528683/2021/BAP-WS(CON)

BHARAT HEAVY ELECTRICALS LIMITED,

RANIPET- 632 406.

TECHNICAL SPECIFICATION

FOR

ULTRA FILTRATION SYSTEM

(Pressurized System)

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Rev. No.	Date	Prepared	Checked	APpproved	Remarks

	SPECIFICATION FOR ULTRA FILTRATION SYSTEM	SPEC.NO.ROS: 6326
		REV : 00

CONTENTS

1.0 SCOPE OF SUPPLY & WORK

The intent of this specification is to cover Design, Engineering, Manufacturing, Shop testing, Supply, of Pressurized UF membrane modules and accessories including Supervision services for Erection, Commissioning and Performance guarantee test as mentioned below.

The scope shall fully cover the requirement of the Design Criteria and Technical requirement of this specification for treating the feed water to meet the product water requirement of Plant. The scope of supply & services shall include but not limited to the following

a) UF system -2 set, Each set consists of UF membrane skids/trains capable of for producing 128 m3/hr net permeate water for down train of BWRO plant with total 256 m3/hr.

Skid/Trains configuration

i. 2 working (W) skid/train. Each skid/train shall be capable of producing 128 m3/hr net permeate output. Flow margin of 20% additional shall be considered for each skid/stream (i.e 153.5 m3/hr).

- Each skid/train shall consist of Pressurized UF membranes, module body, supports of module, mounting frames, anchoring arrangement, feed, filtrate and other applicable header pipes along with flanges etc.

- Each skid shall be supplied with headers for feed, drain, reject, permeate, backwash, airline, CIP, air vent etc as applicable.

- Balance frontal piping of all skids/trains for connecting with a common header with necessary valves and instruments shall be carried out by BHEL (frontal piping valves & instruments are excluded from the bidder scope).

b) 1 sets of foundation bolts, packing materials & fasteners for offered skids/trains/blocks. 1 set means quantities required for total UF system offered by bidder.
c) 1 set of Commissioning spares for UF membrane modules
d) 1 set of fiber repair kit (if applicable)
e) Supervision of Erection, Commissioning & PG test.
   i) 20 man-days (excluding travelling days, Sundays, & Holidays) shall be considered.
   ii) Number of visits shall be 6 .
   iii)Price for Supervision charges shall be quoted as lump sum including travelling, stay, conveyance and other incidental charges.

The scope for supervision of erection, commissioning and PG test requirements shall be as mentioned elsewhere in the specification. Items though not mentioned but

needed to make the system complete as stipulated under these specifications are also to be furnished unless otherwise specifically excluded.

1.1 It is not the intent to specify all the details of the design & manufacture. However, the equipment shall conform in all respects to high standard of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Engineer / Customer, who will interpret the meaning of drawing & the specification and shall be entitled to reject any work or material, which is not in full accordance herewith.

1.2 In case of any deviation, the Bidder shall indicate the same, clause by clause in the deviation schedule. In the absence of the same it will be construed that the bid confirms strictly to the specification.

1.3 General terms & conditions, instructions to the bidder & other attachments referred to elsewhere are part of this specification.

1.4 Note. In case of any contradiction between different chapters / sections / annexures of the technical specification, bidder may bring it to the purchaser's notice prior to bid submission in the form of pre bid queries and get it clarified from the purchaser. Otherwise, the most stringent specification shall be applicable in case of contradiction as decided by the purchaser.

2.0 TECHNICAL REQUIREMENT

2.1 UF SYSTEM CAPACITY

No. of UF trains/ skids	: 2 nos. (2W) (2X60%)
Net output per UF train/skid	:128 m3/hr/ stream (153.6 m3/hr/ stream at 60% load)
Mode of Flow	: Dead end flow
Recovery per UF train	: 95% minimum
Membrane material	: PVDF/ PES
Output SDI15	: ≤ 3
Gross average Flux*	: ≤ 60 LMH

Note*:

Average flux = (Total permeate required per day including back wash requirement in m^3 x 1000) / (Total area of the membranes for 2 skids in m^2 x 24 hrs)

2.2 INLET WATER QUALITY FOR DESIGN

The feed water quality to be considered for the design of Ultra Filtration System is indicated below. Feed water to UF system is filtered cooling tower blowdown water from vertical Dual Media Filters (DMF). DMF outlet will be directly fed to the UF system through basket strainer and no intermittent storage tank is envisaged. For details refer attached P&ID. UF permeate is stored in UF permeate water storage tank. Pressure at UF skid inlet shall be sufficient to cater the following requirements:

- Max. membrane fouling condition
- Downstream piping & valve loss requirements
- UF permeate water storage tank static head

FILTERED COOLING TOWER BLOWDOWN WATER ANALYSIS

S.No	Description	Unit	Value
1.	**General**		
a)	pH	---	7.0 - 8.0
b)	Temperature range	Deg C	20 – 40
c)	Turbidity	NTU	5
d)	Total Suspended Solids (TSS)	mg/l	5
e)	Total Dissolved Solids (TDS)	mg/l	2020
2.	**Cations**		
a)	Calcium	mg/l	525
b)	Magnesium	mg/l	260
c)	Sodium & Potassium	mg/l	690
3.	**Anions**		
a)	Chloride	mg/l	205
b)	Sulphate	mg/l	1120
e)	Bicarbonate as HCO_3	mg/l	150
4.	**Density of water**	Kg /m^3	1000

2.3 PERFORMANCE & GUARANTEE REQUIREMENT OF UF SYSTEM

The plant performance should meet the outlet water quality at UF outlet as indicated below:

Sl. No.	Guarantee Parameters	Unit	Value
1	UF Permeate Flow Net. (total)	m^3/day	6144 (256 m3/hr x 24 hrs)
2	SDI_{15}		≤ 3
3	Recovery per skid	%	95

1) Net permeate flow rate from each Ultra-Filtration skid/train shall be guaranteed and it shall not be less than rated flow. Net Permeate flow rate from the Ultra-Filtration Plant shall not be less than 256 m3/hr (with 20% Margin – 307 m3/hr).
2) Availability factor of each UF skid delivering net permeate flow shall be not less than 95%.
3) Filtration Capacity of Ultra-Filtration System shall be guaranteed meeting the effluent quality and the same shall not be less than specified capacity.

4) SDI test shall be carried in accordance with ASTM standard D4189.

3.0 TECHNICAL SPECIFICATION - MECHANICAL

3.1 DESIGN CRITERIA

UF plant shall be operated and controlled through DCS based control system. Complete Ultra-filtration plant, is conceived with multiple skid/trains. The product water is envisaged to be stored in storage tank & further fed to BWRO system. It shall be possible to operate each skid/train to its full design capacity or in part capacity by isolation of another skid/train. This operational flexibility built into the scheme shall be achievable through control system.

Operation of UF Plant shall be completely automatic through common DCS system. DCS system (**excluded from bidder's scope**) will be provided by (BHEL). Bidder shall furnish control logics and render all technical assistance in operating their system through / DCS system.

Ultrafiltration system shall be designed to allow multiple starts and stops without affecting the service life of the membranes. The system may experience extended periods of no flow. System design shall protect the system against periods of no flow as recommended by membrane manufacturer.

DCS logic shall be developed considering both streams /skids are working.

Provisions for local grab sampling points shall be available at various points throughout the system to monitor UF Filter performance. Sample ports on the feed, concentrate and permeate (to enable evaluation of system performance) & Sample port on each pressure vessel permeate outlet to facilitate troubleshooting.

UF membranes shall be hollow-fiber, pressurized type. Membrane materials shall be Polyvinylidene di fluoride (PVDF) or Polyethersulfone (PES). Gross maximum design flux rate shall not be more than 60 l/m^2/h. Filtration direction shall be Out-to-In or In-to-Out. Design UF recovery shall not be less than 95%.

Visible inspection window built into the filtrate discharge pipe or any other arrangement as per manufacturer's standard shall be provided so that in the event of fiber breakage, the affected module shall be easily identifiable on the skid/train/block.

For Direct Integrity Testing at site, arrangement and facilities like air pressure system, gaskets, instruments, valves, fittings and any other equipment as required shall be provided as per manufacturer's standard practice to detect any leak from fibres / modules.

UF normal backwashing and chemical cleaning frequency shall be adjustable individually and controlled from the control system including number of cycles before

chemically cleaning is initiated. Time duration of these backwash cycles shall also be adjustable from the control system.

After the manufacture, following tests for membrane shall be demonstrated at membrane manufacturer's works in the presence of BHEL / customer's representative.

1) Bubble Point Test in one batch (if applicable)
2) Integrity test (Pressure decay test/vacuum hold test) for 1 % of total membrane population.

In case such test facilities are not available at manufacturer's works, the test may be carried out at any other test facility with the approval of customer. All cost associated with testing at membrane manufacturer's works or at any other test facility shall be borne by the bidder.

Integrity test shall be carried out in accordance with ASTM D 6908-06, Standard Practice for Integrity Testing of Water Filtration Membrane Systems (Pressure decay test/vacuum hold test) and approved test procedure. Bidder shall submit the test procedure for Employer's approval within two months of award

3.2 EQUIPMENT SPECIFICATION (ULTRAFILTRATION SKIDS)

1.	No. of UF trains	: 2W
2.	No. of blocks per train/skid	: Bidder to specify. No. of membrane module per block and no. of rows per block shall also be specified.
3.	Location	: Under shade
4.	UF Module Type	: Pressurized (Dead end)
5.	Net Output capacity / train	:128 m3/hr (normal) : 153.6 m3/hr (20%margin)
6.	Recovery	: 95 % (min)
6 (a)	Operation	: 24 hrs
7	Membrane Guarantee	: 2 years cliff + 3 years prorata
8.	Membrane Pressure Vessel Dia.	: Bidder to specify
9.	MOC: Housing, shell, end caps Piping in the skid Flexible couplings Fasteners Skid frame	 CPVC / Equivalent CPVC Sch.80 SS316/Engg. Thermoplastic SS316 ASTM A36 + epoxy paint
10.	Rating of Pressure Vessel	: Bidder to specify.

11.	Type of membrane mounting	: vertical
12.	Membrane Type	:Hollow Fiber, Chlorine tolerant (bidder to specify the no. of ppm-hours for the life of the membrane)
13 .	Membrane material	: Polyvinylidene di fluoride(PVDF) or Polyether sulfone(PES) Bidder to specify
14.	Surface area of membrane	: Bidder to specify.
15.	Membrane pore size	: Bidder to specify
16.	Gross Flux	: ≤ 60LMH
17.	Membrane flow mode / configuration	: out to in / in to out. Bidder to specify.
18.	Membrane assembly per block	: Total as a assembly with membranes modules in vertical position
19.	Size of the skid / train	: Bidder to specify. Note: both skids / trains shall be accommodated within the UF shed space as per the attached Equipment layout (including membrane removal & handling space). The no. of UF membrane modules in a row shall be decided by vendor .
20.	Trans Membrane Pressure (TMP) for normal operation	: Vendor to specify
21.	Backwash waste water disposal scheme	: Vendor to specify
22.	NaOCl concentration tolerance (Backwash)	2000 ppm (max.)

Notes.

1) Necessary clamping arrangements shall be in bidder’s scope.

2) Bidder shall develop the skid such a way to accommodate the layout space allocated for UF skids. Clear spacing between two adjacent UF skids shall be minimum 1200 mm for maintenance & walkway purpose. The skid piping / header shall not project out of the UF skid/train boundary area.

3) Necessary spacing (minimum 600 mm) between adjacent membrane module rows (blocks) shall be provided to facilitate easy maintenance, assembly & removal of membrane modules from the interconnecting piping/rack, without

disturbing other adjacent modules. Bidder to clearly indicate the spacing between adjacent membrane module rows in their typical skid/train assembly drawing.

4) Membrane modules mounted in rows shall be connected to respective feed, permeate, backwash, reject, CIP, air, headers etc. Further scope of piping shall be done by BHEL. Flanged terminal connection with fasteners & dummy shall be provided for all the piping headers mentioned above.

5) The membrane modules shall be connected to the respective headers with rigid piping with quick remove couplings (flexible hoses are not allowed).

6) Provision shall be provided for carrying out the bubble test / leak test for each membrane module.

7) Necessary clearance shall be provided between the roof shed and the UF skids/trains for lifting the membrane elements/maintenance. Bidder shall furnish the size of crane required for handling the UF skids.

8) The membrane mounting frame MOC shall be corrosion resistant suitable for power plant environment having sufficient strength and rigidity to support the all membrane modules, headers, inter connecting piping etc. Typical skid/train arrangement shall be submitted along with the bid.

9) For each UF stream, the frontal piping connection shall be placed on one side of the skid and not in between.

10) The total net permeate quantity of 256 m3/hr is required continuously to cater to the requirement of downstream systems. In addition, the permeate water requirement for UF backwash, chemical cleaning and other UF plant process requirement if any are also to be included. Bidder shall confirm the adequacy of the capacity of the train for all these requirements. If required, Bidder can make upward revision of the output quantity per train. UF backwash system & Chemical cleaning system shall be Common for both the trains and shall cater to the requirement of one complete train at a time.

11) Foundation bolts with necessary packing materials and fasteners required for the UF skids/blocks shall be supplied by the bidder. All the fasteners & foundation bolt MOC shall be SS316L.

12) Bidder shall provide the UF backwash, CIP and air scouring requirements.

13) The scope of bidder shall also cover review and vetting of scheme drawings such as PFD, P&ID diagram, etc., as well as layout and piping drawings for the UF plant prepared by BHEL based on the inputs from successful bidder.

4.0 GENERAL DESIGN REQUIREMENTS

The common requirements for the system are stated in the general design requirements. However, the requirements indicated in the technical specification for mechanical equipment section 3 shall be strictly complied with.

4.1 COMMON REQUIREMENTS

1. Only latest revision of standards shall be used.
2. Sampling connections and air vent at the top most point of piping and vessels shall be provided at all stages of the Unit.
3. The size of the overflow pipes of all storage tanks shall be one size higher than inlet pipe sizes of these tanks.
4. All the piping & valves are to be located to facilitate easy accessibility and operation from the ground level.
5. The direction of Flow shall be indicated by an arrow at regular intervals on all pipelines.

5.0 TECHNICAL DETAILS FOR CIVIL WORKS

All civil works are excluded from bidder's scope. However, the bidder shall provide the equipment layout drawing along with bid. Detailed construction drawing with foundation requirement like load details, foundation pockets, etc., for all the skids, equipment, flooring requirements, trenches for pipe routing, cable routing & drains etc. shall be furnished for approval after order.
Any special requirement like handling arrangement, floor / trench protection etc. shall also be indicated in the drawings. All the plant drains & trenches are to be connected in a common trench and terminated near UF Plant boundary. The approximate area & location are indicated in the enclosed lay out drawing. Bidder to accommodate the UF system with in the stipulated area only as indicated in the typical layout drawing attached along with this specification.

6.0 PERFORMANCE GUARANTEE TEST

6.1 The bidder shall guarantee all equipment for workmanship, materials and satisfactory performance. The guarantee for performance will cover individual items and systems including electrical for their ratings / outputs as well as for the integrated operation of equipment and its auxiliaries as a whole. On completion of satisfactory commissioning, performance / acceptance tests shall be conducted on the equipment and system as a whole for demonstrating the guaranteed performance parameters specified. The PG test shall be normally carried out for 72 hr of continuous operation subject to end Customer approval. The guarantee tests shall cover the following but not be limited to the rated parameters for smooth operation of complete UF system:

a. UF outlet water quality as indicated in section 2.3
b. UF system net output capacity and recovery as indicated in section 2.3

6.2 Bidder shall provide necessary technical assistance during PG test. PG test shall be conducted in the presence of representative from BHEL, Customer and successful bidder. Bidder shall comply to the approved PG test procedure issued by customer.

6.3 General

In addition to the guarantees mentioned above, the requirements of specifications on all guarantees as elaborated under relevant clauses of Technical Specifications should be met.

Any part which proves defective either in design, materials / and / or manufacture within the guarantee period shall be replaced at free of cost to the owner at site and the provision of this clause shall apply to the portions of the plant so replaced or renewed until the expiration of the guarantee period or from the date of replacement whichever is later.

7.0 SUPERVISION OF ERECTION & COMMISSIONING

20 man-days (excluding travelling days, Sundays, & Holidays) shall be considered for supervision of Erection, commissioning & PG test of the system.

The scope of supervision of Erection & commissioning shall involve the following

1. Supervision of erection of all the equipment supplied by the bidder.
2. Supervision of commissioning of the UF system.
3. Technical services during PG test- Bidder shall be responsible for achieving / demonstrating guaranteed parameter as per specification. Bidder shall render all the technical services during PG test.
4. Bidder shall render technical assistance for establishing UF plant operation through DCS and interfacing the control logics with existing control system.
5. If UF blocks are supplied to site in dismantled condition as loose items, they shall be assembled at site by bidder with no additional cost.
6. Bidder shall impart training to customer & BHEL in operation and maintenance of the UF skids.

8.0 DOCUMENTATION

8.1 GENERAL

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

1. All documents and drawing shall be submitted in English
2. Soft copies of all final documents in MS word / MS office in the form of CD –1 set
3. Soft copies of all final calculations in MS excel / MS office in the form of CD –1set
4. Soft copies of all final drawings in Auto Cad, latest version in the form of CD – 1set

8.2 DOCUMENTS ALONG WITH BID:

The following drawings / documents are to be enclosed along with the bid for scrutiny.

1. Technical write-up giving details of equipment operation, interlocks / control requirement
2. Typical Quality Plan for major equipment (UF skid, UF membrane, etc.,)
3. Qualification Requirement (QR) documents as per **Annexure B**
4. UF membrane projections & process calculations
5. Typical membrane guarantee document
6. Membrane storage procedure before commissioning
7. Membrane preservation procedure (short term & long term) after commissioning
8. Membrane Datasheet
9. Correction curve for variation in feed water turbidity (from 5 NTU to 25 NTU)
10. Preliminary P& I diagram
11. Preliminary Equipment layout drawing
12. Typical arrangement drawing & isometric drawing of skid with membranes, piping, valves, headers arrangement including space for membrane removal, maintenance, walkway etc.,
13. Write-up about membrane removal & maintenance.
14. Filled up data sheets as called in the specification – Annexures 1 to 3
15. Chemical consumption for maintenance and recovery cleaning with frequency.
16. Utility requirements like instrument air, service air and service water for maintenance & recovery cleaning of UF Module
17. Cleaning sequence with flow rate, duration, effluent details, etc.,
18. Preliminary civil requirements.
19. PLC/ DCS I/O list for each train covering all instruments, valves, etc.,
20. Reference list of the plants of similar capacity of single train executed in the last five years.
21. Deviation schedule duly filled, if any – Annexure – 4. Any deviation should have cost of withdrawal for our evaluation in the commercial bid.
22. Unpriced commercial offer on the scope of supply

Bidder to note that failure to submit the above will be considered as incomplete and offer is liable for rejection.

Note:
If there is no deviation “NIL” Deviation statement shall be furnished. In the absence of the non-attachment of this Annexure-4, it will be construed that the bid confirms strictly to the specification.

8.3 DOCUMENTS AFTER ORDER

The following drawings / documents are to be submitted post award of order.

8.3.1 PHASE-I DOCUMENTS (for approval-within 7 days from the date of LOI):

1. Technical Write-up and design basis
2. Sizing, projections / process calculations for UF membrane modules.
3. Filled up datasheets for approval as per Annexures 1 to 3
4. P&ID
5. Equipment layout
6. UF system “Control Description” write-up including operation, controls, interlocks, protection, annunciation etc.
7. Activity chart / Bar Chart and schedules for drawing submission, manufacturing, erection and commissioning.
8. Quality Plan and field quality checks, stage inspection etc. (for UF skid, UF membrane, etc).
9. Membrane Guarantee Document.
10. Membrane Datasheet.
11. Typical arrangement drawing & isometric drawing of skid with membranes, piping, valves, headers arrangement including space for membrane removal, maintenance, walkway etc.,
12. Write-up about membrane removal & maintenance.
13. PLC/ DCS I/O list.

8.3.2 PHASE-II DOCUMENTS (for information-within 2 weeks from the date of LOI):

1. Membrane storage procedure before commissioning
2. Membrane preservation procedure after commissioning
3. Foundation Design drawings indicating foundation design, load data, anchor bolt location, pocket details, floor & trenches etc.
4. General arrangement drawings for all the equipment showing dimensions and details of materials.
5. As-built manufacturing drawing of the UF skid, frame and equipment

8.3.3 PHASE-III DOCUMENTS (for information-before dispatch):

1. Erection Manual indicating
    a. Erection/installation instructions of equipment.
    b. Log sheet containing stage check parameters & clearance
    c. Field quality checks
2. Performance Test procedure
3. Shipping list for BHEL’s approval in BHEL format

8.3.4 PHASE-IV DOCUMENTS (for review):

1. Operation and maintenance manual indicating operating procedure for start-up, normal operation, chemical cleaning, shut down and emergency shutdown. (O&M manual shall be supplied in 6 sets of hard copies and one set in soft form in CD).
2. Maintenance instruction & assembly
3. Lubrication chart.
4. UF System Logic diagram & Sequential Flow Chart (SFC) for PLC/ DCS.
5. Test Certificates for all the supplied equipment.
6. List of alarm, interlock & trip set points
7. Installation drawings for instruments
8. As built drawings.
9. All other details called in Electrical specification.

Note: Bidder to confirm in their offer that these details called in section 8 will be provided.

9.0 REFERENCES

1. Annexure-A Painting specification
2. Annexure-B Qualification Requirement
3. Annexure-C Typical GA drawing of UF skid arrangement
4. 1-WT-022-02156: Equipment Layout for CWBD Water Treatment Plant
5. 1-WT-022-02157: P&ID of UF system

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Annexure – 1

DATA SHEET

1. UF OUTLET WATER QUALITY & QUANTITY

Sl. No.	Description	Unit	Values
1.	Net permeate output per UF train/skid	m^3/hr	
2.	Total net permeate output from the UF system	m^3/hr	
3.	UF System Recovery	%	
4.	Turbidity	NTU	
5.	SDI_{15}	-	

2. CHEMICAL REQUIREMENT FOR ONE CLEANING

Sl. No.	Description	Unit	Per time / train	Total per day / train
1.	Acid (HCl) - 33%	kg		
2.	NaOCl - 6%	ltrs		
3.	Any other chemical			

3. CHEMICAL DOSING DURATION & FREQUENCY

Sl. No.	Description	Solution Conc. (%)	Duration in minutes	No. of cycles per day
1.	Acid (HCl)			
2.	NaOCl			
3.	Any other chemical			

4. MEMBRANE GUARANTEE

Sl. No.	Description	Unit	Values
1.	Guaranteed life of the membrane	years	

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Annexure- 2

EQUIPMENT DATA SHEET

A. PRESSURE VESSEL

Sl. No.	Description	Bidder to fill the details	
1.	Make		
2.	Model		
3.	Material of construction		
	- Pressure vessel		
	- End Plate		
	- End adapters		
	- Holding strips		
	- Support saddle		
	- O rings		
4.	Feed port		
	Permeate port		
5.	No. of pressure vessels offered per block		
6.	Pressure rating, psi		
7.	Design Pressure, psi		
8.	Test pressure, psi		
9.	Burst Pressure, psi		
9a.	Operating temperature (max), ºC		
10.	Port size / Orientation		
	- Feed		
	- Permeate		
11.	Port Victaulic Groove Style		
	- Feed		
	- Permeate		
12.	Empty weight, kg		
13.	Filled weight, kg		
14.	Shipment weight, kg		
15.	Vessel Drawing No.		

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Annexure - 3

EQUIPMENT DATA SHEET

B. UF MEMBRANE

Sl. No.	Description	Bidder to fill the details		
1.	Make			
2.	Model			
3.	Type / Material			
4.	Membrane pore size (Nominal/Absolute) micron			
5.	Membrane diameter, mm			
6.	Membrane length, mm			
7.	Nominal membrane area, m^2			
8.	Number of fibres			
9.	Fibre dimensions			
10.	Filtrate flow per element (min/max), m3/hr			
11.	Membrane flow mode / configuration	IN to OUT / OUT to IN		
12.	Quantity offered per train (per skid)			
13.	Membrane Housing assembly	Vertical		
14.	Guaranteed Life of membrane, years			
15.	Recommended membrane replacement (If any)			
16.	Feed temperature (Design/Min/ Max)			
17.	Feed TSS (Design/ Min/ Max)			
18.	Feed pressure for design TSS, bar(g)			
19.	Trans Membrane Pressure(TMP) for design TSS for normal operation, bar(g)			
20.	Maximum applied feed pressure, bar(g)			
21.	Maximum permissible Trans Membrane Pressure(TMP), bar(g)			
22.	Maximum Backwash Trans Membrane Pressure, bar(g)			
23.	Max. chlorine exposure, ppm-hours			

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Sl. No.	Description	Bidder to fill the details	
24.	Feed Flow rates (Min/ Max), m^3/hr		
25.	Permeate flow (Min/ Max), m^3/hr		
26.	Recovery, %		
27.	Membrane flux (Design/Maximum), l/m^2/hr		
28.	Maximum permitted pressure drop in bar for the above operating conditions		
29.	Maximum permitted temperature in deg.C for membrane		
30.	Minimum permitted temperature in deg.C for membrane		
31.	Operating pH range		
32.	Guaranteed filtrate SDI_{15} / NTU		
33.	Maximum allowable organic loading - TOC ppm : - BOD ppm : - COD ppm :		
34.	Weight per element, kg		

Annexure - 4

TECHNICAL DEVIATIONS

Sl. No.	Sec. No.	Cl. No.	Pg. No.	Specification	Statement of Deviations / variations	Reason for Deviation

Annexure - A

TECHNICAL SPECIFICATION
FOR
PROTECTIVE LINING AND PAINTING

CONTENTS

PROTECTIVE LINING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a)	SSPC SP 10 / NACE 2 /	:	Near White Blast Cleaning
b)	SSPC PA 2	:	Measurement of dry film Coating Thickness with magnetic gauges.
c)	ASTM D 4541	:	Method for pull off strength using portable Adhesion Tester.
d)	NACE RP 0274 – 2004	:	High-Voltage Electrical Inspection of Pipeline Coatings
e)	NACE SP 0188 – 2006	:	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
f)	NACE RP 0169 – 2002	:	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
g)	AWWA C 210 – 2007	:	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
h)	IS 3589:2001 Annexure B	:	Steel Pipes for Water and Sewage Specification.

i) AWWA C222-2000 : Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.

j) IS 13213 : 2000 : Polyurethane Full Gloss Enamel (Two pack)

3.00.00 GENERAL REQUIREMENTS

3.01.00 The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.

3.02.00 The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.

3.03.00 The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.

3.04.00 The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.

3.05.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.

3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.

3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.

3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.

3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.

3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.

3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti corrosive painting.

3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.

3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).

3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.19.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER

4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted.

Colour bands of Purchaser's approved shade shall however be applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 Surface Preparation

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting to Sa 2-1/2 Swiss Standard before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.02.03 The minimum degree of surface preparations for all equipment, piping, fittings, valves, structures etc. shall be "Near White" according to Steel Structure, Painting Council-SSPC-SP-10 before application of any primer/paint.

4.03.00 Painting

4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc. to be installed indoor shall be as follows :

a) Surface preparation shall be done either manually or by any other approved method.

b) Primer Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based zinc phosphate.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber paint of approved shade and colour with glossy finish.

e) Total DFT of paint system shall not be less than 150 microns.

4.03.02 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc to be installed **outdoor** shall be as follows :

a) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.

b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.

e) Total DFT of paint system shall not be less than 300 microns.

4.03.03 Specification for application of paints for external surfaces protection of steel pipes and fittings which are **buried underground / laid inside a hume pipe & or submerged Under Water and laid under Pipe Trenches** (in road/rail/pipe or trench crossings) shall be as follows :

External surface of the pipe, fittings, specialties etc. handling raw water/clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 2000 micron including primer coat.

4.03.04 Specification for application of paints for **internal surface protection of large diameter pipes** (sizes above 600 mm NB and above) if any, shall be as follows :

a) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.

b) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.

c) The minimum dry film thickness (DFT) of internal lining shall be 600 micron.

4.03.05 Specification for application of paints for protection of **internal surfaces of DM Water Storage Tank(s)** shall be as follows :

a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.

b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.

c) Total thickness of primer and paint should not be less than 500 microns.

4.03.06 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.

4.03.07 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.

4.03.08 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.

4.03.09 All machined surfaces shall have two (2) coats of water repellant grease after thorough cleaning.

5.00.00 COATING PROCEDURE AND APPLICATION

5.01.00 Surface Preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2½ of ISO 8501 (near white metal)

a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.

b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 Application of Epoxy Coating

a) Coating shall be applied when

i) When the pipe surface temperature shall be atleast 3°C above dew point temperature.
ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater that 50°C.

b) Material preparation shall be in accordance with manufacturer's recommendations.

c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.

5.03.00 Application of PU Coating

a) PU coating shall be applied when the pipe surface temperature atleast 3°C above dew point temperature (when R.H is more than 85%).

b) Material preparation and application shall be done as per manufacturer recommendation.

6.00.00 TEST REQUIREMENTS

6.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating : Coating thickness shall be in the range of ±20% and as per SSPC PA 2.

6.01.01 Apparatus / Instrument:-

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 Procedures:-

a) Number of measurements:
For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness. Area measurement must be within specified range.

6.02.00 **ELECTRICAL INSPECTION (HOLIDAY) TESTS**

6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

6.03.00 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.

6.04.00 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing Voltage $V = 7900 \sqrt{T} \pm 10$ percent where T is the average coating thickness in mm.

6.05.00 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

6.06.00 **ADHESION PULL OFF TEST**

After holiday the coated surface is subjected to adhesion pull off test as per ASTMD 4541.

6.06.01 Apparatus / Instrument: Adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “Jaw” at the bottom and also dollies.

6.06.02 Prepare the test surface

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

6.06.03 Prepare Dolly (Test Pull Stub)

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.07.00 Select an adhesive:

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.08.00 Attach the dolly to the surface.

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.

d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.09.00 Adhesion Test Procedure

a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.

b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.

c) Slide the dragging indicator pin on the black column to zero by pushing it downward.

d) Firmly hold the base of the instrument in one hand and rotate the handwheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.10.00 **COATING REPAIR**

Defective Coating shall be repaired in accordance with the following subsections.

6.10.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The

adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.10.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.11.00 Coating Application

The coating system shall be applied to the prepared areas in accordance with procedure.

6.12.00 Repair Inspection

Repaired portion shall be electrically inspected using a holiday detector.

6.13.00 **WELDED FIELD JOINTS**

6.13.01 Preparation :

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

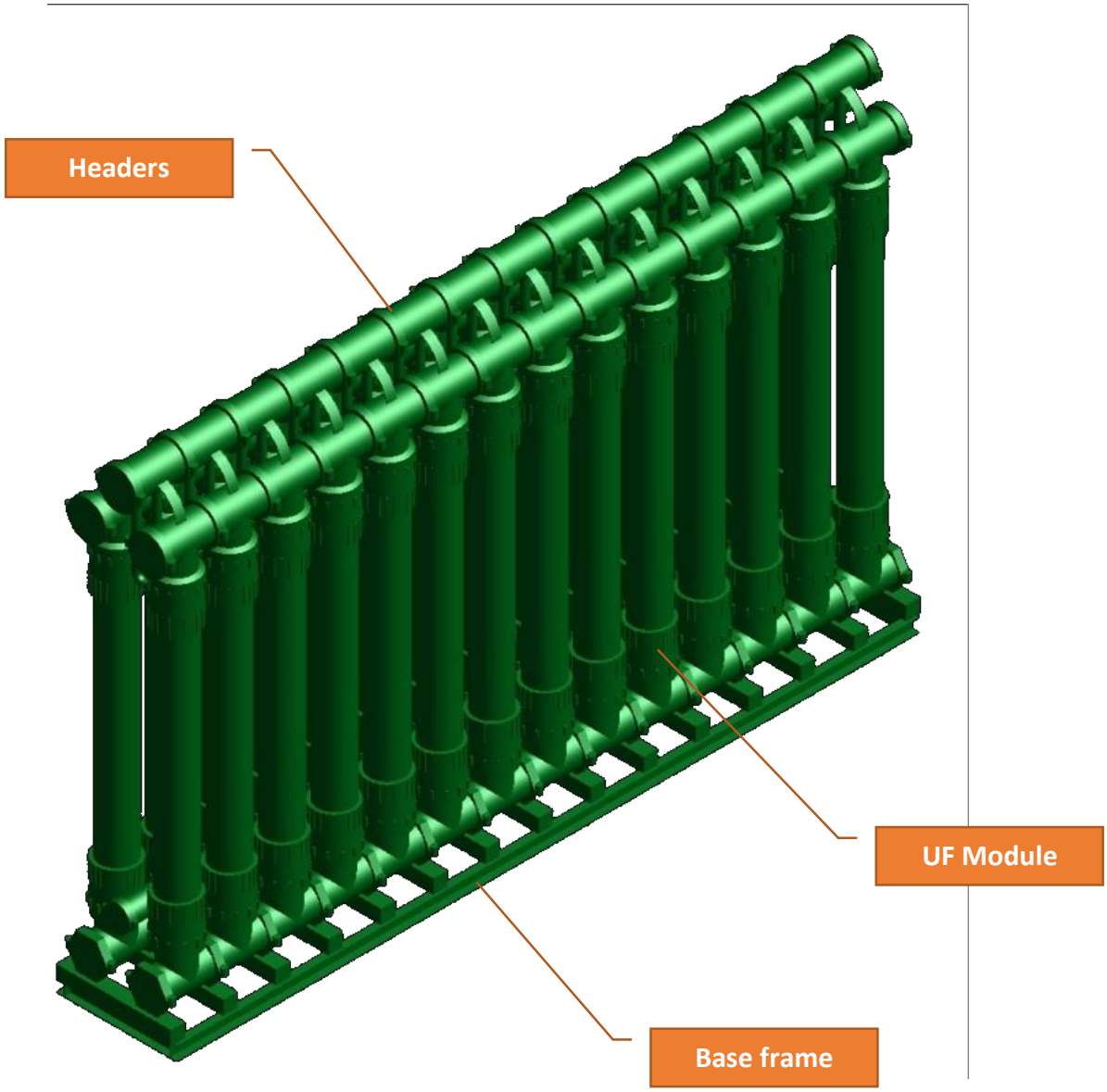
6.13.02 Electrical Inspection :

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

7.00.00 INFORMATION/DATA REQUIRED

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.

Annexure-C



Note: All terminal piping connections shall be flanged

DRAWING NO. **1-WT-022-02157**

ALL DIMENSIONS ARE IN MILLIMETRES

NOTES :

1. THE CAPACITIES OF THE EQUIPMENT INDICATED ARE TENTATIVE. THESE ARE SUBJECTED TO CHANGE BASED ON THE FINAL DETAILS OBTAINED FROM THE SYSTEM SUPPLIERS.

FILTERATE FROM DMF

BASKET STRAINER
QTY: 1W+1S
FLOW: xx m³/hr

TO DRAIN

INSTRUMENT AIR

UF SYSTEM

UF AIR BLOWER
QTY : (1W+1S)
FLOW :xxx M³/HR
HEAD :xxx PSI
MOC : CAST IRON (IS-210, Gr.FG260)
TYPE : ROTARY TWIN LOBE

INST. AIR

SKID BOUNDARY

PERMEATE HDR.

WASTE HDR.

FEED HDR.

AIR HDR.

PIPING INST.

COMMON SOL VALVE BOX

UF MODULE

STREAM – A

STREAM – B

TO RO REJECT SUMP

PRESSURISED UF BLOCK
QTY : (2W)
RECOVERY:95%
FLOW : 153 m³/hr/Skid

UF PERMEATE (3RD B-12)

SER. WATER
(FOR INITIAL FLUSHING)

TYPICAL.

NaOCL DOSING

CITRIC ACID DOSG.

HCL DOSG.

TO DRAIN

TO DRAIN LEADS TO RO REJECT SUMP

UF CIP TANK
QTY : 1 NO.
CAP : xx M³
MOC : CSRL

UF CIP PUMPS
QTY : (1W+1S)
FLOW: xx M³/HR
HEAD: xx KG/CM²
MOC : SS 316

UF CIP CARTRIDGE FILTER
QTY : 1 NO.
FLOW: xx M³/HR
MOC : SS 316

UF BACKWASH PUMPS
QTY : (1W+1S)
FLOW: xx m³/hr
HEAD: xx Kg/cm²
MOC : Duplex SS

UF BACKWASH TANK
QTY : 1 NO.
CAP : xx M³
MOC : CSRL

NaOCL DOSING (OPTIONAL)

BWRO FEED PUMP BYPASS

BWRO FEED PUMP

UF PERMEATE WATER TANK
QTY : 1 NO.
CAP : 600 M³
MOC :RCC WITH FRP LINING

PRELIMINARY

FOR TENDER PURPOSE ONLY

REV	DATE	ALTERED
ZONE		CHECKED

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: **WBPDCL 1x660 MW TPS SAGARDIGHI UNIT #5**

BHARAT HEAVY ELECTRICALS LTD., UNIT: BOILER AUXILIARIES PLANT, RANIPET – 632 406.

	NAME	SIGN	DATE	NO.OF VAR.
DRN	RSP		01.11.21	
CHD	AK/SV		01.11.21	
APPD	DBN		01.11.21	

DEPT	GRADE OF UNTOL.DIM	SCALE	WEIGHT (KG).	REF. TO ASSY/OLD DRG.	ITEM NO.	NO. OF ITEMS
9776						
CODE NP	PR: QA: 500					

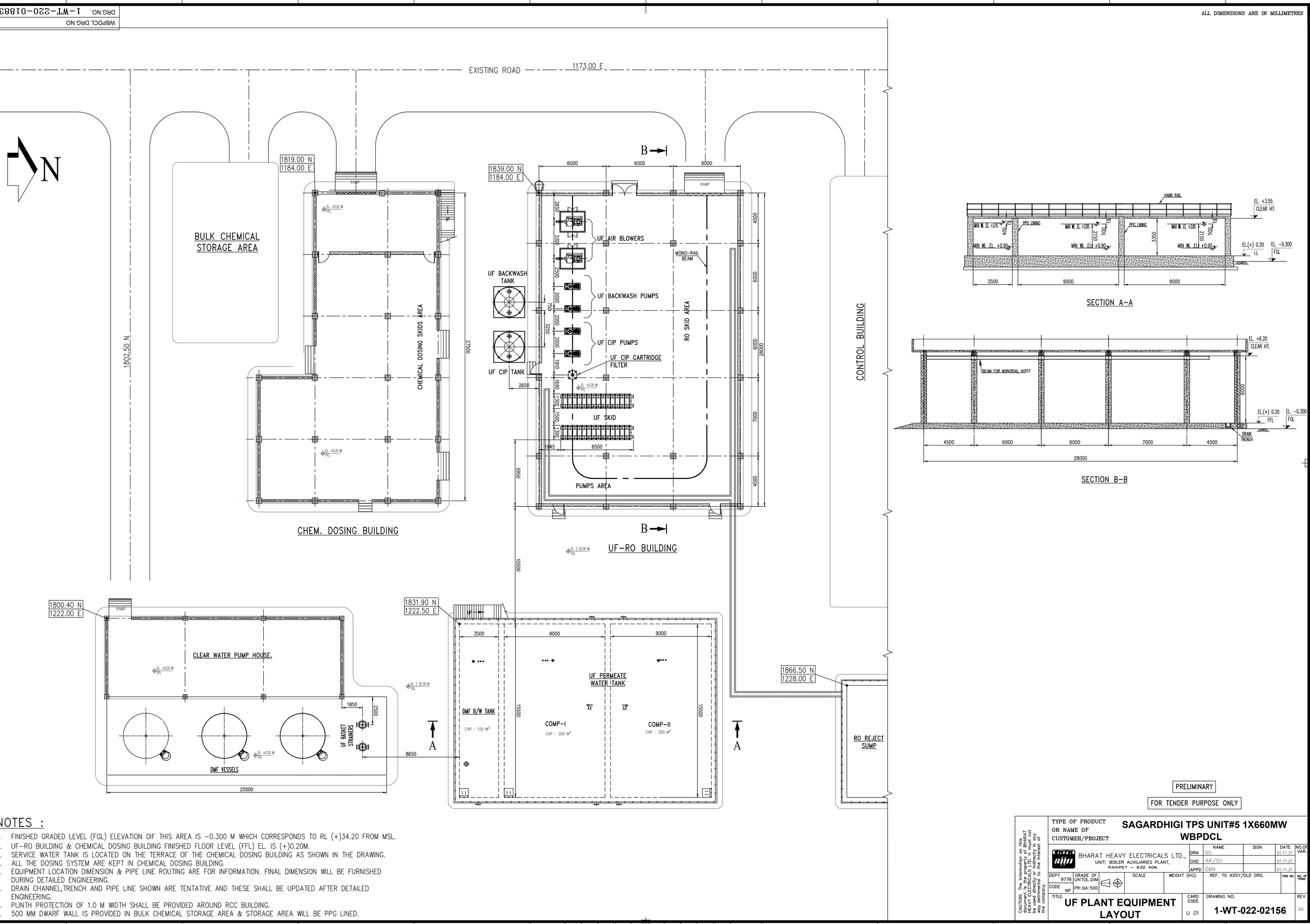
TITLE	CARD CODE	DRAWING NO.	REV
P & ID FOR ULTRA FILTRATION SYSTEM	U 01	**1-WT-022-02157**	00

Size A1

WBPDCL DRG NO. 1-WT-220-01883

DRG NO.

ALL DIMENSIONS ARE IN MILLIMETRES



SECTION A–A

SECTION B–B

NOTES :

1. FINISHED GRADED LEVEL (FGL) ELEVATION OIF THIS AREA IS –0.300 M WHICH CORRESPONDS TO RL (+)34.20 FROM MSL.
2. UF–RO BUILDING & CHEMICAL DOSING BUILDING FINISHED FLOOR LEVEL (FFL) EL. IS (+)0.20M.
3. SERVICE WATER TANK IS LOCATED ON THE TERRACE OF THE CHEMICAL DOSING BUILDING AS SHOWN IN THE DRAWING.
4. ALL THE DOSING SYSTEM ARE KEPT IN CHEMICAL DOSING BUILDING.
5. EQUIPMENT LOCATION DIMENSION & PIPE LINE ROUTING ARE FOR INFORMATION. FINAL DIMENSION WILL BE FURNISHED DURING DETAILED ENGINEERING.
6. DRAIN CHANNEL,TRENCH AND PIPE LINE SHOWN ARE TENTATIVE AND THESE SHALL BE UPDATED AFTER DETAILED ENGINEERING.
7. PLINTH PROTECTION OF 1.0 M WIDTH SHALL BE PROVIDED AROUND RCC BUILDING.
8. 500 MM DWARF WALL IS PROVIDED IN BULK CHEMICAL STORAGE AREA & STORAGE AREA WILL BE PPG LINED.

PRELIMINARY

FOR TENDER PURPOSE ONLY

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: **SAGARDHIGI TPS UNIT#5 1X660MW WBPDCL**

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: BOILER AUXILIARIES PLANT,
RANIPET – 632 406.

	NAME	SIGN	DATE	NO.OF VAR.
DRN	SG		01.11.21	
CHD	AK/SV		01.11.21	
APPD	DBN		01.11.21	

DEPT	GRADE OF UNTOL.DIM	SCALE	WEIGHT (KG).	REF. TO ASSY/OLD DRG.	ITEM NO.	NO. OF ITEMS
9776						
CODE NP	PR: QA: 500					

TITLE: **UF PLANT EQUIPMENT LAYOUT**

CARD CODE: U 01

DRAWING NO.: **1-WT-022-02156**

REV: 00

Size A1