BHEL for GRP piping. Bidder shall submit detailed installation procedure for GRP piping for BHEL approval. It is Bidder's responsibility to supervise & ensure correct installation & proper quality (including pipe trench and PCC/ RCC bed) of complete GRP piping system. Bidder shall be deemed responsible for any possible defect (like leakage through joints, excessive ovality or deflection or dislocation of joints & pipe spools) found in GRP piping during hydro-testing of the system after complete installation.

(a) Below ground Piping

Based on the final layout drawing (BHEL approved) and based on Bidder's civil inputs, civil works i.e. trench excavation, bed preparation, concrete encasing, thrust blocks, backfilling etc. for the below ground GRP pipes shall be done by BHEL during project execution. RCC encasement shall be suitable enough to protect pipe against live load, at rail / road / pipe crossings.
GRP pipes and fittings shall be joined with unrestrained sleeve couplings (Double REKA joint) or un-restrained double `O' ring Bell-Spigot joints.

For GRP piping layout, Bidder is requested to refer attached Annexure-II.

Proper installation is very important for performance of GRP pipes in long term. Further, please note that piping shall be laid as per details given in Figure-1. Also refer attached Annexure-II, suggestive Sketch for RCC encasement of GRP pipe for stage –wise concrete encasement of GRP piping. Bidder shall be provided with trench for pipe laying with concrete Stage-1 casted for pipe jointing/ installation. Bidder shall supervise & ensure proper quality of trench as well as RCC bed. Trench Excavation, encasement, thrust block installation and backfilling processes to be performed by BHEL; furthermore, these activities shall also be monitored by Bidder in order to ensure that the desired pre and post installation conditions are achieved. Pipe transportation from storage yard to site, lowering & jointing and installation of piping/ fittings/ manholes etc. are in Bidder's scope.



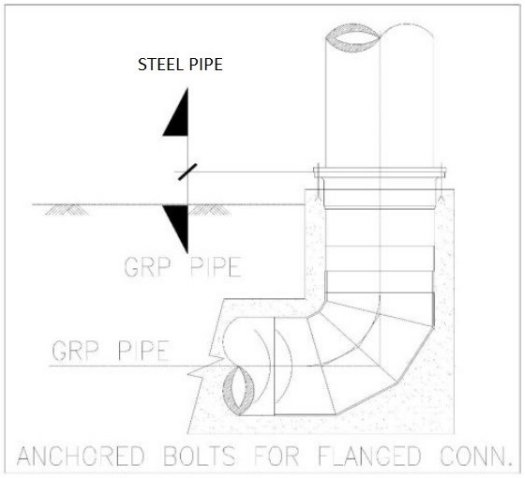
Pipe laying details for underground Piping with RCC Encasement

(b) Flanged joint

Flanged joints shall be used for connecting GRP pipes with Valves and Terminal Points (Flange details shall be as per AWWA). Flanged joints shall be used with EPDM gasket and SS316 bolts. The flanged joint shall be made from the same material as the pipe. All components of the joint shall be suitable for sea water application & Sodium hypochlorite application as indicated in the specification respectively.

GRP connections to steel pipes shall also be flange joints. Where a GRP pipe is to be connected to a steel pipe, it shall have a special flange matching the steel flange of the steel pipe. The GRP special flange shall be designed to provide the equivalent strength and resistance against the anticipated loading as the steel pipe.

In case GRP flanges are not designed to provide the equivalent strength, a few bolts of the flanged joint shall be designed with a longer bolt length and anchored in the concrete (refer sketch below) to take care of longitudinal stress due to thrust loads in GRP piping near flanged joint.



(c) Rubber Gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS:
5382/ ASTM F 477. Rubber gaskets for use with flanged joints shall conform to IS 5382 or equivalent.

(d) Dewatering

Flooded trench condition shall be avoided as far as possible during erection of GRP Pipes. Suitable mitigation measures to prevent floatation of pipes shall be taken by Bidder, by considering suitable dewatering process.

8) Testing
Please refer Sl.7 of GRP specification: PE-TS-435-100-M042

9) MARKING FOR PIPE & FITTING
Please refer Sl.8 of GRP specification: PE-TS-435-100-M042

10)TRANSPORTATION, DELIVERY & SITE STORAGE
Please refer Sl.9 of GRP specification: PE-TS-435-100-M042

11)QUALITY ASSURANCE
Please refer Sl.10 of GRP specification: PE-TS-435-100-M042

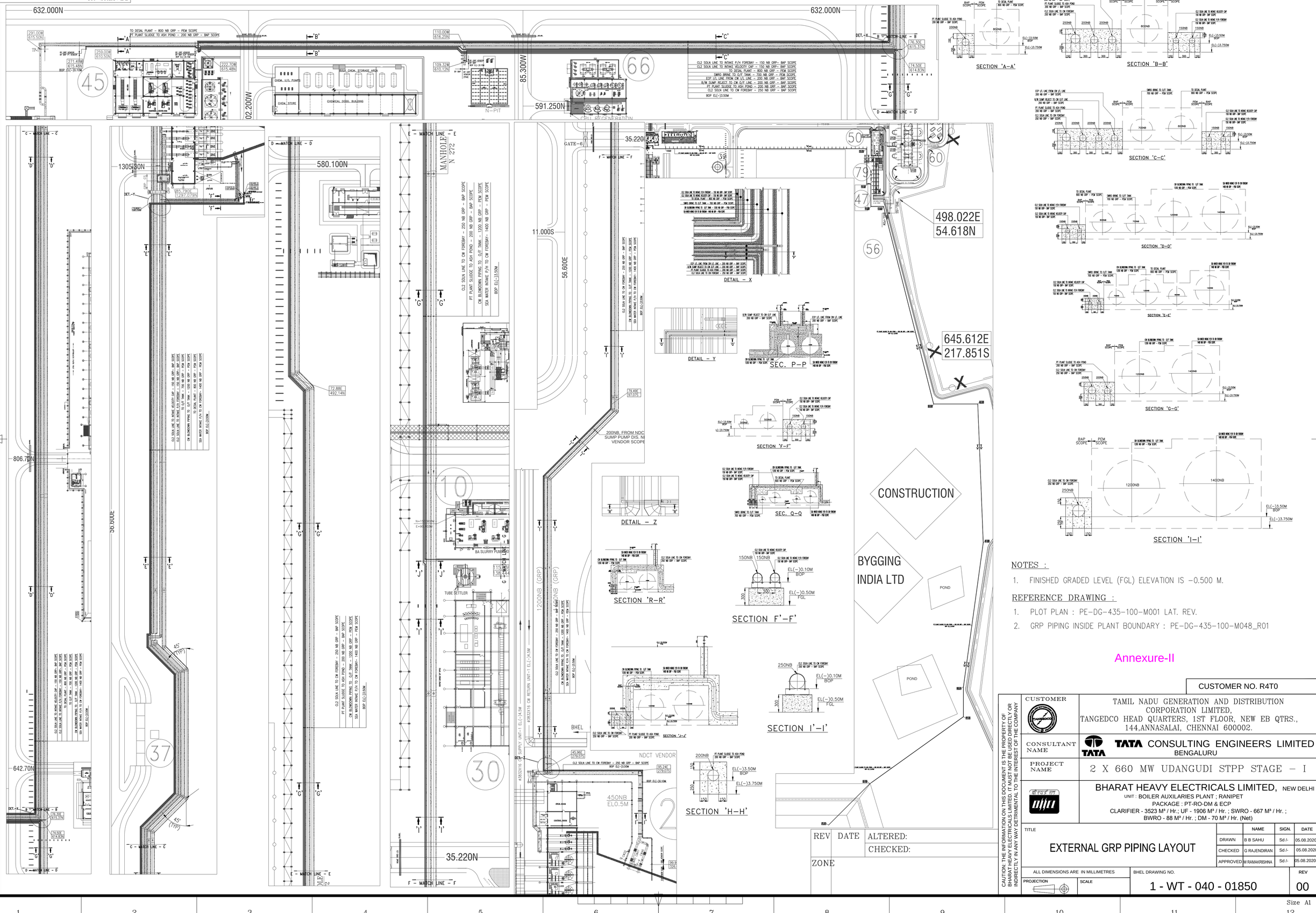
12)DRAWINGS AND DOCUMENTS
Please refer Sl.11 of GRP specification: PE-TS-435-100-M042

13)Compliance sheet
Please refer Compliance sheet enclosed in Spec: PE-TS-435-100-M042 pg.23/33.

				ANNEXURE-I: ESTIMATED BILL OF MATERIAL (GRP-UNDERGROUND)													DOCUMENT No:						REV NO: 00
																	BAP-WS-UDG-GRP-001						05.08.2020
				PROJECT TITLE: 2x660 MW UDANGUDI STPP STAGE-I										PREPARED BY		CHECKED BY:		APPROVED BY:					
				CUSTOMER: TANGEDCO										BBS		SS		IMRL					

Sl. No.	LINE DESCRIPTION	OPERATING		DESIGN		PIPE MATERIAL	PIPE SIZE			BENDS / ELBOWS				TEES		REDUCERS		FLANGES		END CAPS		REMARKS
		PRESS. Kg/cm2 (g)	TEMP (°C)	PRESS. Kg/cm2 (g)	TEMP (°C)		Nb (mm)	THK (mm)	LEN (M)	SIZE (NB)	R	dg	No	SIZE (NB)	No	SIZE (NB)	No	SIZE	No	SIZE (NB)	No	
Plant water System																						
1	Hypochlorite dosing Line from Electrochlorination plant (ECP) to Intake Pump house	3.5	33	7	50	GRP	150	To be selected by Bidder for PN10 rating	1050	150		90 45	15 6	-	-	--	--	150	4	--	--	Buried & Encased 3 mm inner layer (min.)
2	Hypochlorite dosing Line from ECP to Intake Velocity well	3.5	33	7	50	GRP	150		1050	150		90 45	15 6	-	-	--	--	150	4	--	--	Buried & Encased 3 mm inner layer (min.)
3	Sea water Backwash line from Backwash sump to CW blowdown pipeline leading to outfall	1.5	33	3	50	GRP	200		210	200		90 45	6 -	-	-	--	--	200	2	--	--	Buried & Encased
4	PT plant sludge from sludge sump to Ash Pond	3	33	6	50	GRP	200		2490	200		90 45	20 8	-	-	--	--	200	2	--	--	Buried & Encased
5	Hypochlorite dosing line from ECP to CW fore-bay	3	33	6	50	GRP	250		1350	250		90 45	16 10	-	-	--	--	250	2	--	--	Buried & Encased 3 mm inner layer (min.)
6	Sea water from CW makeup line to ECP	1.5	33	5	50	GRP	200		320	200		90 45	6 4	-	-	--	--	200	2	--	--	Buried & Encased
7	Air Vents	3	33	6	50	GRP	25		40	25		90 45	20 -	-	-	--	--	25	20	--	--	Buried & Encased

DRAWING NO. 1-WT-040-01850



NOTES :

1. FINISHED GRADED LEVEL (FGL) ELEVATION IS –0.500 M.

REFERENCE DRAWING :

1. PLOT PLAN : PE-DG-435-100-M001 LAT. REV.
2. GRP PIPING INSIDE PLANT BOUNDARY : PE-DG-435-100-M048_R01

Annexure-II

CUSTOMER NO. R4T0

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CUSTOMER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED, TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS., 144,ANNASALAI, CHENNAI 600002.
CONSULTANT NAME	TATA CONSULTING ENGINEERS LIMITED BENGALURU
PROJECT NAME	2 X 660 MW UDANGUDI STPP STAGE – I
	BHARAT HEAVY ELECTRICALS LIMITED, NEW DELHI UNIT : BOILER AUXILARIES PLANT ; RANIPET PACKAGE : PT-RO-DM & ECP CLARIFIER - 3523 M³ / Hr.; UF - 1906 M³ / Hr. ; SWRO - 667 M³ / Hr. ; BWRO - 88 M³ / Hr. ; DM - 70 M³ / Hr. (Net)

TITLE: EXTERNAL GRP PIPING LAYOUT

	NAME	SIGN.	DATE
DRAWN	B B SAHU	Sd /-	05.08.2020
CHECKED	G RAJENDIRAN	Sd /-	05.08.2020
APPROVED	M RAMAKRISHNA	Sd /-	05.08.2020

REV	DATE	ALTERED:
		CHECKED:
ZONE		

ALL DIMENSIONS ARE IN MILLIMETRES

PROJECTION | SCALE

BHEL DRAWING NO. 1 - WT - 040 - 01850

REV 00

Size A1

Annexure-III

DATA TO BE FILLED BY THE BIDDER FOR EACH SIZE & PRESSURE CLASS

1	Outside Diameter	mm	
1.1	Nominal reinforced Wall thickness	mm	
1.2	Liner Thickness	mm	
1.3	Total Wall Thickness	mm	
1.4	Hoop Tensile Modulus of Elasticity	N/mm2	
1.5	Hydrostatic Design Basis -for Stress basis	N/mm2	
1.6	Hydrostatic Design Basis -for Strain basis	%	
1.7	Long Term Ring Bending Strain	%	
1.8	Deflection Lag factor	-	
2	Stiffness Class 5000 N/m2 (min)	N/m2	
2.1	Design Pressure rating	Kg/sq.cm (g)	
2.2	Pressure Class considered	PN	
3	Standard permitted deflection	%	
3.1	Max. allowable long term vertical deflection (rel)	%	
	Calculations at Minimum Soil cover of 1.5 m or equal to pipe diameter, whichever is maximum (for design purpose)		
4	Predicted deflection		
4.1	Combined loading working strain due to		
a	internal pressure	%	
b	max permissible deflection	%	
5	Buckling pressure		
5.1	Allowable calculated value	N/mm2	
5.2	Max value due to vacuum, ground water & soil pressure	N/mm2	
5.3	Max value due to traffic, ground water & soil pressure	N/mm2	
	Calculations at Maximum soil cover of 4.0 m (for design purpose)		
6	Predicted deflection		
6.1	Combined loading working strain due to		
a	internal pressure %		
b	max permissible deflection %		
7	Buckling pressure		
7.1	Allowable calculated value	N/mm2	
7.2	Max value due to vacuum, ground water & soil pressure	N/mm2	
7.3	Max value due to traffic, ground water & soil pressure	N/mm2	