IS:2209	Mortice locks (vertical type).
IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

R oof Water Proofing and AlliedWorks

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.

	IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
	IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.
	Floor Finishes and Allied Works	
	IS:1237	Specification for cement concrete flooring tiles.
	IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
	IS:2114	Code of practice for laying in-situ terrazzo floor finish.
	IS:2571	Code of practice for laying in-situ cement concrete flooring.
	IS:3462	Specification for unbacked flexible PVC flooring.
	IS:4971	Recommendations for selection of industrial floor finishes.
	IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
	IS:8042	Specification for white portland cement.
	IS:13801	Specification for chequered cement concrete flooring tiles.
	Painting and Allied Works	
	IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
	IS:1477	Code of practice for painting of ferrous metals in buildings.
	Part-I	Pretreatment.
	Part-II	Painting.
	IS:1650	Specification for colours for building and decorative finishes.
	IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
	IS:2338	Code of practice for finishing of wood and wood based materials.
	Part-I	Operations and workmanship

Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint
IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.
Piling and Foundation	
IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.

IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines with rotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines.
Stop Log and Trash Rack	
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.
IS:11855	General requirements for rubber seals for hydraulic gates.
Roads	
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.
IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	
	IRC:SP:13	Guidelines for the design of small bridges & culverts.
	IRC - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
	IS:73	Specification for paving bitumen
	Loadings	
	IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
	IS:1893	Criteria for earthquake resistant design of structures.
	IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
	IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
	M.O.T.	Deptt. of railways Bridge Rules.
	Safety	
	IS:3696 (Part I & II)	Safety code for scaffolds and ladders.
	IS:3764	Safety code for excavation work.
	IS:4081	Safety code for blasting and related drilling operations.
	IS:4130	Safety code for demolition of buildings.
	IS:5121	Safety code for piling and other deep foundations.
	IS:5916	Safety code for construction involving use of hot bituminous materials.
	IS:7205	Safety code for erection on structural steelwork.
	IS:7293	Safety code for working with construction machinery.
	IS:7969	Safety code for handling and storage of building materials
	IS:11769	Guidelines for safe use of products containing asbestos.
	- Indian Explosives Act. 1940 as updated.	
	Architectural design of buildings	
	SP:7	National Building Code of India
	SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in
(Relevant parts)	overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Creteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes.
Publication	

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).
   b) Electonic transmitters BS:6447.
2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
3. Process operated switch devices (Pr. Switch) BS-6134.

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	एनटीपीसी NTPC

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).
11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.
13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.
14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.
15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.
3. Water and steam in power cycle - ASME PTC 19.11.
4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.
2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472
3. Damp heat cycling test - IS:2106
4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
3. Turbine water damage prevention - ASME TDP-1-1980.
4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.
2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.
3. Surge withstand capability test - ANSI C 37.90 1 -1989.
4. Performance testing of UPS - IEC 146.
5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.

2. Seamless carbon steel pipe ASTM - A - 106.

3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.

4. Material for socket welded fittings - ASTM - A - 105.

5. Seamless ferritic alloy steep pipe - ASTM - A - 335.

6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.

7. Composition bronze of ounce metal castings - ASTM - B - 62.

8. Seamless Copper tube, bright annealed - ASTM - B - 168.

9. Seamless copper tube - ASTM - B - 75.

10. Dimension of fittings - ANSI - B - 16.11.

11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.

2. Material of socketweld fittings - ASTM - A105.

3. Dimensions of fittings - ANSI - B - 16.11.

4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472
7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)
8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.
9. Oxygen index and temperature index test - ASTM D - 2863.
10. Smoke density measurement test - ASTMD - 2843.
11. Acid gas generation test - IEC - 754 - 1.
12. Swedish Chimney test - SEN - 4241475 (F3).
13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.
14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.
15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.
2. -do- Test Standards. NEMA VE-1-1979.
3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

Public Address System

1. Specifications for lod speakers - IS:7741 (Part-I, II and III)
2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301
3. Specification for Public Address Amplifiers - IS:10426.
4. Code of practice for outdoor installation of PA system - IS:1982.
5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.
6. Basic environmental testing procedures for electronic and electrical items - IS:9000.
7. Characteristics and methods of measurements for sound system equipment - IS:9302
8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732
9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)
10. Fittings for rigid steel conduits for electrical wiring - IS:2667
11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

Vibration Monitoring System

1. API 670 - 1994
2. BS : 4675 Part-2

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	**MANUFACTURING QUALITY PLAN**		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM:	QP NO.: REV.NO.: DATE: PAGE: …. OF….	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C / N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER C**:** MAIN SUPPLIER, **N**: NTPC **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** NTPC SHALL IDENTIFY IN COLUM "N" AS ' W"		DOC. NO.: REV…… CAT…..	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE		
SIGNATURE				REVIEWED BY	APPROVED BY / APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F1-R1 **1/1** **ENGG. DIV./QA&I**

ANNEXURE-II

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: PAGE: …. OF….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK #	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.		10.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;
'A' SHALL BE WITNESSED BY NTPC FQA, **'B'** SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE)

FOR NTPC USE

DOC. NO.:		REV……
REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F2-R1 1/1 ENGG. DIV./QA&I

ANNEXURE-III

एनटीपीसी NTPC	**Project :** **Package :** **Supplier :** **Contractor No. :** **Stage ::**	**LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL** **SUB-SYSTEM :**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – **For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.**

DR – **For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.**

NOTED – **For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'**

QP/INSPN CATEGORY:

CAT-I **: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.**

CAT-II **: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.**

CAT-III **: For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.**

UNITS/WORKS **: Place of manufacturing Place of Main Supplier of multi units/works.**

FORMAT NO.: QS-01-QAI-P-1/F3-R0 1/1 Engg. Div. / QA&I

ANNEXURE-IV

एनटीपीसी NTPC	**Project :** **Stage ::** **Package :** **Contractor :** **Contractor No. :**	**STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

S. N.	Item / Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

FORMAT 1/1 Engg. Div. / QA&I

ANNEXURE-V

एनटीपीसी NTPC	**Project :** **Stage :** **Contractor :** **Contractor No. :** **System :**	**FIELD WELDING SCHEDULE** **(To be raised by the contractor)** **Welding Code: ……**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

Sl. No.	**DRG No. for Weld Location and Identification mark**	**Description of parts to welded**	**Matl. Spec.**	**Dimensions**		**Process of welding**	**Type of Weld**	**Electrode filler spec.**	**WPS. No.**	**Min. pre-heat**	**Heat treatment**		**NDT method/ Quantum**	**REF**		**Remarks**
											Temp.	**Holding time**		**Spec. No.**	**ACC Norm Ref.**	

NOTES:

SIGNATURE

FORMAT	1/1	**Engg. Div. / QA&I**

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS (Annexure-VI)

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	▪ Layout (A0&A1 sizes)	4	-
	▪ Other Drawings/Documents (A0&A1 sizes)	2	-
	▪ P&ID (All sizes)	4	-
	a) Final drawings/documents (Directly to site)	6	2
	b) "As Built" Drawing/Documents (Directly to site)	6	2
	c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	4 sets	2
3	Operation & Maintenance manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2
4	Plant Hand Book i) First Submission	1	1
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS (Annexure-VI)

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	–
	ii) Approved Copies (Direct to Site)	4 sets	2
7	Project Completion Report (Directly to site)	6 sets	2
8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	–
9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	–
10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	–
	ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	–
	ii) Approved copies (Direct to Site)	4 sets	2
12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
1.0	**Steam Generator & Auxiliaries (Mechanical)**													
1.1	Boiler	General famlarisation of supplied boiler	6 months	3	a) General Design, equipment, system and parameter famlarisation of supplied boiler i.e. features, design, operating parameters etc. b) Genaral Layout of boiler & ESP area, basic layout selection criteria, arrangement of pressure part, flue gas duct, coal pipe, bunker, valves, dampers, equipments, piping trestles etc.	Design office of the QSGM	3	1. Manufacturing of pressure parts 2. Welding processes 3. Testing Facilities 4. Product Development in process/ progress 5. Future plan for Technology induction 6. R&D work in progress	Manufacturer's works where the boilers of the subject project is being manufactured.	4	1. General Design, equipment, system and parameter famlarisation of operating boiler (visited) (which preferably should be simillar to supplied boiler) i.e. features, design, operating parameters. The palnt visit should include the following: a) Boiler each floor level walk through b) Visit to all the boiler auxiliaries location. c) Visit to BOP area. 2. Collection of Performance data of the plant	Operating plants in any country including India where same make with similar capacity boilers are under operation.	2	27
1.2	Boiler	Pressure parts	6 months	3	Basic theory/ concept, calculation with illustrative example, Design application, arrangement of following: 1. Thermal design and hydraulic circulation balance 2. Strength Calculation 3. Pressure Part arrangement, coil orientation and basis. 4. Tube metal temperature calculation, criteria for location of thermocouple. 5. Selection Creiteria for soot blower (i.e. location, nos. etc.)	Design office of the QSGM	3							9
1.3	Boiler	Performanc e	6 months	3	Basic concept, calculation of performance data with illustrative example (such as Heat Duty, boiler efficiency, predicted performance, NOX calculation, furnace sizing etc.) of offered boiler and its application to boiler design.	Design office of the QSGM	4							12
1.4	Boiler	Boiler System	6 months	3	a) Basic concept, Sizing calculation of following systems with illustrative examples alongwith details of criteria affecting the sizing calculation : 1. Air & Gas System (duct sizing, air & gas weight calculation, damper & gates sizing etc.) 2. Start up system (Circulation calculation, sizing and input data for SGWC pump etc.) 3. Fuel firing/ Combustion system (Sizing calculation of Pulveriser, feeders, burners, PA & Seal Air Fans etc.) 4. Fuel Oil firing system (Sizing calculation of HFO/ LFO pump, heater, strainers, pressure drop calculation etc.) 5. Draft System (sizing calculation of FD & ID Fans etc.) b) Impact of the above sizing calculation on the overall boiler design/ performance.	Design office of the QSGM	6							18

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
					c) Selection/ optamisation of above system from techno-economics point of view such as start up system: selection criteria for wet mode upto 30% or 40% BMCR flow etc. d) Selection/ Optamisation of various auxilieries/ equipments covered under above systems from techno-economics point of view. Such as type & no. of fans (axial- single/ double stage), APH (Tri sector/ bisector APH), Mills etc.	Design office of the QSGM								
1.5	Boiler	General familarisation of supplied SCR System	6 months	3	General Design, equipment, system and parameter famlarisation of supplied SCR system i.e. features, design, operating parameters etc.	Design office of the SCR System supplier	2	1. Manufacturing of Catalyst 2. Testing Facilities for Catalyst 3. Product Development in process/ progress 4. Future plan for Technology induction 5. R&D work in progress	Manufacturer's works where the SCR Catalysts of the subject project is being manufactured.	1	1. General Design, equipment, system and parameter famlarisation of operating SCR System (visited) (which preferably should be simillar to supplied boiler) i.e. features, design, operating parameters. The plant visit should include the following: a) SCR system each floor level walk through b) Visit to all the SCR system auxiliaries location including Ammonia Dosing system. 2. Collection of Performance data of the plant	Operating plants in any country including India where same make with similar capacity SCR system are under operation.	1	12
1.6	Boiler	Ammonia Dosing System for SCR System	6 months	3	1. Basic theory/ concept. 2. Selection & Sizing calculation of Ammonia dosing system with illustrative examples for Compressors, Storage Tanks, Pumps, vaporisers, Air-NH3 mixers, Glycol-water heaters etc. 3. Familirisation of Safety measures to be ensured for Storage & Using Ammonia. 4. Selection & Sizing Criteria for Safety equipments to be ensured as per Indian Regulations for Ammonia Handling	Design office of the SCR System supplier	2							6
1.7	Boiler	Catalyst Modules for SCR System	6 months	3	1. Basic theory/ concept. 2. Seclection criteria of catalyst 3. Sizing calculation of catalyst & calculation of performance data (i.e. Activity etc.) with illustrative examples	Design office of the SCR System supplier	1							3
1.8	Boiler	FGD System	6 months	3	1. Mass balance, Design, selection and sizing calculations of FGD 2. Training on factors affecting sizing/ efficiency of FGD system, equipments & auxiliaries 3. Materials for FGD & selection 4. Basic concepts, Design and sizing calculations on slurry systems including piping, valves, etc. 5. Layout & model of FGD area, cable & piping trestles etc. 6. Erection strategies, erection procedures. 7. Performance as per applicable code and demonstration tests.	Design office of the FGD System supplier	5	1. Manufacturing process of Absorber and other equipment 2. Welding process 3. Testing facilities 4.Product development in process 5. Future plan for technology induction 6. R&D work in progress.	Manufacturer's works where FGD system equipment of the subject project are being manufactured.	2	1. Familiarization with various system and equipment 2. Performance, data collection analysis and review 3. O&M feed back 4.Operation history of various equipment and system 5. Failure analysis	Operating plants in any country including India where same type with similar capacity FGD system are under operation.	3	30
1.9	Boiler	Buck stay & structure	6 months	3	Basic theory, calculations with illustrative example & Design application of Buck stay & structure design	Design office of the QSGM	2							6
1.10	Boiler	Erection & PG Test	6 months	3	Erection strategies, erection procedures Performance and demonstration tests.	NTPC PMI	2							6

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
1.11	Boiler	Review & discussion after Plant Visit	6 months	3	1. Analysis and review of collected performance data of the plant visited. 2. Co-relation of the operating plant design, parameter visited wrt to boiler supplied under contract. 3. O&M feedback of the plant 5. Failure analysis: Atleast elaborative case study of one major failure	NTPC PMI	2							6
1.12	Boiler Auxiliaries	Equipments /Auxiliaries	6 months		Selection criteria of auxiliaries (Type, Model, Nos. etc.) based on input data, design features, working & importance of	NTPC PMI			Manufacturer's works where the equipment of the subject project is being manufactured.					
				2	1. Coal pulveriser		2	Visit to manufacturer Works		1				6
				2	2. Fans (ID, FD, PA & Seal Air Fans)		2	Visit to manufacturer Works		1				6
				2	3. Air-preheater		2	Visit to manufacturer Works		1				6
				2	4. Soot Blowers		1							2
				2	5. Dampers & Gates		1							2
				2	6. Valves including safety valves		2							4
				2	7. Feeder		1							2
				2	8. Burner		1							2
				2	9. SG WC pump		1							2
				2	10. Fuel Oil (HFO & LFO) Pumps, Heaters, Strainers etc.		2							4
				2	11. Any other equipment/ auxiliaries not specified above		1							2
Steam Generator & Auxiliaries (Mechanical) TOTAL Mandays		***173***					***128***			***27***			***18***	173

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
2.0	**Steam Generator & Auxiliaries (Power Cycle Piping)**													
2.1	Power Cycle Piping	Stress analysis of piping	6months	4	1. Critical pipe sizing including pressure drop calculation	Design office of the QSGM	2	1. Familarisation of manufacturing/ fabrication/testing of critical piping (including welding techniques & heat treatment methods employed) and norms	Manufacturer's works	2	Familarisation of Power cycle piping & equipment layout	Operating plants in any country including India operating on similar parameters	1	20
2.2	Power Cycle Piping			4	2.Static analysis of critical piping system	Design office of the QSGM	2	2. Familarisation of variable & constant load hanger setting & snubber setting	Manufacturer's works	1				12
2.3	Power Cycle Piping			4	3.Dynamic analysis (safety valve blowing, wind, siesmic & steam hammer) of critical piping	Design office of the QSGM	2							8
2.4	Power Cycle Piping			4	4.Familarisation of Hanger engineering	Design office of the QSGM	1							4
2.5	Power Cycle Piping			4	5.Familarisation of piping vibration analysis & norms	Design office of the QSGM	1							4
POWER CYCLE PIPING TOTAL Mandays		***48***		***4***			***32***			***12***			***4***	48

3.0	**Steam Generator & Auxiliaries (Electrical)**													
3.1	Boiler	Electrical	6 months	3	Integral Actuator	Manufacturer Works	3	1. Design,interface and funtional aspect 2. Familiarisation with various types of actuator	Manufacturer Works	2				15
3.2	Boiler	Electrical	6 months	3	BCW motor	Manufacturer Works	3	1. Design review , manufacturing process, preservation. 2. operation and maintenance,preservation during storage	Manufacturer Works	2				15
3.3	Boiler	Electrical	6 months	3	HT Motor	Manufacturer Works	3	Design review , manufacturing process, storage.	Manufacturer Works	2				15
Electrical TOTAL Mandays		***45***		***3***			***27***			***18***			***0***	45

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
4.0	**Steam Generator & Auxiliaries (Control & Instrumentation)**													
4.1	C&I	SG-DDCMIS-Hardware and Operating System	18 months	4	(a) Hardware & Software organization of the system (b) Basis of selection of H/W memory sizing (c) Operating System features (d) Interface with other system, Openness and inter-operability (e) Upgradability and System testing features	SG-DDCMIS vendor works	2	(a) Hardware & Software organization of the system (b) Basis of selection of H/W memory sizing (c) Operating System features (d) Interface with other system, Openness and inter-operability (e) Upgradability and System testing features	SG-DDCMIS vendor works	2	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1.5	22
4.2	C&I	SG-DDCMIS-Human Machine Interface System Engineering & Application Software	18 months	5	(a) Specific system customization (b) Various system modules & interface with OS © Database organisation & development (d) Development of mimics, other applications like calculations, logs, historical storage functionalities & use	SG-DDCMIS vendor works	4	Hands on experience, Testing methodologies	SG-DDCMIS vendor works	2	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1	35
4.3	C&I	SG-DDCMIS-(i) Control system hardware (ii) Control system Application Software	18 months	4	(i) (a) Basic design features for system & its Modules, (b) System capabilites & system design techniques (c) Communication with HMI & other systems	SG-DDCMIS vendor works	4	(a) Manufacturing processes with special attention to handling of the modules (b)	SG-DDCMIS vendor works	1	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in	1	24
				4	(ii) (a) Database structure (b) Organization & interface between appplication program & database(c) Application for implementation of Control functions (d) Study of standard algorithms & development of new algorithm	SG-DDCMIS vendor works	3	(ii) (a) System integration & system capabilites testing	SG-DDCMIS vendor works	1				16
4.4	C&I	Boiler Controls: (i) Study of Control loops (ii) Burner Management system	20 months	4	(i) (a) General concept of closed loop controls of the OEM (b) Critical analysis of some important control loops like Boiler Start up control, Feedwater control etc.	Design office of the QSGM	3				Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1	16
				4	(ii) (a) Hardware logic (b) NFPA-85/ EN-50156/ EN-61508/ En-61511 requirements and other applicable safety standards (c) Flame scanner locations.	Design office of the QSGM	4							16
4.5	C&I	Special SG-related instrumentation (i) Flame Scaneers (ii) Boiler Flame viewing system(iii) Acoustic	24 months	2	(i) (a) Flame scanners: Principle of Operation (b) Suitability for the proposed boiler	Flame scanner vendor's work	1	Manufacturing & testing procedures	Flame scanner vendor's work	1	Operational feedback	Operating plants in any country including India where same make/ model of Flame scanner is in operation.	1	6
				2	(ii) (a) Boiler Flame viewing system: Principle of operation (b) Location (c) Details of software & methods of modification/ customization	Flame camera vendor's work	1				Operational feedback	Operating plants in any country including India where same make/ model of Flame scanner is in operation.	1	4

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
		Pyrometer		2	(iii) (a) Acoustic Pyrometer: Principle of operation (b) Location (c) Details of software & methods of modification/ customization	Acoustic Pyrometer vendor's work	1				Operational feedback	Operating plants in any country including India where same make/ model of Acoustic Pyrometer is in operation.	1	4
4.6	C&I	Electric Power Supply System	22 months	2	System architecture and Component details	Electric power supply system vendor's work	2	Manufacturing/ assebling & testing procedures	Electric power supply system vendor's work	0.5				5
C&I TOTAL Mandays		***148***					***94***			***29***			***25***	148
5.0	**Steam Generator & Auxiliaries (Quality Assurance)**													
5.1	Quality Assurance & Inspection- QA System & Programme	QA System Procedure, Plant Standard	12 months	2	a) Integrated QAManagement System for enhanced reliability of equipments. b) QA system in design, procurement, manufacturing, installation and operation of equipments/ systems. c) QA System for developing and establishing new processes and vendors. d) System of structured documentation of Engg. and test records.	Manufacturer's work	5	1. Appreciation of implementation of QA programmes in various manufacturing, asembly and testing activities. 2. Appreciation of developmental activities for new processes and vendors. 3. System of prequalification of special processes.	Manufacturer's works where the equipment of the subject project is being manufactured.	3	1. operating feedbacks 2. Co-relation of reliability and performance of the equipment with implementation of QA system. 3. Appreciation of the use of structured Engg./ QA documentation during operational phase of plant and during RLA studies of plant.	Operating plants in any country includinh india where same make and similar capacity boilers are under operation.	1	18
5.2	Quality Assurance	SG & Auxiliaries	12 months	5	a) General Design, equipment, system and parameter famlarisation of supplied boiler	PMI	3							15
5.3	Quality Assurance	SG & Auxiliaries (Mechanical)	12 months	4	Pressure parts (Water wall panels, superheaters, Reheaters, headers, economiser, power cycle piping etc.) & Auxiliaries (Fans, Pulversier, APH, Soot blowers, Gates & Dampers, Feeder, SGWC pump etc.) Main design aspect including material of construction and applicable codes/ standards, manufacturing processes, machinery involved, various welding process involved, testing and inspection etc.	Manufacturer's work	3	1. Manufacturing, testing and inspection at various stages of Boiler Pressure parts and Auxiliaries 2. Shop level exposure to these processes with understanding of applicable code/ standard/ parameters involved in manufacturing of main pressure parts and auxiliaries. 3. Various testing and inspection activity in shop for above components.	Manufacturer's works where the equipment of the subject project is being manufactured.	4				28

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
5.4	Quality Assurance	SG & Auxiliaries: Control & instrumentation: Material, construction, Manufacturing, assembly, testing wrt QA aspects, quality procedure and QA system & I	12 months	1	1. Familarisation with control system and instrumentation. 2. QA system for manufacturing of reliable components.	Manufacturer's work	2	1. Manufacturing activities for critical instruments/ items. 2. Implementation of testing programme to ensure reliability.	Manufacturer's works where the equipment of the subject project is being manufactured.	2	Feedback on performance of C&I system	Operating plants in any country includinh india where same make and similar capacity boilers are under operation.	1	5
QA TOTAL Mandays		***66***					***39***			***24***			***3***	66

SUMMARY

1.0	**Steam Generator & Auxiliaries (Mechanical) TOTAL Mandays**	***173***
2.0	**Power Cycle Piping TOTAL Mandays**	***48***
3.0	**Electrical TOTAL Mandays**	***45***
4.0	**C&I TOTAL Mandays**	***148***
5.0	**QA TOTAL Mandays**	***66***
GRAND TOTAL MANDAYS OF TRAINING FOR STEAM GENERATOR & AUXILIARIES		**480**
GRAND TOTAL MANMONTHS OF TRAINING FOR STEAM GENERATOR & AUXILIARIES		**16.0**

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine	
	Rotor dynamic behavior studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process	
	Casing & diaphragm design	Failure analysis	Future plan for technology induction	
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress	
	Selection of turbine type (i.e. Tandem vs cross compounding, separate HP/IP vs combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the			

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	specific project. of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system Performance calculation Steam path audit Layout principle of various equipment's of TG and its integral system Latest technological advancements			
MANDAYS **Boiler Feed Pumps**	**45** Techno-economic studies for Selection of BFP Configuration and its drive Criteria for selection of boiler Feed Pump parameters Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	**10** Familiarization of power plants of various makes of feed pumps for super critical units Data collection of BFP parameters and configuration Collection of data for analysis of availability of BFP	**10** Manufacturing process of various components of BFP Assembly of BFP Testing, capabilities of BFP at works wrt performance, NPSH, dry run, visual cavitation, axial thrust measurement	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Impeller design and its hydraulic behavior Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps Material selection of BFP components Guiding factors for selection of BFP seals Computation of axial thrust under various flows Performance calculation Transient analysis in pump suction piping wrt NPSH margin Latest technological trends in BFP design	O&M history/problems related to BFP Comparative studies for various types of BFP& its features	Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**20**	**5**	**10**	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**10**	**5**	**5**	
Feed Regenerative Equipment's	Thermal and mechanical design calculation of heaters Basis of selecting horizontal/vertical heaters Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate Configuration of HP heaters (2x50% v/s100% capacity Sizing criteria for De- aerator/Heaters Selection of tube & tube sheet material of heaters	Comparative studies of salient features Analysis of data O&M history/problems related to heaters	Manufacturing process of various components of heaters Assembly Testing capability at works Product development in process Future plan for techno-logy induction R&D work in progress	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
MANDAYS	Latest technological trends in heaters design **15**	**10**	**10**	
3-dimensional CFD modeling	CFD model development and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	**20**			
CONTROL & INSTRUMENTATION DDCMIS*-Man Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter-operability Upgradability System testing features Trouble shooting and fault analysis	Operational feedback		
MANDAYS	**15**	**5**		
DDCMIS*-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development	Operation feedback		

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Development of mimics Other application like calculations, logs historical storage functionalities & use Trouble shooting and fault analysis			
MANDAYS	**30**	**5**		
DDCMIS* - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	**15**	**3**	**10**	
DDCMIS*- Control system Application Software	Database structure Organisation & interface between application program & database Application for implementation of Control functions Study of standard algorithms & development of new algorithms Trouble shooting and fault analysis	Operation feedback	System integration & System capabilities testing	
MANDAYS	**8**	**2**	**4**	
DDCMIS* - DDCMIS-Control Strategies for TG System:	P&ID and process/System Descriptions of Governing System, Protection System, Automatic Turbine Testing, Oil System, Evacuation System & Generator Auxiliaries, Turbine stress Computation	Yes	Yes	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
Process Concepts of Main TG Integral Systems	System, Gland seals, Turbine Start up and Shut-down process, Hot ,cold and Warm modes of Turbine start up etc.			
DDCMIS* - DDCMIS-Control Strategies for TG System: Control Strategies	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system. Function Blocks: Introduction and explanation of TG process specific Function block as being implemented in offered Control system. Open Loop Control strategies for ATRS, including turbine Run/Up Shutdown, Auto Synch, Oil System Automation concept, Auto Changer over philosophies, Condenser evacuation system, ATT and Generator Auxiliaries. Close Loop Control strategy-EHTC, Seal/Leak steam Controls, Interfacing of unit Controls Protection-Fail Safe philosophy implementation in turbine protection.	Yes	Yes	
DDCMIS-Control Strategies for TG System: Process Concepts of HP/LP BP Systems	P&ID and process/System Descriptions of HP/LP BP System, Protection System, Oil System, HPBP operations under various modes like start up, Shutdown, Load throw off etc.	Yes	Yes	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
DDCMIS-Control Strategies for TG System: HP/LP BP Systems Control Strategies	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system. Function Blocks:- Introduction and explanation of HP/LP process specific Function block as being implemented in offered Control system. Open Loop Control strategies for HPBP operation during various modes of plant operation like Start Up/Shut down and Load Throw Off etc. Close Loop Control strategy- Applicable Control Loops like HP/LP BP Press Control/Position Control, LP BP Spray Controls etc. Interfacing o unit Controls etc. Protection-Fail Safe philosophy implementation in HP/LP BP system	Yes	Yes	
DDCMIS-Control Strategies for TG System: Process Concepts of BFP Drive Turbine/ BFP Systems	P&ID and process/System Descriptions of Drive Turbine Governing System, Protection System, Oil System, Turbine Start up and Shut-down process, Hot, cold and Warm modes of Turbine start up etc.	Yes	Yes	
DDCMIS-Control Strategies for TG System:	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system.	Yes	Yes	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
BFP Drive Turbine/ BFP Systems Control Strategies	Function Blocks:- Introduction and explanation of BFP Drive Turbine process specific Function block as being implemented in offered Control system. Open Loop Control strategies for Drive Turbine Start UP/Shutdown, Oil System Automation concept, Auto Changer over philosophies. Close Loop Control strategy-EHTC, Seal/Leak steam Controls, Interfacing of unit Controls Protection-Fail Safe philosophy implementation in Drive turbine protection.			
MANDAYS	**24**	**5**	**4**	
DDCMIS-operator	Use of the system at work + at Site			
MANDAYS	**4**			
Turbo supervisory system : Measurement Concepts	Discussions on various measurement points, Types, Ranges and locations for the offered Turbine	Yes	Yes	
Turbo supervisory system : System Concepts	System implementation of sensors, Monitors, Drivers, Cabling, earthing shielding and grounding, Buffered signals, Technical aspects of sensor selection, Sensor specifications, filter setting, Configuration settings for displacement, Velocity ,acceleration, key phasor and other types of sensors. Diagnostics and	Yes	Yes	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	trouble shooting features of Sensors, Drivers and Monitors.			
Turbo supervisory system : Analysis Software	1)System Setup-Hardware and Software 2)Case Studies showing utilization of various data displays e.g Bode Plot, Polar Plot, Waterfall Plot, Orbit & Waterfall Plot etc. 3)Tools and methods of finding Machinery faults like oil whirl, Oil whip, Mis-alignment etc	Yes	Yes	
MANDAYS	**8**	**2**	**2**	
Wherever "DDCMIS" is indicated, it will mean TG C&I part of DDCMIS, which is in Contractor's Scope				
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas - Insulation system - Cooling medium & arrangement - Winding & core support systems b) Design aspects associated auxiliary systems	- Operational feed back - Familarisation with different sub-systems	(a) Manufacturing process for - Core - Winding bars - Assembly (b) Testing facilities	
MANDAYS	**30**	**15**	**15**	
Generator Excitation system including AVR.	Design features of various sub- System Exciter PMG Transformer Controllers & different limiters etc.	- Operational feed back - Familiarisation with various equipment functioning at reference plants	Manufacturing process & testing facilities for various equipment of excitation system	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	PSS & associated system studies	functioning at referplants		
MANDAYS	**30**	**15**	**15**	
Integral Actuators	a) Basic design philosophy of integral actuator b) Design aspects of wiring diagram c) Type and range of application of integral actuators d) Operation and selection of integral actuator to various type of loads Methods of fault diagnose system.		Manufacturing process & testing facilities for various equipment of actuators	
MANDAYS	**2**	**1**	**1**	
MDBFP motor	Design criteria for the stator core and winding rotor core and winding, insulation systems and cooling arrangement. Study of forces and vibration. Diagnostic and testing of large Electrical machines	Operational Feedback	Manufacturing process and testing facilities.	
MANDAYS	**14**	**4**	**10**	

ANNEXURE-IX

Area	Topics	MANDAYS
DDCMIS-Man Machine Interface - Hardware & Operating System	• Hardware & Software organization of the system • Basis of selection of H/W memory sizing • Operating system features, interface with other system, openness & inter-operability • Upgradeability • System testing features	**20**
	• Trouble shooting and fault analysis.	
DDCMIS-Man Machine Interface System Engineering & Application Software	• Specific system customisation • Various system modules & interface with OS • Database organisation & development • Development of mimics • Other application like calculations, logs historical storage functionalities & use • Trouble shooting and fault analysis.	**40**
DDCMIS - Control System Hardware and Control system Application Software	• Basic design features for system & its modules • Manufacturing processes with special attention to handling of the modules Maintenance facilities	**50**
	• System capabilities & system design techniques • System integration & System capabilities testing	
	• Communication with MMI & other system	
	• Database structure Organisation & inter- face between application program & database	

	• Application for implementation of Control functions • Study of standard algorithms & development of new algorithms	
	• Trouble shooting and fault analysis.	
DDCMIS-Operator Training	• Use of the system at Works + at Site	**20 + 100**
DDCMIS-Specialized Network security training	• To be finalized during detailed engineering.	**15**
UPS system	• Theory & design features Manufacturing/assembly process • Testing methodology	**5**
	• Trouble shooting and fault analysis.	
24 V DC system	• Theory & design features Manufacturing/assembly process • Testing methodology • Trouble shooting and fault analysis.	**5**
SWAS	• Theory & design features • Trouble shooting and fault analysis	**5**
PA System	• Theory & design features • Trouble shooting and fault analysis	**4**
CCTV System	• Theory & design features • Trouble shooting and fault analysis	**4**

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	
	QA SYSTEM & PROGRAMME	• Integrated QA Management system for enhanced reliability of equipments. • QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems. • QA system for developing and establishing new processes and vendors. • System of structured documentation of Engg and test records. • Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities. • Appreciation of develop-mental activities for new processes and vendors. • System of pre-qualification of special processes.	**10**
	Controls & Instruments	• Familiarization with control system and instrumentation • QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items. • Implementation of testing programme to ensure reliability.	**10**
	Note	**One week shall constitute of five (5) man days.**	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-X			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
GIS			Training on GIS equipments including system description basic design and engineering. Quality assurance concepts and Erection and operational aspects for the offered equipments. Concepts and operational aspects for the offered equipments	Training on Operation, Maintenance,, site testing & troubleshooting of GIS.
MANDAYS			**40**	**30**
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at NTPC site.
MV and LT Switchgear : Numerical relays & Switchgear SCADA system	Numerical relay engineering and associated training for relay software and O&M SCADA system design, engineering and associated training for SCADA and O&M			
MANDAYS	**60 (Total) inclusive of visit to manufacturer's site)**			

ANNEXURE - XI

Area	Topics	MANDAYS
UF Membranes	**Product design** - Basic design features - Theory & principle of operation - Latest technological trends in Ultrafiltration membranes and design **Plant Visit** - Operational feedback - O&M history/problems related to UF membranes **Visit to Manufacturer's Work** - Manufacturing process of UF membranes and equipments - Testing facilities **Operation & Maintenance of Plant** - Trouble shooting and fault analysis - Familiarization of special maintenance techniques - Special tool and tackles familiarization	**7**

RO membranes	**Product design** - Basic design features - Theory & principle of operation - Latest technological trends in RO membranes and design **Plant Visit** - Operational feedback - O&M history/problems related to RO membranes **Visit to Manufacturer's Work** - Manufacturing process of RO membranes and equipments - Testing facilities **Operation & Maintenance of Plant** - Trouble shooting and fault analysis - Familiarization of special maintenance techniques - Special tool and tackles familiarization	**7**
Zero Liquid Discharge (ZLD)	**System Design** - Plant water optimization and Scheme to achieve the ZLD - Basic design features - Latest technological trends for ZLD in Thermal Power Plant **Plant Visit** - Operational feedback	**5**
Note	**One week shall constitute of five (5) man days.**	

Annexure-XII

TRAINING REQUIREMENTS FOR SIMULATOR

In addition to the other stipulations in the bidding documents regarding training of Employer's personnel, the following shall also be covered:

(i) The scope of service under training of Employer's Engineers shall necessarily include, training in the areas of:

(a) Design, engineering and Quality Assurance.

(b) Operation & maintenance.

Arrangement for the trainees to get trained at the Works of the Contractor's, Works of their sub-vendors and at the plants of similar type and comparable size, operating elsewhere shall be made by the Contractor.

(ii) The training shall enable the O&M personnel to individually take responsibility of operating & maintaining the respective systems to ensure sustained guaranteed performance of the equipment and availability of the systems offered. The design & engineering personnel of the Employer shall be familiarized with the design philosophy adopted & practices followed by the Contractor or Sub-Contractor's Engineers for design engineering and shall be given special training in the shops, where the equipment will be manufactured and/or in their collaborator's works and where possible, in any other plant where equipment manufactured by the Contractor or his collaborator is under installation operation, or testing to enable these personnel to become familiar with the equipment being furnished by the Contractor. The training requirements of Employer's Engineering and O&M personnel are as below:

Area	Topics	MANDAYS
Simulator & Human Machine Interface – Hardware and Operating System	• Hardware & software organization of the system	90
	• Basis of selection of HW memory sizing	
	• Operating system features, interface with other system, openness & inter operability & upgradability System Testing features	
	• Trouble shooting & Fault Analysis	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	

Simulator System Engineering (Simulator Kernel and Interface) & Application Software (Process and C&I Modelling)	• Overview of Simulator • Starting up and Shutting down of the simulator • Details of Simulator hardware & software • Interaction between Simulator Models and controls & Instructor Station operations • Manipulation of Simulator parameters and data.	**150**
	• Details of Plant Modelling & C&I Modelling simulation software	
	• Details of Simulator and DCS interface	
	• Backup and Restore procedures	
	• Details of I/O system	
	• Fault finding of simulator hardware & Software diagnostic procedures	
	• Simulator maintenance procedures	
Human Machine Interface System Engineering & Application Software	• Specific system customisation	**90**
	• Various system modules & interface with OS	
	• Database organisation & development • Development of mimics • Other application like calculations, logs historical storage functionalities & use • Trouble shooting and fault analysis.	
Instructor Training	Use of the system including • Interaction between Simulator Models and controls • Instructor Station operations	**150**
	• Communication with MMI & other system	
	• Database structure Organisation & inter-face between application program & database	

	• Application for implementation of Control functions • Study of standard algorithms & development of new algorithms	
	• Trouble shooting and fault analysis.	
UPS system	• Theory & design features manufacturing/assembly process • Testing methodology	**10**
	• Trouble shooting and fault analysis.	
Note	**Note One week shall constitute of five (5) man days.**	

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

MECHANICAL SYSTEMS & EQUIPMENT

1.00.00 GENERAL

1.01.00 The scope of the water Treatment plant includes Design, Engineering, Supply, Construction, Erection, Testing & Commissioning of complete Water treatment System including all Civil, Electrical and Control & Instrumentation works. Broad scope of work described below shall be read in conjunction with the Data Sheets, Electrical works and Control & Instrumentation works and Civil Works, various subsections of Part-B of this Technical Specification and relevant Tender drawings. The broad scope of Water Treatment Plant includes but not limited to the following systems and equipment.

1.02.00 The analysis of Raw water to be adopted for design of water treatment plant is enclosed elsewhere in the technical specification. Bidder to decide the design filter water analysis for RO/DM based on the Pre-treatment.

1.01.00 WATER PRE-TREATMENT PLANT

1.01.01 PT- ACW System

a) Raw water pipe (CS) up to the aerator through a set of Control Valve & Isolation Valves for Control Valves.

b) One (1) number Aerator and one (1) number stilling chamber of RCC Construction of required capacity along with isolation gates at the inlet to the inlet channels for PT-ACW system clarifier.

c) Two (2) numbers of inlet channels with flow measuring element in each channel (parshall flume) of RCC Construction.

d) One (1) number bypass channel of RCC Construction to by-pass clarifier(s) with required isolation gate(s)

e) Two (2) numbers of reactor type clarifiers of RCC Construction each of required capacity including associated equipment and drives for PT-ACW system.

f) One (1) number Clarified Water Storage Tank/Clarified water distribution chamber of RCC Construction of required capacity/sizes with required isolation Valves.

g) Outlet channels of RCC Construction from Clarifiers up to the Clarified Water Storage Tank/Clarified water distribution chamber.

h) Interconnection between the clarified water outlet channel and outlet channel of PT-DM System.

1.01.02 PT-Potable Water System

a) Outlet channel of RCC Construction from Clarifiers header up to the Gravity filters of Potable Water System

b) Two (2) numbers of Gravity Filters (Potable Water System) of RCC Construction each of required capacity with all accessories as described elsewhere, interconnecting piping, valves etc.

c) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of required capacity, filtered water sump and common filtered water pump house for PT–Potable water & PT-DM systems.

d) Two (2) numbers of Potable water pumps (Colony), its drives, associated suction pipes from filtered water sump, isolation valves, pump(s) discharge pipes(CS), non-return valves & isolation valves at the discharge etc.

e) Two (2) numbers of Potable water pumps (Plant), its drives, associated suction pipes from filtered water sump, isolation valves, pump(s) discharge pipes(CS), non-return valves & isolation valves at the discharge etc.

f) Three (3) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the filter for air scouring of filters during backwash operation.

g) One (1) number electrically operated monorail hoist (common for both PT-DM & PT-Potable System) of required capacity for handling all the pumps, blowers, drives etc.

h) Required interconnecting air (Galvanised CS) piping, valves etc from the blowers to each Gravity filter for air scouring of filters during backwash operation.

i) Pipe & Valves to facilitate future expansion.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

1.01.03 **PT- DM System**

a) Raw water pipe (CS) up to the aerator through a set of Control Valve & Isolation Valves for Control Valves.

b) One (1) number Aerator and one (1) number stilling chamber of RCC Construction of required capacity along with isolating gates at the inlet to the inlet channels for PT- DM system clarifier.

c) One (1) number inlet channel of RCC Construction with flow measuring element in each channel (parshall flume).

d) One (1) number bypass channel of RCC Construction to by-pass clarifier(s) with required isolation gate(s).

e) One (1) number reactor type clarifier of RCC Construction of required capacity including associated equipment and drives for PT-DM system.

f) Outlet channel of RCC Construction from Clarifier up to the Gravity filters of PT-DM System

g) Two (2) numbers of Gravity Filters (PT-DM System) of RCC Construction each of required capacity with all accessories as described elsewhere, interconnecting piping, valves etc.

h) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of capacity, filtered water sump and filtered water pump house.

i) Three (3) numbers of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the filter for air scouring of filters during backwash operation.

j) Required numbers of Filtered water Transfer pumps & drives for feeding to DM plant etc.

k) Required interconnecting air (Galvanised CS) piping, valves etc. from the blowers to each Gravity filter for air scouring of filters during backwash operation.

l) Pipe & Valves to facilitate future expansion.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

1.01.04 Chemical House Equipment

a) Two (2) numbers of electrically operated monorail hoists for transporting the chemicals from the ground floor to the respective preparation tanks and required number of weighing scales.

b) Lime preparation & dosing system consisting of required number of RCC lime slaking tanks, RCC lime solution preparation tanks, agitators, lime slurry transfer pumps, lime solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

c) Alum Solution preparation & dosing system consisting of required number of RCC Alum solution preparation tanks, agitators, alum solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

d) $FeCl_3$ preparation & dosing system consisting of required number of preparation tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

e) PE dosing system consisting of required number of tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. (in case of PT-RO)

f) PAC dosing system consisting of required number of tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

g) One (1) number RCC overhead filtered water storage tank of required capacity, on top of chemical house with water supply line from the discharge of filtered water pumps, associated valves, piping, fittings etc.

h) Mechanical Ventilation system for complete chemical house building covering chemical storage area, chemical preparation area, toilets etc.

1.02.00 CHLORINATION PLANT

ACW Chlorination

a) Required numbers of Chlorine tonners, Evaporators, chlorinators, chlorinators, ejectors, Chlorine water booster pumps its drives, required piping, valves etc. from pumps up to CT basin of ACW pump house, diffusers for dosing chlorine, associated valves etc.

b) Required Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits.

c) Required numbers of hoist(s) for handling Chlorine ton-containers in the chlorination plant building.

d) Chlorine Leak absorption system (each for ACW & PT Systems) consisting of required number of hoods over the tonne containers, ducting arrangement, absorption tank, alkali recirculation pumps, blowers, piping, valves, chlorine leak detectors etc. as detailed out in Data sheets and Part-B of technical specification.

e) Required Mechanical Ventilation system for complete building.

PT Chlorination

a) Required numbers of Chlorine tonners, chlorinators, ejectors, Chlorine water booster pumps, its drives, required piping, valves etc. from pumps up to the aerators & stilling chambers of each clarifier, diffusers for dosing chlorine, associated valves, Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits etc. Capacity of each of the equipment/items shall be as mentioned in the data sheets.

1.03.00 LIQUID EFFLUENT TREATMENT SYSTEM

1.03.01 PT- Plant Clarifier Sludge Disposal System

a) One (1) number RCC sludge pit (2 sections) to collect sludge from all the clarifiers of PT-ACW & Potable system, PT-DM system & Tube settlers/Lamella clarifiers of required capacity, sludge piping from clarifiers up to the pit, associated valves etc.

b) Sludge disposal pumps of required capacity, its drives, associated valves, piping etc.

c) Air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the sludge pit for air scouring of sludge.

d) One (1) number of Sludge thickener of required capacity, pumps, associated valves, piping etc.

e) Centrifuge/filter press (2x50%) of required capacity, pumps, associated valves, piping etc.

1.03.02 Filter Back Wash Waste Disposal System

a) One (1) number RCC Filter backwash waste collection pit of required capacity to collect the backwash water from both PT-DM & PT-Potable gravity filters, back wash waste water piping from filters up to the pit, associated valves etc.

b) Required number of backwash water pumps, its drives, associated piping and valves from the above pumps to stilling chamber of PT-DM and PT-CW system.

1.03.03 Waste Service Water Treatment System

a) One (1) number RCC waste service water sump (WSWS) (2 sections) for collection of various waste water of the plant.

b) Facility to collect free oil from these sumps to a MS oil drum of 200 litre capacity with the help of Drum type (2 Nos.) oil skimmers, Centrifuge (1 no.) of required capacity.

c) Required number of Waste service water transfer pumps to transfer the waste service water from the sump to the tube settlers/lamella clarifiers, its drives associated piping (CS) & valves etc.

d) Two (2) numbers tube settlers/lamella clarifiers of RCC Construction along with RCC flash mixers and RCC flocculation chambers. Both the flash mixers and flocculation chambers shall be provided with agitators (SS-316 construction).

e) The capacity of waste service water sump and tube settlers/lamella clarifiers shall also meet the requirement of supernatant flow from the clarifier of coal slurry settling pond.

f) One (1) number of RCC treated water tank for collection of treated water. Required number of Treated water pumps of capacity required to transfer the treated service water, its drives, associated piping (CS) & valves etc.

g) Sludge Pipeline (Cast Iron) with associated valves from the tube settlers/ lamella clarifiers by gravity flow up to the common sludge pit.

1.03.04 Coal Handling Plant Run-Off Water Treatment System

a) Inlet connection channel from drain in Coal Stockyard area up to the Coal Slurry Settling (CSSP) Pond to transfer waste water laden with coal dust to the CSSP.

b) Required number of Coal Slurry Settling (CSSP) Ponds of RCC Construction each of size/capacity as mentioned in Data sheets/ tender drawings.

c) Required number of Coagulant-aid tanks of Mild steel rubber lined construction.

d) One (1) number decanted water sump of RCC Construction (2 sections) to receive decanted water from above settling ponds of required size/capacity and discharge channel from the CSSP to decanted water sump as well as to the plant drain.

e) Required number of Coal Decanted Water Pumps and Clarified feed pumps (CSSP area) of required capacity, its drives, associated piping (CS), Valves etc.

f) Decanted water channel of RCC Construction from CSSP to the drain with gates etc.

g) Two (2) numbers portable submersible type pumps for draining the water from the CSSP, with hose pipes etc.

h) One (1) number stilling chamber, two (2) numbers of inlet chambers and two (2) numbers of reactor clarifiers of RCC construction, RCC channels, distribution chamber etc. of required capacity to receive excess storm water from settling ponds, required number of pumps, piping, valves etc. to discharge treated supernatant water to storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc.

i) Lime preparation & dosing system consisting of required number of RCC lime slaking tanks, RCC lime solution preparation tanks, agitators, lime slurry transfer pumps, lime solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

j) Alum Solution preparation & dosing system consisting of required number of RCC Alum solution preparation tanks, agitators, alum solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

k) Suitable synthetic flocculent dosing shall also be provided to increase the settling rate suspended solids. Flocculent preparation & dosing system consisting of required number of preparation tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. shall be provided.

l) The sludge removed from underflow of the clarifier shall be dewatered using the Filter press for dried coal particles to be reused. Required numbers of filter presses, necessary pumps, piping, valves etc. shall be provided.

1.03.05 **Central Monitoring Basin**

a) One (1) number (twin section) Central Monitoring (CMB) Basin of RCC Construction of required capacity to receive treated water from tube settlers/ lamella clarifiers, excess ACW system blow down water, neutralised effluent of DM plant, any other treated plant effluents etc.

b) Required number of waste water RO effluent pumps of required capacity, its drives, associated valves, piping etc. to pump the plant waste water to the stilling chamber for waste water RO plant.

1.03.06 Any other equipment required for the completeness of the plant as per system requirement and specification requirements as specified in Part-B.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

2.00.00 DEMINERALISATION (DM) PLANT

A) OPTION – 1 (ION EXCHANGE BASED DM PLANT)

a) Required number of Filtered Water transfer Pumps of required capacity, its drives & associated piping from filtered water pump house (in PT area) to DM Plant.

b) Two (2) numbers of Activated carbon filters with all accessories.

c) Two (2) numbers of Cation exchangers units (both weak and strong) with all accessories.

d) Two (2) numbers of Degasser system comprising of Degasser Tower, storage tank, Air Blowers [two (2) numbers per degasser tower]& its drives and required number of Degassed water transfer pumps & its drives with all accessories.

e) Two (2) numbers of Anion exchanger units (both weak and strong) with all accessories.

f) Two (2) numbers of Mixed bed unit along with Two (2) numbers air blowers with its drives and all accessories.

g) Complete Hydrochloric acid handling, measuring tanks and dosage system.

h) Complete Alkali handling, storage and dosage system

i) Required numbers of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

j) Three (3) numbers of DM water storage tanks with all accessories.

k) Required numbers of DM water pumps for regeneration system and its drives.

l) Neutralizing waste disposal system - All DM plant Effluent drains (except backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units) shall be connected to the Neutralisation Pit. Neutralised waste shall be pumped to central monitoring basin.

m) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led into the inlet channel of PT-DM clarifier of Water Pretreatment Plant. UF back wash water shall also be led to this back wash pit.

n) First fill of filter media for AC filters.

o) First fill of resins for all Ion Exchange units.

p) 25 NB Stainless steel DM water line from Mixed Bed headers to DM plant lab.

q) Interconnecting piping, valves, fittings and accessories including Pre Cast RCC pipes at road crossing as required.

r) Supply and application of final painting to all the equipment, piping & accessories.

s) All approach ladders and operation/maintenance platforms, handrails as required for various equipment, valves and instruments, support trestles, bridges, brackets, bolts, nuts, clamps etc. for the associated piping.

t) Suitable MS Epoxy Painted elevated Access Platform to be provided for internal inspection of all the AC Filters and Ion Exchanger vessels.

u) Required numbers of DM water makeup pumps and drives & associated valves and piping etc.

v) Required numbers of Boiler Fill pumps and drives & associated Valves and piping etc.

w) Required numbers of condensate transfer pumps and drives & associated Valves and piping etc.

x) Brine Solution Preparation Tank and Brine transfer pumps, piping and valves.

y) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

B) OPTION-2 (UF + RO+MB BASED DM PLANT)

1. ULTRAFILTRATION (UF) SYSTEM

a) Required numbers of UF (Filter Water Supply Pumps) of required capacity with electrical motor drives, suction & discharge pipe header, valves and all accessories.

b) Interconnecting Pipe from filtered water transfer pumps to filtration system.

c) Interconnecting piping, Valves etc. between filtration system and suction header of RO plant.

d) Required numbers of Basket strainers, Ultra filtration system membranes (UF skids) (2x50%) (Pressurised type) along with necessary valves, piping, fittings etc.

e) Required numbers of UF backwash pumps along with flushing tanks and pumps, CEB tank, chemical dosing system, required storage tank etc. CIP system (as applicable) shall be provided as per manufacturer's standard.

f) Piping from Gravity filter outlet to Ultra filtration system, outlet piping from UF to UF permeate storage tank, backwash water supply from UF permeate storage tank to UF membranes, recirculation pipe from backwash waste of Gravity filters & UF to backwash pit and further pumping to stilling chamber of PT-DM clarifier, associated valves, instruments, controls etc.

g) UF streams shall be pressurized type.

h) Required numbers of UF permeate water storage Tanks of required capacity/sizes with required isolation Valves.

i) Required numbers of UF permeate transfer pumps of required capacity, its drives, associated valves, piping etc.

j) Piping from UF system up to the backwash pit, associated valves etc.,

k) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

l) Piping from the discharge header of above backwash water disposal pumps up to the stilling chamber of PT-DM clarifier.

2. MICRON CARTIRDGE FILTERS

b) Required numbers of Micron Cartridge Filter (MCF) shall be sized for rated capacity of UF permeate transfer pumps.

c) The design pressure of vessel shall be at least 115% of sum of shut-off head of UF permeate transfer pumps and suction head available.

3. RO SYSTEM

a) Required numbers of High Pressure (HP)-RO feed pumps with electric motor drives, suction header from discharge header of Cartridge filters & discharge pipe header, valves, accessories, associated piping, valves, fitting etc.

b) Three (3) (3x50%) (2W+1S) numbers of RO Streams/trains module rack assemblies, sampling facilities and automatically operated reject control valves, piping, fittings etc.

c) Complete system for chemical cleaning and Flushing system comprising the necessary tanks and pumps for RO trains/streams. The effluent of RO chemical cleaning shall be led to the sludge pit.

d) Complete degassifier system for removal of CO_2 in permeate water from RO units, consisting of one degasser towers of required capacity with spray nozzles, mist eliminators, packing, packing support structures, operating platforms, ladders, gratings etc.

e) Required number of RO permeate water storage tanks of required capacity and required numbers of Degasser Blowers for Degasser.

f) Required number of Degassed water/RO permeate transfer pumps of required capacity with electrical motor drives, suction & discharge pipe, valves, accessories etc.

g) Three (3) numbers of Mixed bed unit along with two (2) numbers air blowers with its drives and all accessories.

h) Complete Hydrochloric acid handling, measuring tanks and dosage system.

i) Complete Alkali handling, storage and dosage system.

j) Required number of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

k) Neutralizing waste disposal system - All DM plant Effluent drains (except backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units) shall be connected to the Neutralisation Pit. Neutralised waste shall be pumped up to Central monitoring basin.

l) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led into the inlet channel of PT-DM clarifier.

m) First fill of filter media for AC filters & First fill of resins for all Ion Exchange units

n) 25 NB Stainless steel DM water line from Mixed Bed headers to DM plant lab.

o) Approach ladders and operation/maintenance platforms, handrails as required for various equipment, valves and instruments. Construction of support trestles, bridges, brackets, bolts, nuts, clamps etc. for the associated piping are under bidder's scope.

p) Suitable MS Epoxy painted elevated access platform to be provided for internal inspection of all the AC Filters and Ion Exchanger vessels

q) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration

pumps to be sized considering above requirement in addition to that required for regeneration.

r) Three (3) numbers of DM water storage tanks with all accessories.

s) Required number of DM water pumps for regeneration system and its drives.

t) Required number of DM water makeup pumps and drives & associated Valves and piping etc.

u) Required number of Boiler Fill pumps and drives & associated Valves and piping etc.

v) Required number of Condensate transfer pumps and drives & associated Valves and piping etc.

w) Supply of Antiscalant and Antioxidant applicable as offered for RO skids for a period of one (1) year from the date of successful commissioning of the proposed water treatment plant.

x) RO Reject water piping from RO trains up to CHP tank. The effluent of RO chemical cleaning shall be led to the sludge pit.

y) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

z) Interconnecting piping, valves, fittings etc.

4. CHEMICAL STORAGE & DOSING SYSTEM

a) Complete system for coagulant handling, preparation and dosing system comprising the necessary bulk coagulant storage tanks, required structures, operating platforms, ladders etc., Coagulant unloading cum transfer pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Coagulant preparation tanks & its accessories, required numbers of Coagulant dosing pumps, its drives, piping, valves, fittings etc., dosing piping from the pumps up to the clarifiers.

b) Complete system for coagulant aid handling, preparation and dosing system comprising the necessary coagulant aid preparation tanks, required structures, operating platforms, ladders etc., required numbers of Coagulant aid dosing pumps, its drives, piping, valves, fittings etc., dosing piping from the pumps up to the clarifiers as the case may be and as required for the process.

c) Bulk antiscalant storage tank(s), required numbers of Anti-scalant preparation tanks & its accessories, required number of Anti-scalant dosing pumps, its drives, required suction & discharge piping, valves, fittings, etc., dosing piping from the pumps up to the dosing point as required for the process.

d) Bulk antioxidant storage tank(s), required numbers of Anti-oxidant preparation tanks & its accessories, required numbers of Anti-oxidant dosing pumps, its drives, required suction & discharge piping, valves, fittings, etc., dosing piping from the pumps up to the dosing point as required for the process.

e) Required numbers of Hydrochloric Acid unloading cum transfer pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Bulk storage tanks for Hydrochloric acid of 30-33% concentration & its accessories, required numbers of Acid (HCl) measuring tanks & its accessories, required numbers of Acid (HCl) dosing pumps/ejectors for pH control of RO system and for Mixed Bed regeneration, its drives, required piping, valves, controls etc., dosing piping from the pumps up to dosing points and whenever pH control is required as per process requirement.

f) Required numbers of Sodium Hydroxide (Alkali) unloading pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Sodium Hydroxide (Alkali) transfer cum re-circulation pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Bulk storage tanks for Alkali (NaOH in lye form), operating platforms, ladders, etc., required number of Alkali preparation tank & its accessories, required numbers of Alkali measuring tanks for pH control of RO System & its accessories, required numbers of Alkali (NaOH) dosing pumps/ejectors for pH control of RO system and Mixed Bed regeneration, its drives, required

piping, valves, fittings, etc., dosing piping from the pumps up to dosing point wherever pH control is required as per process requirement.

g) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

h) Required number emergency safety shower with eye wash units in the Chemical Storage Handling facility at each locations such as Acid/Alkali Storage area, Chemical storage area, Chlorination plant area and Chemical preparation & doing equipment area.

i) All Interconnecting piping, valves, fittings etc.

3.00.00 Mechanical Ventilation system for various buildings like chlorination building, chemical house, pump houses, MCC rooms/Switchgear rooms and toilets etc.

4.00.00 Required number of Drainage pumps of capacity as mentioned in data sheets along with all accessories.

5.00.00 Any other equipment required to meet the System/Technical Specification requirement.

6.00.00 **REVERSE OSMOSIS PLANT FOR WASTE WATER**

A Reverse Osmosis plant for Waste water to treat waste water from CMB shall be provided. The broad scope of RO Plant for waste water shall include but not limited to the following systems and equipment:

a. Pre-treatment system including one (1) number of Clarifier with stilling chamber and inlet chamber, associated channels of RCC construction, two (2) numbers of Gravity sand filters.
b. Ultrafiltration (UF) skid (2x50%), required numbers of self-cleaning strainers, UF permeate storage tank, UF permeate transfer pumps, Cartridge type filters, associated pumps, blowers, interconnecting piping, fittings, valves, chemical storage & dosing system etc. as per system requirement.
c. Required numbers of RO High pressure pumps, RO Streams/trains (2x50%), required numbers of RO permeate water storage tank and automatically operated reject control valves, piping, fittings etc.

d. Complete Chemical handling, storage & dosing system for Pre-treatment plant, UF&RO system.

e. Chemical cleaning and Flushing system for UF & RO system comprising of tanks, pumps etc.

f. Required numbers of RO Permeate-transfer pumps to pump permeate to FGD System, Auxiliary Cooling water system & DM/RO system with individual motorised isolation valves in each line.

g. Required numbers of RO reject water pumps (if required) to pump RO Reject water to Coal handling plant for Recycle/reuse of RO reject, all piping, valves, fittings etc. as per system requirement.

h. The Reverse Osmosis plant for Waste water to treat waste water from CMB shall be designed to achieve zero liquid discharge from the plant and the minimum capacity of the same is specified. However, if any additional capacity or additional system is required to achieve complete zero liquid discharge plant, the same shall be provided by the bidder.

7.00.00 CONDENSATE POLISHING PLANT

a. Three (3) numbers of identical, separate Condensate Polishing Plants (CPP) for TG (Turbine-Generator) units, along with complete external regeneration systems common for all the Condensate polishing plants shall be provided as detailed out in relevant sub-section of Part-B of Technical Specification. Each Condensate Polishing unit shall consist of four (4) service vessels (4x33.33% capacity) for each TG Unit along with emergency bypass system, resins, blowers, valves, piping etc. Two (2) x 50% cartridge pre-filters for each unit, complete with automatically operated by-pass, associated piping, pneumatically operated valves etc. Two (2) sets of cartridges one each for commissioning & start up shall be provided for each TG Unit.

b. Inclusion of adequate resins for all the condensate polisher service vessels, resin storage vessels (2 nos.) in regeneration area and two (2) additional charge for use during commissioning stage of unit. Therefore, total number of charges supplied by bidder shall be sixteen (16).

c. For regeneration, resin from the exhausted exchanger vessel will be transferred hydraulically/hydro pneumatically through resin transfer pipe line to the regeneration system. The exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

d. Regeneration facilities shall consist of but not limited to the following systems and equipment:

Two (2) sets of regeneration facilities consisting of Resin separation vessel, Cation, Anion regeneration vessel(s), Resin make-up hopper, Mixed resin storage vessel, Air blowers & drives, One (1) set of alkali solution preparation & dosing skid, One (1) set of acid solution preparation & dosing skid, Three (3) (3x100%) DM water Pumps for chemical preparation & dilution, Three (3) (3x100%) DM Water Pumps for resin transfer operation, Neutralisation pit, Effluent re-circulation/disposal pumps, Two (2) numbers of DM water Storage tanks, Bulk acid and alkali storage tanks and acid & alkali unloading facilities, Adequate number of safety shower units and Eye-fountains to protect against any chemical hazard, Dosing of acid and lime to neutralize effluents in N.Pit, lime solution preparation facilities for neutralization etc.

e. Waste water generated during resin transfer operation shall be collected in collection pit located in the regeneration area & pumped by Resin transfer waste water disposal pumps (2x100%) to ACW system.

f. Any other equipment required for the completeness of the plant as per system requirement and specification requirements as specified in Part-B.

8.00.00 Air Conditioning for DM Plant Lab Building, Water System Control Building & various RIO rooms shall be in the scope of the bidder.

9.00.00 Ventilation for various Pump Houses, MCC Rooms/ Switchgear rooms etc. shall also be in the bidder's scope.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

SEPARATION OF PLANT DRAINS FROM STORM WATER DRAINS

1.00.00 General

Arrangements shall be made that effluents and storm water do not get mixed. It is not the intent to specify here the complete details of the separation and treatment system. Basic philosophy has been specified below. The contractor shall provide the various other system, equipment etc. as specified in various chapters in Part-A and Part-B of this specification.

In general, the following philosophy shall be adopted for separation of plant drain from the storm water drain.

a) Area wash water, Oil/Coal/Ash/Chemical contaminated water are considered as Plant Water.

b) Plant water has to be completely isolated from the Storm/Rain water and only Plant water needs to be treated & recycled/reused for various plant use. Storm water drains will be separated out for free discharge.

c) Area Pit(s)/Sump(s) shall be created broadly in the following areas to facilitate the collection of plant drains (as applicable):

1) TG area
2) Condenser pits & ACW Valve pits area
3) Boiler area
4) CHP transfer point in the main plant area
5) CHP area
6) Lime stone and Gypsum handling area
7) Vacuum pump sealing water area
8) Mill & Bunker area
9) ESP area
10) FOH area
11) Chemical storage area
12) Chemical storage area
13) Other Clusters in the plant area etc.

d) Submersible Pumps (Capacity-2x100%) interlocked with Level control devices shall be installed in the Area Pit/sump(s) to transfer the Plant Water to Waste Service Water Sump (WSWS) located in main power house area or WTP area, Vacuum pump sealing water, ~~Ash slurry sump~~/~~tank~~, Coal Slurry Settling Pond (CSSP), Central monitoring basin(CMB) depending on the proximity.

e) The rain water down comers shall be led to storm water drains without entry of Wash water drains into such down comers.

f) Service water effluents etc. from various plant areas shall be separately collected in Area pit(s)/sump(s) as described above and pumped to the Waste service water sump (WSWS). Excess storm water from settling ponds after treatment etc. and other plant effluents as required shall also be led to the WSWS. The effluents shall further be pumped up to tube settlers/lamella clarifiers (2x100%) for treatment of suspended solids. Treated service water shall be recycled for use. Provision for diverting the treated service water to CMB shall also be kept. Portable type oil skimmer(s) & a Portable oil centrifuge etc. shall be provided in WSWS.

g) **Fuel oil handling area**

The wash water from the FOPH area containing traces of oil requires to be pumped to oil water separator pit in the fuel oil unloading area. The decanted water shall be reused/recycled for the washing of fuel oil handling areas or collected in FOH Area Pit/sump(s) & pumped (Capacity-2x100%) to Waste Service Water Sump (WSWS).

h) **Coal stock piles area**

1) In the plant Coal stock piles are provided for storage of coal. The drains from coal handling plant contain coal particles. Apart from this, the coal pile-run off water during the rainstorm will also contain large quantity of coal particles. All the drains emanating from Coal Handling Plant shall be routed to coal slurry settling (CSSP) ponds (minimum 03 numbers) where coal particles shall be settled. After settling decanted water shall be led to the sump for pumping the same by coal decanted water pumps (4x33%) (3W+1S) to a tank in coal handling plant for reuse and to the clarifier for further treatment. Provision to dose Coagulant aid (Polyelectrolyte) solution from a set of coagulant aid storage tanks in the inlet channel of CSSP drain shall be provided. Suitable baffles shall be provided in the inlet channel to facilitate mixing of coagulant aid with the waste water before entry to CSSP. Provision shall be made to lead 100% of waste water flow (considering rain flow) to the settling ponds for settling. Facility to discharge the treated water to the nearest drain shall also be provided with an isolation valve.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

2) One (1) number of reactor clarifier (1000 cum/h) with stilling chamber, inlet chamber, channels, distribution chamber etc. shall be provided to receive excess storm water from coal slurry settling pond for further treating and to recycle the supernatant liquid to CT basin and Waste service water sump (WSWS). Lime, alum and suitable synthetic flocculent dosing shall also be provided to increase the settling rate suspended solids.

3) The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) of suitable capacity for dried coal particles to be reused. Necessary pumps (2x100%), piping, valves etc. shall be provided. Transfer pumps 2x100% (1W+1S) shall be provided in distribution chamber in CSSP to recycle the supernatant liquid to CT basin and Waste service water sump. Chemical storage and dosing area shall be provided under shed.

i) An effluent management scheme for the plant consisting of collection, treatment, maximum recycle & reuse shall be adopted by the contractor in order to optimize the make-up water requirement and minimizing various plant effluent water. Excess ACW blowdown/Treated plant water/effluents etc., DM plant neutralized effluent, effluent from different areas as envisaged by the contractor etc. shall further be collected in Central Monitoring Basin (CMB) & treated in Waste water RO plant for **meeting and maintaining the zero liquid discharge (ZLD) of the station.**

j) **DM plant effluent**

The effluent waste from DM Plant etc. shall be led to a Neutralizing pit (N-pit) for neutralization and further led to Central monitoring basin (CMB).

k) Power cycle blow down shall be recycled to condenser. Provision for recycling the same to the ACW system shall also be kept with suitable quenching arrangement.

l) All liquid effluent shall be collected and treated to meet the latest effluent norms prescribed by SPCB/CPCB. The treated effluents conforming to the prescribed standards only shall be recirculated and reused within the plant.

m) Any other system, equipment required to meet the System/Technical specification requirement shall also be in the scope of the contractor.

CLAUSE NO.	TECHNICAL REQUIREMENTS

9. The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.
10. The maximum velocity to be considered in compressed air and cooling water piping shall be as mentioned elsewhere in Subsection titled "Low Pressure Piping" in Part-B of this Technical Specification.
11. The lifting capacity of EOT crane of Compressor house shall be 125 percent (%) of the weight of the heaviest part to be lifted during erection or operation or maintenance inside the compressor house. However, the minimum capacity shall be 8 Tones.
12. All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.

3.09.00 **Separation of Plant drain (effluents) from Storm water drain**

Arrangements shall be made that effluents and storm water do not get mixed. In general, the following philosophy shall be adopted for separation of plant drain from the storm water drain.

a. Area wash water, Oil/Coal/Ash/Chemical contaminated water are considered as Plant Water.

b. Plant water has to be completely isolated from the Storm/Rain water and only Plant water needs to be treated & recycled/reused for various plant use. Storm water drains will be separated out for free discharge.

c. Area Pit(s)/Sump(s) shall be created broadly in the TG, Boiler, CHP transfer points, Mill & Bunker areas, ESP, Fuel oil, Chemical storage, Chemical unloading areas, and other cluster areas etc.

d. Submersible Pumps (Capacity-2x100%) interlocked with Level control devices shall be installed in the Area Pit(s)/sump(s) to transfer the Plant Water to Waste Service Water Sump (WSWS) located in main power house area or Water Treatment Plant (WTP) area, Ash handling system, Coal Slurry Settling Pond (CSSP), Central monitoring basin (CMB) depending on the quality of Plant water generated and/or proximity.

e. The rain water down comers shall be led to storm water drains without entry of wash water drains into such down comers.

3.10.00 All liquid effluent shall be collected and treated to meet the latest effluent norms prescribed by SPCB/CPCB. The treated effluents conforming to the prescribed standards only shall be recirculated and reused within the plant and the complete plant shall be designed as a Zero Liquid Discharge (ZLD) Plant.

3.11.00 **A. PRE-TREATMENT SYSTEM**

Design criteria of Pre-treatment Plant for Auxiliary Cooling Water and Potable water System (PT-ACW & Potable), DM system (PT-DM):

1) "PT-ACW & Potable" System with minimum two (2) reactor type clarifiers, one (1) number aerator (1x100%) & one (1) number stilling chamber (1x100%) (Common for all the Clarifiers), two (2) Inlet channels of RCC Construction with flow measuring

CLAUSE NO.	TECHNICAL REQUIREMENTS

element (Parshall flume), outlet Channels, Clarified Water Storage Tank, bypass channel to by-pass the clarifier(s). ACW make-up water shall be led by gravity or pumping. Two (2) numbers of Gravity filters (2x100%), associated filtered water reservoir (twin section), pump house etc. Gravity Filter Blowers (3x50%) shall be provided Potable water System.

2) "PT-DM" System with one (1) number reactor type clarifier (1x100%),one (1) number aerator (1x100%) & one (1) number stilling chamber (1x100%), one (1) number inlet channel of RCC Construction with flow measuring element (Parshall flume) and two (2) numbers of Gravity filters (2x100%), filtered water reservoir (twin section), pump house etc. Gravity Filter blowers (3x50%) shall be provided.

3) Three (3) numbers (3x100%) (2W+1S) Filtered Water Transfer Pumps shall be provided for Ion Exchange based DM plant. In case of RO+MB plant be envisaged for DM water, three (3) numbers (2W+1S) Filtered Water Supply Pumps (UF Feed Pumps) shall be provided. Potable water pumps for colony and plant shall be provided as specified elsewhere.

4) Interconnection provision shall be provided between the clarified water outlet channels of ACW System with the DM System to have flexibility in operation.

5) Filter house shall be RCC building.

6) Chemical House: A common two (2) storey Chemical house of RCC construction shall be provided to install various Chemical dosing equipment, pumps, tanks, piping etc. of PT–ACW & Potable, PT–DM, PT-RO plant (As applicable) :

   a) Lime preparation & dosing system consisting of minimum two (2) nos. of RCC lime slaking tanks, minimum three (3) nos. of lime solution Preparation tanks of RCC construction, agitators, lime slurry transfer pumps (2x100%), lime solution dosing pumps (2x100%) etc.

   b) Alum Solution preparation & dosing system consisting of minimum four (4) nos of Alum solution preparation tanks, agitators, alum solution dosing pumps (4x100%) (3W+1S) for PT-ACW Clarifiers, (2x100%) (1W+1S) for PT-DM Clarifier, (2x100%) (1W+1S) for Lamella clarifier/tube settlers etc.

   c) $FeCl_3$ (35–45 % conc.) (in case of PT-RO) preparation & dosing system consisting of minimum two (2) nos. of dosing tanks, agitators, coagulant unloading and transfer pumps (2x100%) (1W+1S), $FeCl_3$ dosing pumps (2x100%) (1W+1S) etc.

   d) PE dosing system consisting of minimum two (2) nos. of dosing tanks, agitators (SS-316), dosing pumps (2x100%) (1W+1S) (in case of PT-RO) etc.

   e) PAC dosing system shall consist of minimum two (2) numbers of dosing tanks, agitators, dosing pumps (2x100%), unloading pumps (2x100%) etc.

   f) Bulk Coagulant storage tanks (2), Coagulant unloading cum transfer pumps (2x100%) (1W+1S), Coagulant preparation tanks (2), Coagulant dosing pumps (2x100%) (1W+1S).

   g) Coagulant aid preparation tanks (2), Coagulant aid dosing pumps (2x100%) (1W+1S).

   h) Anti-scalant preparation tanks (2), Anti-scalant dosing pumps (2x100%) (1W+1S),

   i) Anti-oxidant preparation tanks (2), Anti-oxidant dosing pumps (2x100%) (1W+1S).

CLAUSE NO.	TECHNICAL REQUIREMENTS

j) Hydrochloric Acid (HCL) unloading cum transfer pumps (2x100%), Bulk storage tanks (3) for HCL of 30-33% concentration, Acid (HCl) measuring tanks (2), Acid (HCl) dosing pumps (2x100%) (1W+1S) for pH control of RO system and for MB regeneration etc.

k) Alkali (NaOH) unloading pumps (2x100%) (1W+1S), Alkali transfer cum re-circulation pumps (2x100%) (1W+1S), Bulk storage tanks (2) for Alkali (NaOH in lye form), Alkali preparation tanks (2), Alkali measuring tanks (2), Alkali (NaOH) dosing pumps (2x100%) (1W+1S) for pH control of RO system, Alkali (NaOH) dosing pumps (2x100%) (1W+1S) for MB regeneration etc.

l) Two (2) numbers of electrically operated mono-rail hoists each of 1 Ton capacity in chemical preparation area to handle chemicals from ground floor to first floor.

m) Two (2) numbers of weighing scales at ground floor for weighing of chemicals being handled during storage and preparation.

n) Emergency safety showers with eye wash units shall be provided in the Chemical Storage Handling facility at strategic locations such as Acid/Alkali Storage area, outdoor Chemical storage area, Chlorination plant area and Chemical preparation & dosing equipment area. Filtered water shall be used for safety showers.

o) One (1) number Overhead (OST) Storage Tank shall be provided on the top of chemical house to provide adequate storage of filtered water to be used for preparation of the chemicals, flushing of equipment, back washing of gravity filters etc.

7) Mechanical Ventilation system shall be provided for complete chemical house building covering chemical storage area, chemical preparation area, toilets etc.

8) Chemical house and Filter house shall be RCC buildings.

B. CHLORINATION SYSTEM

Chlorination plants for Auxiliary cooling water system (ACW & Potable-Chlorination) and Pre-treatment plant (PT-Chlorination) shall preferably be installed at a common location.

a) ACW & Potable-Chlorination systems is envisaged near CT basin and shall consist of two (2) (1W+1S) numbers of Chlorinator-evaporator sets. PT chlorination system shall comprise of two (2) (1W+1S) numbers of Chlorinator sets.

b) Chlorination Plant shall consist of required numbers of Chlorine tonners, Evaporators (as applicable), Chlorinators, ejectors, Chlorine water booster pumps, Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits etc. To take care of chlorine leakage, chlorine leak absorption system shall be provided.

c) Mechanical Ventilation system shall be provided for complete building.

d) One (1) no of electrically operated hoist (Capacity-2 Ton), Two (2) no of Weighing scales (Capacity-2 Ton) shall be provided in each chlorination plant. If the chlorination building is common for PT & ACW system, then two (2) numbers electrically operated hoists (Capacity-2 Ton each) shall be provided.

C. LIQUID EFFLUENT TREATMENT SYSTEM (LET SYSTEM)

1. PT - PLANT CLARIFIER SLUDGE DISPOSAL SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS

a) One (1) number RCC sludge pit (in 2 sections) to collect sludge from all the clarifiers of PT-ACW system, PT-DM system & Lamella clarifiers/tube settlers and any other effluent connected to this sump (in case envisaged).

b) Two (2) numbers air blowers (2x100%) (1W+1S) for the air agitation system of the sludge pit.

c) Three (3) (3x50%) (2W+1S) numbers of sludge disposal pumps.

d) Sludge thickener (1x100%)

e) Centrifuge (2x50%)/Belt filter press (2x50%)

2. FILTER BACK WASH WASTE DISPOSAL SYSTEM

a) One (1) number RCC Filter backwash waste collection pit (in 2 sections) to collect the backwash water from all the filters including Ultra filtration system. The filters backwash water shall be collected and recycled back to the PT-ACW clarifier.

b) Two (2) (2x100%) (1W+1S) numbers of backwash disposal pumps shall be provided.

3. WASTE SERVICE WATER TREATMENT SYSTEM

a) One (1) number RCC waste service water sump (WSWS) in two (2) sections shall be provided for collection of waste service water. Service water effluents and other plant effluents from various areas of the plant shall be routed to this waste service water sump. Facility shall be provided to collect free oil from these sumps to MS Oil drum and oil skimmers (2 nos.) Portable oil Centrifuge (1x100%) of suitable capacity shall be provided for reuse of oil.

b) Three (3) (3x50%) (2W+1S) numbers of Waste Service water pumps.

c) Two (2) (2x100%) numbers of Lamella Clarifier/tube settlers of RCC construction of suitable capacity shall be provided to treat the total service water of the plant for reuse.

d) One (1) number of RCC Treated water tank/Service water tank for collection of treated water from Lamella Clarifier/tube settlers. Service water pumps shall be provided to transfer the treated service water to plant service water system.

4. COAL HANDLING PLANT RUN-OFF WATER TREATMENT SYSTEM.

a) Four (4) numbers of Coal Slurry Settling (CSSP) Ponds (minimum size of 40m x 8m x 3m deep) of RCC Construction shall be provided.

b) Two (2) numbers Coagulant-aid tanks (with SS-316 agitators) of MS rubber lined construction.

c) One (1) number decanted water sump of RCC Construction (2 sections) to receive decanted water from above settling ponds.

d) Two (2) numbers (2x100 %) (1W+1S) Coal Decanted Water Pumps.

e) Four (4) numbers (4x25%) (4W) Clarifier Feed Pump (CSSP area)

f) Two (2) Reactor Clarifiers (2x50%) with stilling chamber (1), inlet chambers (2) and RCC channels, distribution chamber etc. shall be provided to receive excess storm water from settling ponds, along with, piping, valves etc.

g) 2x100% Transfer pumps (if applicable) in distribution chamber in CSSP shall be provided to discharge the treated supernatant water to storm water drain.

h) Lime preparation & dosing system consisting of lime slaking tanks , lime solution preparation tanks, agitators, lime slurry transfer pumps (2x100%), lime solution dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

i) Alum Solution preparation & dosing system consisting of Alum solution preparation tanks , agitators, alum solution dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

j) Suitable synthetic flocculent dosing shall also be provided to increase the settling rate suspended solids. Flocculent preparation & dosing system consisting of preparation tanks, agitators, dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. shall be provided.

k) The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) of suitable capacity for dried coal particles to be reused. Necessary pumps (2x100%), piping, valves etc. shall be provided.

l) Chemical storage and dosing area shall be provided under shed. Chemical storage shall be designed to meet 15 days requirement.

5. CENTRAL MONITORING BASIN

a) One (1) number (in 2 sections) Central Monitoring (CMB) Basin of RCC Construction.

b) Two (2) (2x100%) (1W+1S) numbers of Waste water RO effluent pumps.

6. All liquid effluent shall be collected and treated (as required) to meet the latest effluent norms prescribed by SPCB/CPCB.

D. DM PLANT (ION EXCHANGE PROCESS OR RO+MB PROCESS)

Design criteria of DM plant (Ion Exchange process or RO+MB process):

1) The capacity of DM plant (either by Ion exchange process or RO process) shall be sized to meet the steam water cycle makeup at the rate of 1.5 % (minimum) of the boiler MCR, makeup water for closed cycle ECW system, regeneration & any other requirement as envisaged by the bidder. Additional DM water requirement for Hybrid System (SCR + SNCR) (if applicable) shall also be considered while sizing of the DM water system. However, the minimum capacity of DM plant shall be as specified.

2) Minimum three (3) numbers of DM water storage tanks, each of minimum capacity 2000 cum shall be provided.

If CPU regeneration facilities are located in DM plant regeneration area, total DM water storage requirements for CPU plant may be clubbed with total DM water storage requirements of DM plant as specified above to decide the effective capacity of the DM tanks. Also, minimum three (3) numbers of DM water storage tanks shall be provided.

3) ION EXCHANGE BASED DM PLANT

CLAUSE NO.	TECHNICAL REQUIREMENTS

a) Ion Exchange Demineralising Plant (2x100%) shall be provided. Weak acid Cation exchanger, Strong acid Cation exchanger, Weak base anion exchangers, Strong base anion exchangers shall be designed for 12 hours of operation cycle followed by 4 hours regeneration period. MB unit shall be regenerated after minimum 108 hours of operation followed by regeneration period not exceeding 6 hours.

b) Two (2) (2x100%) numbers of Activated carbon filters with all accessories.

c) Two (2) (2x100%) numbers of Cation (Weak & strong) exchangers units and Anion exchangers units (Weak & strong) with all accessories.

d) Two (2) (2x100%) numbers of Degasser system comprising of Degasser Towers and storage tanks, Air Blowers (2X100% per Degasser unit), three (3) (3x100%)(2W+1S) numbers Degassed water transfer pumps etc.

e) Two (2) (2x100%) numbers of MB unit along with Two (2) (2x100%) numbers air blowers with its drives and all accessories.

f) Complete Hydrochloric acid handling, Alkali handling, measuring tanks and dosage system etc.

g) Two (2) numbers of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

h) Brine Solution Preparation Tank and Brine transfer pumps, piping and valves etc.

i) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

4) RO BASED DM PLANT

A. ULTRAFILTRATION (UF) SYSTEM

a) UF skids (2x50%) (Pressurized type), Simplex strainers (2x100%) (1W+1S) for each stream, UF backwash pumps (2x100%) (1W+1S) along with flushing tanks and pumps, CEB & CIP systems, UF permeate water storage tanks (2), UF permeate transfer pumps (3x50%) (2W+1S) etc.

b) (3x50%) (2W+1S) Micron Cartridge Filter (MCF).

B. RO SYSTEM

a) High Pressure (HP)-RO feed pumps (3x50%) (2W+1S) with one(1) store standby, RO Streams/trains (3x50%)(2W+1S) with module rack assemblies, RO permeate water storage tanks (2), RO Permeate transfer pumps (3x50%) (2W+1S), sampling facilities, reject control valves, Complete system for Chemical cleaning (CIP) and Flushing system comprising of necessary tanks and pumps for RO trains/streams etc.

b) Complete Degassifier system for removal of CO_2 in permeate water from RO units, consisting of minimum one (1) Degasser tower, Degasser/RO permeate water storage tank (2), Degassed Water Pumps (3x100%), RO Chemical dosing system consisting of Anti-oxidant dosing tank and pumps, Anti-scalant dosing tank and pumps etc., etc.

c) Degasser Blowers for Degasser (2x100%) (1W+1S), RO permeate transfer pumps (3W+1S) etc.

d) Mixed bed (MB) unit (3x50%) (2W+1S) along with air blowers (2x100%) and complete regeneration system etc.

5) OTHER REQUIREMENTS FOR DM PLANT

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a) Complete Hydrochloric acid handling, measuring tanks and dosage system etc.

b) Complete Alkali handling, storage and dosage system etc.

c) Three (3) numbers of DM water storage tanks with all accessories.

d) Two (2) numbers (2x100%) (1W+1S) DM water pumps for regeneration system.

e) Neutralizing waste disposal system- DM plant Effluent drains shall be connected to the N-Pit and shall be led suitably to Ash handling system. Additionally, provision for diverting N-pit waste to CMB shall also be provided.

f) Backwash waste disposal system for DM plant - Backwash water from AC filters, rinse waste water and fast/final rinse waste water of DM plant shall be connected to the backwash collection pit (DM), UF back wash shall also be led to this backwash pit. Back wash water shall be pumped to the inlet channel of PT-DM clarifier.

g) Two (2) (2x100%) (1W+1S) numbers of backwash disposal pumps shall be provided. Two (2) numbers air blowers (2x100%) (1W+1S) for the air agitation system of the filter backwash pit shall be provided.

h) First fill of filter media for AC filters and first fill of resins for all Ion Exchange units shall be provided.

i) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

j) 25 NB SS DM water line from Mixed Bed headers to DM plant lab shall be provided.

k) Suitable MS Epoxy Painted elevated access platform to be provided for internal inspection of all the AC Filters, Ion Exchanger vessels, UF, RO skids, Hot water tank, dosing tanks, degasser tower and tank etc.

l) Supply of Anti-scalant and Anti-oxidant as offered for RO skids for a period of one (1) year from the date of successful commissioning of WTP plant shall be provided by the bidder.

m)RO Reject shall be led to Coal handling plant for reuse in dust suppression system.

n) The effluent of RO chemical cleaning shall be led to the sludge pit.

o) Each set of UF Cartridge filters, HP pump skids and RO membrane units shall be aligned in a row forming a RO train/stream for RO system.

p) Adequate space for access and maintenance shall be provided for HP Pumps (at the end of the pump bay) and RO membrane (at the sides) of assembly.

q) CIP & Flushing System skids shall be provided at suitable location.

r) Sufficient numbers of portable type ladders with platform to be supplied for ease of maintenance.

s) A two (2) storeyed Laboratory RCC building for DM plant shall be provided. The ground floor shall typically have office, store room, resin store room, coal analysis room, coal sampling room, toilet blocks etc. The first floor shall typically have office, record room, Pollution laboratory room, Instrument laboratory room, Water analysis laboratory room, Instrument room, Resin testing laboratory, toilet blocks etc. which shall be air conditioned.

t) Chemical laboratory equipment shall be provided as defined elsewhere.

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u) DM Plant shall be kept under shed open from side. DM plant regeneration area shall be kept under steel shed.

6) Any other equipment required to meet the system requirement for complete Water-treatment plant and as envisaged by the contractor shall also be provided.

7) All wetted parts in the plant shall be constructed with suitable corrosion resistant material suiting to the fluid.

8) Facilities for maintenance of the pumps by means of mobile cranes or jib crane or gantry cranes shall be provided based on pumps layout.

5. REVERSE OSMOSIS PLANT FOR WASTE WATER

1) A UF+RO Plant for waste water treatment shall be designed considering an inlet TDS of 5000 ppm minimum.

2) Clarifier (1x100%), Gravity sand filter (2x100%) etc. Ultrafiltration skid (2x50%) with self-cleaning strainers at inlet, One(1) number of UF permeate-cum-back wash water storage tank, UF permeate transfer pumps (3x50%), Cartridge type filters (3x50%),

3) RO skid consisting of High pressure pumps (3x50%), RO Streams/trains (2x50%) module rack assemblies, one (1) number of RO permeate water storage tank sampling facilities and automatically operated reject control valves, piping, fittings etc.

4) Complete chemical storage & dosing system for Pre-treatment, UF&RO system, chemical cleaning and Flushing system for UF & RO system comprising of tanks and pumps (2x100%) etc.

5) RO Permeate-transfer pumps (2x100%) to recycle permeate water to DM plant and CT basin.

6) RO Reject shall be Recycled/reused to Coal handling plant for use in coal dust suppression.

4.00.00 MATERIAL HANDLING

4.01.00 Ash handling System

4.01.01 Brief System Description

Ash handling system consists of the following sub systems:

a) Bottom Ash, Economizer ash and Air preheater ash (if applicable) Handling System ,

i) Completely dry type Bottom Ash and Economiser Ash removal system – A continuous system consisting of dry type bottom ash hoppers, mechanical conveyors, crushers and storage silos etc.

b) Dry Fly Ash Conveying system

Two alternatives for pneumatic conveying system are specified for conveying of fly ash in dry form from ESP hoppers upto buffer hoppers. i.e. vacuum conveying system or pressure conveying system

i) Vacuum Conveying System

It shall consist of liquid ring vacuum pumps, material handling valves, cast iron and MS pipes, instrument air compressor etc.

OR

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A). WATER TREATMENT PLANT APPLICABLE FOR LIQUID EFFLUENT TREATMENT (LET/ETP SYSTM)

1.00.00 **WATER TREATMENT PLANT**

This Chapter describes the system description, minimum Technical Requirements of the Water Treatment plant and associated equipment. The minimum technical requirements for plant and equipment shall include, but not be limited to the following:

1.01.00 **SYSTEM DESCRIPTION**

1) The **Pre-treatment plant** would be designed to remove suspended/colloidal matter in the raw water. Pre-treatment plant shall be provided for Auxiliary Cooling water system and Potable water system (PT-ACW & Potable system), Demineralised water system (PT-DM system). The plant shall consist of minimum two (2) clarifiers of reactor type for PT-ACW & Portable water system & one (1) clarifier of reactor type for DM system. The clarified water shall be taken as make-up to ACW system (CT basin) either by gravity or by pumping. Clarified water shall be used for various systems like HVAC (Air conditioning & ventilation), FGD system, plant service water system, Ash vacuum pump sealing and any other system as envisaged by the bidder. ACW blow down water shall be used for CHP dust suppression system etc. Provision of service water for CHP dust suppression system shall also be kept. Gravity Filters (2x100%) shall be envisaged separately for DM system and Potable water system. The filtered water shall be led to DM plant for further treatment to produce demineralized water of specified quality. A common chemical house shall be provided to store chemicals, dosing equipment etc. Chemical house and Filter house shall be RCC buildings.

2) **ACW Chlorination Plant** (Chlorinator-evaporator sets) shall be envisaged near ACW pump house. **PT Chlorination Plant** (Chlorinator sets) shall be envisaged near Pre-treatment plant. The chlorination plants for ACW system and PT system can also be installed at a common location if layout permits. The Chlorination system shall be provided with chlorine ton containers, instrumentation, Chlorine leak detectors etc. Complete chlorination plant(s) shall be located indoor. Chlorine leak absorption system as plant emergency measure shall be provided for the Chlorination plant(s) to neutralize chlorine leakage from the plant. Chlorination Building(s) shall be a RCC construction.

3) Sludge from all clarifiers/lamella clarifier etc. in Pre-treatment plant shall be led to common sludge sump and treated in Centrifuge and Belt filter press.

4) The contractor shall provide either Ion exchange based DM plant or RO based DM plant.

5) The capacity of DM plant either by Ion exchange process or RO process shall be sized to meet the makeup water requirement of the steam cycle, make up water to close circuit equipment cooling water (ECW) system,

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stator water cooling system etc. and any other requirements as envisaged by the Contractor.

6) In case, Ion exchange based DM Plant is provided, the D.M. plant shall consist of two (02) streams (2x100%) and shall comprise of Activated carbon filter, Weak Acid Cation Exchangers, Strong Acid Cation Exchangers, Degasser towers and Degassed water storage tanks, Degassed water pumps & blowers, Weak Base Anion Exchangers, Strong Base Anion Exchangers, Mixed bed Exchangers. The Cation resins shall be regenerated with hydrochloric acid and the Anion resins with sodium hydroxide. The regeneration facilities shall consist of the bulk acid & alkali storage tanks, alkali solution preparation system, acid & alkali measuring tanks and dosing ejectors etc.

7) In case RO based DM plant is provided, the UF+RO+MB combination Plant shall consist of Ultra filtration skids (2x50%), UF permeate water tanks, Backwashing (CEB) system for UF, Clean-In place(CIP) for UF, RO feed pumps, micron cartridge filters, RO High pressure pumps, complete skid mounted RO block (3x50%), Degasser tower and RO permeate (Degassed) water storage tank, Degassed water pumps, Complete chemical dosing systems for RO system, Chemical cleaning skid for RO system, Complete flushing system for RO system, Mixed bed (MB) exchangers (3x50%) along with regeneration system, acid/alkali dosing system, reject disposal system etc. Reject from RO plant shall be recycled and reused in coal handling plant suitably.

8) The DM water of specified quality after mixed bed units (MB units) shall be taken to DM storage tanks. Three (03) numbers of D.M. water storage tanks shall be provided to store DM water.

9) A two (2) storeyed Laboratory RCC building for DM plant shall be provided.

10) DM Plant (either by Ion exchange process or RO process) shall be kept under steel shed open from side. DM plant regeneration area shall be kept under steel shed. DM Pump house shall be kept in open.

11) Effluent treatment system for PT plant: The filter backwash water of PT Plant shall be collected and recycled back to the PT-ACW &Potable Clarifier. The filter backwash water of DM Plant shall be collected and recycled back to the PT-DM Clarifier. Sludge from clarifiers shall be thickened in a thickener and further solidified by using centrifuge/belt filter press.

12) Neutralizing waste disposal system for DM plant: The effluent waste from DM Plant etc. shall be led to a Neutralizing pit (N-pit) and led to Central monitoring basin (CMB).

13) Power cycle blow down shall be recycled to condenser. Provision for recycling the same to the ACW system shall also be kept with suitable quenching arrangement.

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14) Coal handling plant run-off waste water shall be collected in minimum four (4) numbers of Coal slurry settling ponds, treated and decanted water shall be recycled/reused in Coal handling plant suitably by using Coal decanted water pumps. Further, Clarifier feed pumps (4x25%), common stilling chamber (1), inlet chambers (2) and reactor clarifiers (2) of RCC construction, RCC channels, distribution chamber etc. of required capacity shall be provided to receive excess storm water from coal slurry settling ponds and discharge the treated supernatant water to storm water drain. Lime, alum and suitable syn-thetic flocculent dosing shall also be provided to increase the settling rate suspended solids. The pH of treated supernatant water is expected to be acidic in nature (pH-2.8-7.8) and same shall be neutralized prior to discharge in storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc. shall be provided. The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) for dried coal particles to be reused.

15) Service water effluents etc. from various plant areas shall be separately collected in Area pit(s)/sump(s) and pumped to the Waste service water sump (WSWS). DM plant neutralized effluent, excess storm water from settling ponds after treatment etc. and other plant effluents as required shall also be led to the WSWS. The effluents shall further be pumped up to tube settlers/lamella clarifiers (2x100%) for treatment of suspended solids. Treated service water shall be recycled for use. Provision for diverting the treated service water to CMB shall also be kept. Portable type oil skimmer(s) & a Portable oil centrifuge etc. shall be provided. An effluent management scheme for the plant consisting of collection, treatment, maximum recycle & reuse shall be adopted by the contractor in order to optimize the make-up water requirement and minimizing various plant effluent water. Excess ACW slowdown/Treated plant water/effluents etc., effluent from different areas as envisaged by the contractor shall further be collected in Central Monitoring Basin (CMB) & further treated in Waste water RO plant for meeting and maintaining the zero liquid discharge of the station.

2.00.00 **TECHNICAL REQUIREMENTS**

2.01.00 **GENERAL**

1) The aerator shall be of stepped design and shall allow water to flow downward after spreading over inclined thin sheets and the turbulence is secured by allowing the water to pass through a series of steps and baffles. Cascade aerators designed based on the surface flow rate of not less than 0.03 $m^2/m^3/hr$. Exposure time shall be suitably designed by providing adequate number of steps in the aerator.

2) The volume of stilling chamber shall have a retention time of minimum 1 minute and velocity of water rise through the stilling chamber shall be 0.05 m/sec.

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3) The chlorine dosing shall be done in stilling chamber and aerator by using diffusers of proven design. Water from the aerator launder shall be led into the stilling chamber. The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom with the velocity specified elsewhere. Draining arrangement with a valve shall be provided for the stilling chamber.

4) The hydraulic circuit of the complete Pre-treatment plant shall be designed in such a way that water from aerator shall flow by gravity up to the clarified water tank under various flow rates up to maximum flow and the top water level in the clarified water storage tank/distribution chamber shall be maintained as +4.5 M (minimum) from the finished ground level.

5) All the clarifiers shall be designed to operate simultaneously.

6) Hydraulics of the Complete Pre-treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.

7) Pre-treatment plant shall be designed such that CW clarifiers can be bypassed. A back-up line shall be provided between ACW Clarifier outlet channel & DM Clarifier.

8) Layout for Pre-treatment plant shall be designed in such a way that various units (e.g. stilling chamber, clarifiers, chemical house, filter house operating platform etc.) shall be interconnected by at least 1 M wide walkways at the appropriate elevations with hand railings.

9) All the chemicals to be used in the Pre-treatment plant shall generally conform to the requirement of technical grade as per relevant IS.

10) Clarified water distribution chamber/tank shall be covered.

11) All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/tanks/sumps means the capacity between the bottoms of the overflow nozzle to the top of the outlet nozzle. Outlet nozzle center line shall be kept at least 200 mm from the invert level of the chemical tanks/water retaining structures/tanks/sumps**.** All the covered sumps shall be provided with minimum two (2) numbers of manholes and suitable venting provisions.

12) A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as stilling chamber, channels, clarifiers, clarified water storage tank, filtered water reservoir, filtered water sump, overhead filtered water tank, CMB, service water tank etc.) above the maximum water level/overflow level as the case may be excluding the thickness of the slab/beam thickness if any.

13) Any other pumps, blowers required for the completeness of the system shall be designed with a redundancy of N+1 unless stated otherwise (N=No of working pumps, blowers)

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2.02.00 **REACTOR CLARIFIER UNITS**

1) The clarifier shall be solid contact reactor type with integral variable speed impeller/ turbine to internally re-circulate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity. The unit shall be designed with a minimum retention time of 90 minutes in the settling zone.

2) The overall area of the unit shall be based on an average flow velocity not more than 3 M^3/M^2/hr. Weir loading shall not exceed 300 M^3/m/day. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary.

3) Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow.

4) Clarifiers shall be sized such that in the event, one (1) clarifier is out of service for maintenance, the other clarifiers with 20% overload will be able to meet the total clarified water requirement.

5) The clarifier periphery (all around) shall have a walkway (minimum width 850 mm) with handrail and access ladder (RCC) (at least from two locations) for good approach. All the Reactor clarifiers shall be equipped with full bridge of sufficient width. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. However, the sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement.

6) Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge disposal sump. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump.

7) Each of the clarifier shall be provided with a gate at the outlet for isolation of any of the clarifier for maintenance.

2.03.0 THICKENER

a) The sludge thickener shall use the technique of liquid solid separation by gravity setting and thickening of the clarifier sludge.

b) These thickener shall reduce the sludge quantity to be handled by downstream equipment viz. solid bowl type centrifuge/belt filter press.

c) The sludge shall be pumped to the sludge thickener and dosed with polyelectrolyte to assist the thickening process. The supernatant from the thickeners shall be gravitated to the head works. Sludge from the thickeners will be pumped to a suitable thickened sludge sump from where it shall lead to the centrifuge system.

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d) The thickeners shall have sludge feed piping located below the thickener floor or at the top as per manufacturer's standard. Adequate permanent flushing connections shall be provided for inlet feed pipe as well as the effluent thickened sludge pipe.

e) The thickener shall be steel tank. The floor slope shall be between 10 and 20 degree to the horizontal plant equipped with mechanical scraper.

f) The mechanical scraper drive arrangement shall be electrically operated.

g) The thickener shall be designed for maximum overflow loading rate of 25 $m^3/day/m^2$ and maximum solid loading rate of 100 kg/day/ m^2. Minimum side water depth (SWD) should be 3.5 meter. Hydraulic circuit shall be such that overflow from thickener shall flow by gravity. Hydraulic of the system shall be such that it can take 20% overloading.

h) The thickener shall be capable of thickening the sludge to 7% solid consistency.

i) All parts inside the thickener coming in contact with sludge shall be painted with three (3) coats of bitumastic heavy duty paint. Other metallic components shall be painted with one (1) coat of red lead prime and three (3) coats of suitable rust preventive painting.

j) Suitable sampling connections shall be provided in the thickener of performances monitoring.

k) Polyelectrolyte dosing facility required for thickening shall be provided for which necessary piping, pumps, valves etc. shall be supplied by bidder.

l) Suitable access rungs, ladder, platform, hand railing etc. shall be provided as per manufacturer's standard design.

2.04.00 **CENTRIFUGE /BELT FILTER PRESS**

a) The centrifuges shall operate with the technique of liquid solid separation of differential centrifugal force.

b) The centrifuge/belt filter press shall be used for dewatering the sludge coming out of preceding thickener.

c) The solid bowl centrifuge shall have the system components (indicative) for effective performance like feed tube, bowl, conveyor scroll, gear box, discharge ports for solid and liquids, housing, drive motor etc.

d) The centrifuge/belt filter press shall be designed for continuous operation. The centrifuge shall be either be co-current or counter-current design as per manufacturer's standard. The axis of rotation of the unit shall be horizontal.

e) The feed shall be pumped into the centrifuge/belt filter press by the help of screw pumps. The centrifuge/belt filter press shall be located at an elevated platform. The solids from the centrifuge/belt filter press shall flow by gravity. The elevation of the centrifuge/belt filter press platform shall be at least 3.5 M above ground level so that clearance below the chute shall be suitable for

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truck/trolley movement. The centrate shall be sent back to thickener by gravity.

f) For dewatering the fine suspended solids, suitable polyelectrolyte shall be dosed in the centrifuge/belt filter press. The recovery of solids shall be at least ninety (90) per cent with poly electrolyte dosing. The feed to centrifuge/belt filter press will contain about 5 to 7 per cent solids. The solids cake discharge from centrifuge/belt filter press shall have minimum twenty five (25) per cent solids and shall be of tractable consistency.

g) The centrifuge/belt filter press shall be provided with washing lines which shall allow clearing of centrifuge/belt filter press.

h) The centrifuge shall be provided with either an epicyclical gear box or cycle gear box as per manufacturer's standard. The centrifuge/belt filter press shall be provided with anti-vibration arrangement for reducing the vibrations. Overload safety for the gear box shall be provided as per manufacturer's standard.

i) All parts coming in contact with the fluids shall also be made of SS-316 material.

j) Polyelectrolyte dosing facility shall be provided. Necessary piping, pumps, valves, etc. shall be supplied by bidder for this purpose. Common polyelectrolyte dosing facility for centrifuge & thickener is also acceptable.

k) Suitable flushing connection with plug/tanks shall be provided for all pipe lines carrying sludge. Pressurized water supply for flushing shall be provided.

l) Suitable access rungs, ladder, platform, hand railing etc. shall be provided as per manufacturer's standard design.

2.05.00 **FILTERS**

2.05.01 **GRAVITY FILTERS**

1) The inlet channel from clarifiers to gravity filters shall be designed considering operation of all the gravity filters including standby filters under exigency.

2) Filter box of gravity filters shall be of water tight RCC structure covered with RCC roof. Gravity filters shall be twin section type complete with a rate of flow indicator and a loss of head gauge.

3) Gravity filters shall be designed for surface flow rate not more than $5m^3/m^2/hr$.

4) Only one filter shall be backwashed at a time. Backwashing of filters shall be done in not less than 24 hours.

5) The velocity of water during backwashing shall not exceed 35.0 m /hr, when air scouring is employed.

6) Effective Capacity of both sections of the filter water reservoir (excl. common sump) shall be adequate to store filtered water output from one complete filter for one (1) hour.

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7) At least 50% free board shall be left over the filtering media to facilitate backwashing.

8) The filtering medium shall be washed, screened and hydraulically graded anthracite coal or sand having an aggregated depth not less than 1200 mm.

9) Details of various layers of Gravity filter medium should be as follows:

150 mm of No.	7 size	60 mm X 50 mm
100 mm of No.	6 size	40 mm X 20 mm
75 mm of No.	4 size	15 mm X 8 mm
75 mm of No.	3 size	8 mm X 4.5 mm
50 mm of No.	2 size	4.5 mm X 2.8 mm
750 mm of No.	1 size	0.45 mm to 0.7 mm effective size

Anthracite shall have the following properties: -

Uniformity coefficient	1.6
Hardness	2.5 to 3.5 (Mho. scale)
Dust content	Less than 1%
Specific gravity	1.75 (Approx.)

Anthracite shall be free from iron sulfide, clay, shale, long, thin or scale pieces.

Sand shall have the following properties: - Sand shall be of hard and resistant quartz or quartzite and free of clay particles, soft grains and dirt of every description.

Effective size shall be 0.45 to 0.70 mm.

Uniformity coefficient shall not be more than 1.7 or less than 1.3

Ignition loss should not exceed 0.7 per cent by weight.

Soluble fraction in hydrochloric acid shall not exceed 5.0% by weight.

Silica content should not be less than 90%.

Wearing loss shall not exceed 3%.

Specific gravity shall be in the range between 2.55 to 2.65.

Sand should be clean and well graded. Sand filter shall have a HCL solubility of less than 5% when tested in accordance with AWWA B 11.53.

10) Each filter bed shall be provided with a rate of flow indicator and a loss of head gauge in a local instrumentation panel which shall be located at suitable location on the operating platform of filters. Each filter bed outlet shall be provided with rate of flow indicator & controller.

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11) Each of the gravity filters shall be provided with drain connections with isolating valves for draining complete filter water channel and filter bed. Platform over each of the gravity filters with hand railing shall be provided for the inspection of backwashing operation and filter bed.

12) The manual extension spindles of all the valves of filters shall be operatable from the operating floor of filter bed. Extension spindles and C.I. head stocks for operation of these valves shall be provided. Only valves shall be used for different process of filters. Penstocks/Gates in filter beds will not be accepted.

13) The arrangement of Gravity Filters, filtered water reservoirs, filtered water sump and filtered water pump house for PT-DM and PT-Potable system shall be located together. However, operating floor level of both the filtered water pump houses may be common.

2.05.02 **FILTER BACK WASHING**

1) Filter Back Washing: An overhead storage water tank shall be provided on top of chemical house. The capacity of the overhead filtered water tank shall meet the water requirement for backwashing and backwash flow for simultaneous backwash of one (1) number of gravity filter (both the sections) of Potable System and one (1) number gravity filter (both the sections) of DM and preparation of chemicals etc. and any other requirements envisaged by the contractor.

2) The inlet distribution and under drain collecting system shall be so designed as to give uniform distribution and flow without channeling and obstruction. The under drain system shall either be of header lateral or manufacturer's standard design.

2.05.03 **CARTRIDGE FILTERS**

1) The filter elements shall be cylindrical cartridges constructed from polypropylene fibers, which have a 1 micron nominal 95% efficient rating. Cartridge shall be self-supporting with no reinforcing structures or resins. Polypropylene material shall be 100% polypropylene with no binders, resins lubricants or other residue from the manufacturing process. The filter vessel shall be designed in accordance with ASME boiler and pressure vessel code section VIII, division I. Filter Casing & Internals for Cartridge filters shall be SS-316. Each vessel shall have type bolts and nuts of SS. Each vessel shall have a cover gasket with Buna-N "O" rings. The vessel shall be provided with both clean and dirty water drain nozzles, as well as an air vent at the top. Each vessel shall be provided with a cover-lifting davit arrangement capable of lifting the cover and swinging it to the side. A flanged inspection port shall be installed on the clean side plenum 90 degree from the inlet center line.

2.05.04 **AIR BLOWERS FOR FILTERS**

1) Air blower shall be used for air scouring of filter bed. Blower shall be positive displacement, twin lobed rotary blower. The blower shall be V-belt/directly coupled with electric motor. The blowers shall be oil free type.

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2.05.05	**ULTRAFILTRATION SYSTEM (UF)** 1) Each UF train/stream shall have 15 % spare capacity in order to install additional membranes. 2) UF system shall be pressurized type. The pressure tube shall be side port type and of FRP material. Rated pressure of pressure tubes shall be at least 10% higher than maximum pressure encountered in the system. 3) Membranes shall be of hollow fiber type of PVDF/Polysulphone/ Polyethersulphone material. ~~The pore size of membranes shall not be more than 0.04 microns. Gross flux of membranes shall not exceed 60 LMH.~~ 4) ~~Each stream shall be provided with two (2) (1W+1S) automatic type simplex strainers (100 microns) at inlet to membrane skid.~~ 5) Membrane cleaning system shall be provided as per recommendation membrane designer and membrane manufacturer. The effective capacity of each cleaning tank shall be 120% of chemical required for one (1) cleaning or 0.5 cum. whichever is higher. For each chemical, preparation cum dosing tank shall be provided with agitator, level indicator and pump interlock. The preparation cum dosing tank shall be of MSRL/FRP construction with minimum 6.0 mm thickness. 6) Two (2) numbers of UF permeate storage tanks shall be envisaged to store water to supply feed water to RO system on continuous basis and also to provide water for back washing of UF membranes. Capacity of the tanks shall be calculated based on gross requirement of simultaneous operation of RO & UF backwashing system. A margin of minimum 50% of back wash water requirement shall be considered while calculating capacity of the tanks. 7) Back washing of membranes shall be done automatically and backwash waste shall be pumped to CHP. CIP shall be provided and the same shall be as per the recommendation of membrane manufacturer. 8) Arrangement/facilities for Direct Integrity Testing, like air pressure system, sonic leak detection etc., to detect any leak from fibers/ membranes/cartridges/modules, gaskets, values, fitting etc. which may contaminate the filtrate shall be provided. 9) Design calculations of Ultra filtration system shall be vetted by membrane manufacturer during detailed engineering. 10) The UF membranes shall be supplied from one of the following membrane manufacturers: DowChemicals/Toray/Hydranautics/Inge/Hyflux/Koch/Norrit-Pentair/GE.

CLAUSE NO.	TECHNICAL REQUIREMENTS

2.06.00

CHEMICAL HOUSE

A. CHEMICAL HOUSE FOR PT PLANT

1) Chemical dosing equipment, pumps, tanks, piping etc. of PT- ACW & Potable, PT- DM /RO plant (as applicable) shall be located in a common two (2) Storey Chemical House. The Chemical House shall store chemicals in the ground floor whereas equipment such as chemical preparation tanks and dosing equipments shall be installed on the first floor. The chemical house shall be located such a way that chemical dosing pipelines to PT plants, DM plant are minimum.

2) Preparation & dosing equipment of each type of chemical shall be isolated/segregated to avoid mixing of chemicals, facilitate safe operation, easy movement of personnel during plant operation and emergency condition like chemical leakage etc.

3) Suitable platforms, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided. Chemical house shall have sufficient unloading space, wide corridors for movement of chemicals, office and toilets.

4) Storage area (Alum, Lime, other chemicals etc.), Chemical preparation tanks area, Chemical drain trench & dyke wall shall be provided with corrosion resistant (AR) tiles/lining to protect the surface due to spillage/drains etc.

5) Drains from chemical storage & preparation facility/equipments shall be designed so that the same are not mixed with storm water drainage.

6) Chemical house in the ground floor shall be designed to store the chemicals for one (1) month period considering working of all the clarifiers/tube settlers etc.

   a) Alum as $Al_2(SO_4)_3$: 70 ppm on 100% basis

   b) Lime as $Ca(OH)_2$: 30 ppm on 100% basis

   c) Coagulant aid : 2 ppm

7) Lime slacking tanks: Each tank shall be sized for holding lime slurry (of about 10% W/V concentration from Quick lime of purity of 75% CaO) for 12 hours requirement of all the clarifiers/lamella clarifiers operating at design capacity and a design dosage rate of 30 ppm minimum.

8) Lime solution preparation tanks: Each tank shall be sized for holding lime solution (of about 6% W/V concentration) for 8 hours requirement of all the clarifiers operating at its design capacity and a design dosage rate of 30 ppm minimum.

9) Alum Solution Preparation tank: Each tank shall be sized for holding alum solution (of about 10% W/V concentration) for 8 hours requirement of all the clarifiers operating at its design capacity and a design dosage rate of 70 ppm minimum.

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10) Coagulant aid (Poly electrolyte) Preparation tank: Each tank shall be sized for holding coagulant for minimum 12 hours requirement of all the clarifiers operating at design capacity and a design dosage rate of 2 ppm minimum.

11) $FeCl_3$ (35–45 % conc.) Preparation & dosing system consisting of preparation tanks, agitators (SS-316), coagulant unloading and transfer pumps (2x100%) (1W+1S) dosing pumps (2x100%) (1W+1S) in case of PT-RO.

12) PAC unloading, Preparation & dosing system consisting of at least two (2) numbers of tanks, agitators (SS-316), unloading and transfer pumps (2x100%) (1W+1S) dosing pumps (2x100%) (1W+1S) etc.

13) Any other system/equipment required to meet the System requirement shall be provided.

B. CHEMICAL STORAGE & DOSING SYSTEM FOR RO PLANT

1) Bulk chemical storage of RO chemicals i.e. Coagulant aid, Anti-scalant and Anti-oxidant etc. shall be located at ground floor level. Storage area shall have suitable partitions, physical separations/segregations etc. for each chemical.

2) Bulk storage for Coagulant, acid and alkali shall be located outdoor near the chemical house building. Coagulant/Acid/Alkali unloading pumps and alkali transfer pumps shall be located near chemical storage. Spill containment wall (dyke) shall be provided around chemical storage area in such a way that any chemical spill, during unloading, breakage/failure of tanks etc. is isolated from adjoining area by providing dyke wall. The height of dyke wall shall be minimum 500 mm or to contain volume of biggest tank whichever is high.

3) The capacity of the Overhead (OST) Storage Tank shall meet the water requirement for backwashing and backwash flow for simultaneous backwash of one (1) number of gravity filter (both the sections) of Potable System and one (1) number gravity filter (both the sections) of DM/DM-RO and any other system as envisaged by the contractor.

4) Vehicular approach from plant roads shall be provided for easy unloading and handling of chemicals delivered to the plant. This facility shall be located such a way that chemical dosing pipelines to PT plant, DM plant, RO plant for waste water etc. are minimum.

5) Emergency safety showers with eye wash units shall be provided in the Chemical Storage Handling facility at strategic locations such as Acid/Alkali Storage area, outdoor Chemical storage area, Chlorination plant area and Chemical preparation & doing equipments area.

6)Any other system/equipments required to meet the System requirement shall be provided.

7)Layout of Chemical house and Chemical storage area shall be finalized during detailed engineering.

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2.07.00	**ACW & PT CHLORINATION** 1) Chlorine dosing shall be provided at aerators, stilling chambers of PT system. In addition, chlorine dosing shall also be provided in filtered water sumps of Potable water system. For controlling organics in Auxiliary circulating water system, Chlorine dosing shall be provided.
2.07.01	**ACW-CHLORINATION SYSTEM** 1) Design capacity of chlorinators shall meet requirement for Chlorine dozing for the total circulating water flow to maintain minimum 0.5 ppm free available residual throughout the treatment. 2) Number of chlorine water booster pumps shall be equal to the number of gas chlorinator and design flow of each pump shall be sized to suit the requirement of one chlorinator so that maximum allowable chlorine concentration is limited to 2500 ppm in chlorinated water. 3) The Chlorine toners shall be located in chlorination building or in a separate chlorine toner store building as the case may be.
2.07.02	**PT-CHLORINATION SYSTEM** 1) Design capacity of chlorinators shall meet requirement for Chlorine doze for the total circulating water flow to maintain minimum 0.5 ppm free available residual throughout the treatment. 2) Number of chlorine water booster pumps shall be equal to the number of gas chlorinator and design flow of each pump shall be sized to suit the requirement of one chlorinator so that maximum allowable chlorine concentration is limited to 2500 ppm in chlorinated water. 3) The Chlorine toners shall be located in chlorination building or in a separate chlorine toner store building as the case may be.
2.07.**03**	**PT & ACW CHLORINATION** 1) To handle the ton-container, two (2) number electrically operated monorail hoist of 2 tonne capacity along with load indicator of 2000 Kg shall be provided. 2) Safety equipments as recommended by Chlorine Institute-USA shall be provided. 3) All the equipment in the system shall be sized for absorption of one (1) tonner of chlorine liquid leaking out from a tonner within one (1) hour for common building. All the tonners shall have one (1) hood of FRP in two (2) halves as required for the system. 4) Chlorine leak sensors shall be provided for all the connected chlorine ton containers and in other leak prone areas as per system requirement.

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2.08.00 **OTHER DESIGN & CONSTRUCTION FEATURES**

1) All the metallic parts of equipments of Complete ~~Pre-treatment and~~ LET system, which are embedded in concrete or in contact with water, shall be painted with bitumastic heavy duty paint over a coat of primer with total thickness of 400 microns. All the other parts of the PT plant shall be painted with one coat of primer and three coats of chlorinated rubber paint and total thickness shall be 200 microns.

2) All the tanks shall be provided with vent, overflow, drain and sample connections. Outlet nozzle center line shall be kept at least 100 mm from the invert level of the chemical tanks/water retaining structures/tanks/sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures above the max. water level /overflow level as the case may be excluding the thickness of the slab/beam thickness if any.

2.08.01 The maximum support length in meters for MS pipe as follows

a)	PIPE DIA (MM)	1200	1000	800
b)	SPAN (METERS)	12	10	10

For pipe sizes less than 800 NB, span shall be provided as per ANSI B31.1

2.08.02 ~~The overflow & drains from the various chemical tanks and floor wash drains of chemical house building shall be led to sludge sump.~~

3.00.00 **CONTROL PHILOSOPHY OF WATER TREATMENT PLANT**

3.01.00 The control & operation of various systems described below is indicative only and the actual control & operation philosophy shall be finalized with during detailed engineering. However for all the systems, following basic process related interlocks, alarms /pre-warning signals shall be implemented in the control system as per system requirement.

a) Among the equipment, it shall be possible to select a specific pump or tank or sump for working/standby/ maintenance etc. through control system.

b) Permissive & Interlocks:

1) Starting & tripping of pumps with respect to liquid level in the respective sump/tanks or liquid pressure in the suction lines.

2) Starting & tripping of agitators with respect to liquid level in the respective sump/tanks.

3) Starting & tripping of pumps (which are provided with forced water lubrication) with respect to lubricating water flow (through low pressure/ low flow signal as the case may be).

4) Tripping of pumps when the discharge pressure is very high to avoid operation of the pump under shutoff head.

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5) Stopping/ tripping of equipment due to abnormal parameters related to safety of equipment like high vibration, very high bearing lubrication water (and /or oil) temperature to the drive/pumps, very high bearing temperature of the of pump/drive etc as applicable based on the recommendations of Equipment Supplier.

6) Automatic opening of the re-circulation valve to pre-set percentage, in case of failure of opening of pump(s) discharge valve to ensure minimum flow through the pump, as per the recommendation of manufacturer.

7) Automatic starting of standby pumps upon failure of starting of selected pump or tripping of running pump as the case may be.

c) Alarms /Signals

1) Abnormal parameters such as low & high level in tanks/sumps, high pressure at pump discharge, low header pressure, low lubrication water flow to pumps (provided with forced water lubrication system) etc.

2) Failure of starting of equipment such as pumps, blowers etc. upon start command.

3) Tripping of equipment due to protection logic.

In addition, the control system shall facilitate the operator to know the status of various equipment (Whether equipment is running or stopped or tripped etc, whether the equipment is selected for operation/ standby duty /maintenance mode etc as the case may be).

3.02.00 **SYSTEM OPERATION AND CONTROL PHILOSOPHY**

1) **CLARIFICATION PLANT**

~~The motor operated inlet control valve to clarifiers shall be regulated with respect to the water level in the clarified water storage tank.~~ A variable frequency drive (VFD) shall be provided for turbine/impeller drive of all the clarifiers to control the speed for varying the recirculation rate. The scrapper drives of clarifiers shall be interlocked with torque limit switches on the motors.

~~2) **CHEMICAL HOUSE**~~

1) All the pumps shall be interlocked with the level at sump/reservoir/tank for pumps start permissive as well as pump protection. Annunciation prior to trip shall also be provided.

2) Agitator can be started only when the level in the corresponding dosing tank is adequate. The agitator shall trip when the level in the dosing tank comes below a pre-defined set point.

3) Capacity of the metering pump shall be controllable from 10-100% continuously by adjusting the stroke length manually by a micro meter dial calibrated for 0–100% of pump capacity integral with the pump.

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4) Various annunciations related to low level of the chemical tanks shall be provided.

3.03.00 **SYSTEM OPERATION AND CONTROL PHILOSOPHY (FOR PT & CW CHLORINATION SYSTEM)**

1) In the event of leakage in chlorine tonner, the chlorine leak sensor shall sense the leakage and start the absorbent recirculation pump, blower and open the motorized/pneumatic damper at blower inlet along with audiovisual alarms.

2) In case of chlorine leakage in adjoining areas, such as chlorinator/evaporator rooms etc, the detectors provided in these areas shall sense the leak and give audio-visual alarms. The blower and pump shall then be started and the damper at blower shall be opened automatically. Essentially, the whole absorption unit shall be under vacuum as soon as the blowers are under operation. The absorbent recirculation pumps, however, are interlocked with a level transmitter in the caustic solution tank and will not start if the level of absorbent is low. In that case, the level transmitter will give an alarm. The leaked chlorine gas is brought to the absorption tower. In the absorption tower, leaked chlorine shall meet counter currently the caustic soda solution. The chlorine gas shall be neutralized in the tower and chlorine free air shall be released to the atmosphere.

4.00.00 **LIQUID EFFLUENT TREATMENT SYSTEM**

4.01.00 All liquid effluent emerging out of the power plant shall be collected and treated ~~(as required)~~ to meet the latest effluent norms of statutory authority.

A. ~~PT PLANT~~ CLARIFIER SLUDGE DISPOSAL SYSTEM

1) Two (2) number RCC sludge pit in two (2) sections to collect sludge from all the clarifiers of HRSCC, Lamella clarifiers/tube settlers & Oil Water Separator WS etc. shall be provided. Sludge pit shall be able to store the sludge generated in water treatment plant clarifiers and any other drain/effluent connected to this sump (in case envisaged). Sludge pit shall be provided with agitation by recirculation (jetting nozzles) system and air agitation system.

2) Air blowers (2x100%) shall be used for the air agitation system of the sludge pit to avoid settlement of solids. Sludge pumps (3x50%) (Vertical sump pumps) shall be provided to pump sludge to sludge thickener.

3) The thickener (1x100%) shall be provided for thickening of the sludge. The centrifuge/belt filter press (2x50%) shall be provided for dewatering the sludge coming out of preceding thickener.

B. FILTER BACK WASH WASTE DISPOSAL SYSTEM

1) One (1) number RCC Filter backwash waste collection pit in two (2) sections of shall be provided to collect the backwash water from all the filters. The filters backwash water of shall be collected and recycled back to the clarifiers.

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2) Backwash disposal pumps (2x100%) shall be provided. Each pump shall be capable of evacuating the capacity of complete pit within 1 hours.

C. WASTE SERVICE WATER TREATMENT SYSTEM

1) Service water effluents (after floor washing etc.), other plant effluents etc. having high-suspended solids require treatment for removal of total suspended solids (TSS). It is proposed to reuse/recycle waste service water after treatment by means of Waste Service Water Treatment System. The system broadly consists of Collection sumps, Tube settlers/Lamella clarifiers, oil skimmers, oil centrifuge, pumps, chemical storage, handling and dosing equipment etc.

2) One (1) number RCC waste service water sump (WSWS) in two (2) sections (each of 250 cum capacity minimum) shall be provided for collection of waste service water. Service water effluents from various areas shall be routed to this waste service water sump. Waste service water from the main plant area shall be terminated at a point as specified elsewhere. Further, from this terminal point, waste service water shall be led to the above waste service water sump (WSWS) with all the associated piping, valves etc. which shall be in contractor's scope.

3) Waste service water transfer pumps (3x50%) shall be installed in WSWS to pump waste service water to a set of Tube settlers/Lamella clarifiers.

4) Chemical dosing ($FeCl_3$ & lime) shall be provided for these Tube settlers/Lamella clarifiers in the chemical house. The treated water form Tube settlers/Lamella clarifiers shall be led to Treated/Service water tank & also to Central monitoring basin (CMB) either by gravity or pumping. Provision for clarified water shall also be kept in service water tank. Sludge from the tube settlers/lamella clarifiers shall also be led to the common sludge pit provided.

5) One (1) number of RCC Treated/Service water tank for collection of treated water shall be provided. Capacity of the tank shall be suitable for storing minimum 30 minutes of discharge from one tube settlers/lamella clarifiers. Service water transfer pumps shall be provided as specified elsewhere for plant service water network etc.

6) Suitable oil skimmers shall be provided in the waste service water sump so that oil impurities floating on the sump is skimmed and collected in a tank located over ground. Facility shall be provided to collect free oil from this sump to a MS oil drum of 200 litre capacity.

7) A Portable oil centrifuge (Trolley mounted) of suitable capacity shall be provided to collect and purify the oil of the Waste Service Water System for use in non-critical units for lubrication purpose or the same shall be disposed of.

D. TUBE SETTLER/ LAMELLA CLARIFIERS

1) Two (2) (2x100%) numbers of Lamella Clarifier/tube settlers of capacity to match with discharge capacity of working waste service water pumps shall be

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provided to treat the service water, plant water collected from different areas in the plant. Lamella Clarifier/tube settlers shall be provided with one (1) flash mixer and Flocculation Chamber (RCC construction) at its upstream. Flash mixer shall provide minimum one (1) minute storage at the design flow rate. The water from flash mixer shall flow to a flocculation chamber and from the bottom of flocculation chamber water shall flow to the Lamella Clarifier/tube settler by gravity. The flocculation chamber shall provide 10 minute (min.) storage at the design flow rate. Suitable mechanical stirrer driven by electric motor through speed reducing gearbox shall be provided in each flash mixer and flocculation chamber.

2) The Lamella Clarifiers/tube settlers units shall be designed with side water depth of 4 M minimum. The overall area of unit shall be based on an average flow velocity not more than 5 $m^3/hr/m^2$. The length of the plates through which the water flow shall not be less than 1.5 M. The plates shall be inclined by 50-80 deg. angle to the horizontal. The material of plates shall be UV inhibited virgin PVC. Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 5% of rated flow.

3) The tube settlers/Lamella Clarifiers shall be of RCC and of proven design. The tube settlers/ Lamella Clarifiers shall be circular/rectangular with distinct tube/plate separation zones, sludge thickener zone, clear water zone and oil skimming zone. The tube settler/Lamella Clarifiers shall be counter flow or cross flow type. Co-flow type units are not acceptable.

4) The tube settlers/Lamella Clarifiers shall employ positive removal system of consistent density, central sludge concentrating sump, water flushing nozzles etc. as per the standard design of manufacturer. Sludge removal system shall be designed to thicken the sludge to minimum 2% consistency before disposing from separator bottom. All the pipelines carrying the sludge shall be provided with suitable flushing connection. Angle of inclination of sludge hopper shall be minimum 55 deg. to horizontal plane for effective collection of sludge.

5) The tube settlers Lamella Clarifiers periphery shall have a walkway of sufficient width along-with hand-railing and access ladders for general inspection. However, the manual sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement.

6) Suitable sampling connections shall be provided for performance monitoring.

7) To remove settled particles from the plates/tubes suitable water jet arrangement shall be provided. Pumping and piping arrangement shall be separately provided for this purpose. The tube/ plates shall be easily accessible for the cleaning purpose. The tube pack/ plates shall be placed inside the separator such that these may be individually removed for maintenance even when separator is operating.

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8) Design Conditions for Lamella clarifiers/tube settlers:

	Inlet quality	Outlet quality
TSS	500 ppm (max)	10 ppm (max)
Oil content	50 ppm (max)	5 ppm (max)

E. COAL HANDLING PLANT RUN-OFF WATER TREATMENT SYSTEM

1) The drains from coal handling plant and coal stock pile area where coal is stored contain coal particles. Apart from this, the coal pile-runoff water during the rainstorm will also contain large quantity of coal particles. The drains emanating from Coal Handling Plant shall be routed to coal slurry settling (CSSP) ponds where coal particles shall be settled. After settling decanted water shall flow to the drain by gravity and also to the sump for transferring the same to coal handling plant for reuse. Dosing of Coagulant aid (Polyelectrolyte) solution from a set of coagulant aid storage tanks in the inlet channel of CSSP drain through gravity/pumping shall be provided. Suitable baffles shall be provided in the inlet channel to facilitate mixing of coagulant aid with the waste water before entry to CSSP. Provision shall be made to lead 100% of waste water flow (considering rain flow) to the settling ponds for settling. The decanted water shall be further pumped back to the to the CHP dust suppression in Coal Handling Plant for re-use.

2) Coal handling plant run-off waste water shall be collected in minimum four (4) numbers of Coal slurry settling ponds, treated and decanted water shall be recycled/reused in Coal handling plant suitably by using Coal decanted water pumps (2x100%). Further, Clarifier feed pumps (4x25%), stilling chambers (2), inlet chambers (2) and reactor clarifiers (2) of RCC construction, RCC channels, distribution chamber etc. of required capacity shall be provided to receive excess storm water from coal slurry settling ponds and discharge the treated supernatant water to storm water drain. Lime, alum and suitable synthetic flo-culent dosing shall also be provided to increase the settling rate suspended solids. The pH of treated supernatant water is expected to be acidic in nature (pH-2.8-7.8) and same shall be neutralized prior to discharge in storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc. shall be provided. The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) for dried coal particles to be reused. Suitable storage facilities under shed shall be provided for the various chemicals.

3) Design settling velocity of the coal particles shall be maximum 5 m/hr.

4) The settling ponds shall be designed to take care of coal stack yard runoff water in storm water conditions. Interconnection shall be provided between the ponds such that flexibility of selecting any pond remains.

5) CSSP shall be designed considering rainstorm condition. However, the capacity of each pond of CSSP shall be not be less than 1000 cum/hr.

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6) The exit for run-off water from the settling pond shall be such that the short-circuiting of water is avoided. For this purpose, water shall be allowed to traverse under a breast wall located about 5 mtr. ahead of outlet side of the pond.

7) Overflow water from coal slurry settling pond would be led to a sump. The decanted waste water collected in secondary pond shall be pumped for re-use/recycling.

8) From local grade level, adequate steps/stairs to be provided in coal settling pond for taking out settled coal slurry manually from the pond.

9) Suitable Coagulant-aid (Polyelectrolyte) may be used as an aid to coagulation in coal settling ponds. Bypass arrangement before settling pond & after overflow collection sump during rainfall shall also be provided.

10) An inlet distribution chamber of width 1.2 M (min.) and length equal to width of each pond for each CSSP pond shall be provided for proper mixing of effluents before waste water entry to all the ponds. Over flow level of CSSP shall be less than or equal to invert level of inlet channel of CSSP.

F. CENTRAL EFFLUENT MONITORING BASIN (CMB)

1) One (1) number (in 2 sections) CMB of RCC construction shall be provided to receive treated water of Lamella Clarifiers/tube settlers, excess CW system blow down water, Regeneration waste water from the N-pits of DM Plant and any other effluents as envisaged by the bidder. Sizing of each compartment of the basin will be such that enough dilution water is stored to keep the TDS and other parameters of the mixed effluent below the permissible limit. However, the capacity of each compartment shall be equivalent to minimum 30 minutes flow to the CMB. CMB operation shall be designed in such a way that one section of the pit receive the plant effluent etc. and other section discharge/recirculate the effluent after proper mixing. Combined effluent from CMB shall be led to waste water RO plant by (2x100%) Waste water RO effluent pumps (1W+1S).

2) Final effluent quality monitoring station with instruments such as pH meter, turbidity meter, flow meter, instrument for TDS measurement (conductivity meter) etc. as shown in the tender drawing shall be provided. Any other instruments as prescribed by SPCB/CPCB to meet statutory norms shall also be provided by the bidder. Suitable sampling connections shall be located near Central effluent monitoring basin.

G. REVERSE OSMOSIS PLANT FOR WASTE WATER

A UF+RO Plant for waste water treatment (Design net capacity of RO permeate (minimum) -50 Cum/h) shall be envisaged to teat waste water like excess CW blowdown, treated service water from Lamella Clarifiers/tube settlers, DM plant effluents etc. from CMB. The plant shall be complete with Pre-treatment system like Clarifier, Gravity sand filter etc. Ultrafiltration skid with self-cleaning strainers at inlet, One(1) number of UF permeate-cum-back

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wash water storage tank, UF permeate transfer pumps, Cartridge type filters, associated pumps, blowers, chemical storage & dosing system etc., RO skid consisting of High pressure pumps, RO Streams/trains module rack assemblies, one (1) number of RO permeate water storage tank, sampling facilities and automatically operated reject control valves, piping, fittings etc.

1) Complete chemical storage & dosing system for Pre-treatment, UF&RO system, chemical cleaning and Flushing system for UF & RO system comprising of tanks and pumps etc. shall be envisaged.

2) The sludge sump/pit, N-pit, Backwashing sump/pit, chemical storage and dosing system for Waste water RO plant shall be separately designed and envisaged as per the system requirement. If Waste water RO facilities are located in WTP area, common facilities for Waste water RO plant & WTP may be provided. However, in such case the capacity of the various facilities of Waste water RO plant so designed shall be added to the capacities of sludge sump/pit, N-pit, Backwashing sump/pit, chemical storage and dosing system of WTP area described above in order to arrive at the final capacities of the common systems.

3) RO Permeate-transfer pumps (2x100%) shall be provided to recycle RO permeate to CT basin, DM/RO plant. RO Reject water shall be Recycled/reused to Coal handling plant and any other system suitably etc.

5.00.00 **TECHNICAL REQUIREMENTS OF DEMINERALISATION PLANT**

5.01.00 **DM PLANT (ION EXCHANGE DEMINERALISATION PLANT)**

1) Each stream of DM plant (Ion Exchange process) shall comprise of Activated carbon filter, Weak acid Cation exchanger unit, Strong acid Cation exchanger unit, Degasser system comprising of Degasser Tower, Degasser storage tank, Air Blowers (2x100%) per degasser tower, Weak base Anion exchanger unit, Strong base Anion exchanger unit, Mixed bed unit along with air blowers (2x100%) with drives, required accessories etc. Degassed water transfer pumps (3x100%) shall be provided.

2) Regeneration facility shall comprise of Acid and Alkali bulk Storage facility, Chemical unloading pumps, Alkali & Acid preparation/measuring tanks, Chemical Dosing system Regeneration pumps etc. shall be provided as per follows:

   a) Bulk acid storage tank (HCl-30-33% Conc.): Minimum three (3) numbers to hold one (1) month requirement of acid for regeneration of all operating DM streams operated at its rated capacity, with specified service cycle, regeneration period and using guaranteed chemical consumption plus any other requirements as envisaged by the contractor to be met through these tanks.

   b) Bulk Alkali storage tank (NaOH 48% Conc.): Minimum two (2) numbers to hold one (1) month requirement of alkali required for regeneration of all operating DM streams operated at its rated capacity, with specified

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service cycle, regeneration period and using guaranteed chemical consumption plus any other requirements as envisaged by the contractor to be met through these tanks.

c) Acid unloading pumps, Alkali unloading pumps, Alkali transfer cum recirculation Pumps shall be provided.

d) Two (2) Acid Measuring Tanks shall be provided with effective capacity to hold adequate chemical for 125% of one (1) regeneration of one (1) DM Stream (both Cation & Mixed bed).

e) Two (2) Alkali Day Tanks shall be provided with effective capacity to hold adequate chemical for 125% of one (1) regeneration of one (1) DM Stream (both Cation & Mixed bed).

f) Two (2) Alkali Preparation tanks each of effective capacity of 5 Cu.m and One (1) number Alkali Diluent Water Heating Tank of effective Capacity of 10 Cu.m shall be provided.

g) Three (3) numbers of Degassed Water Pumps (3x100%) with gross capacity of each DM stream (minimum) and Two (2) numbers of DM Regeneration pumps (2x100%) (1W+1S) shall be provided.

h) In addition to regeneration system, a set of Brine preparation tank (1) and brine transfer pumps (2x100%) for pumping brine solution to Anion exchanger vessels to facilitate removal of organics as and when required shall be provided.

i) Neutralizing waste disposal system (DM plant)- All DM plant (Ion Exchange/RO) effluent drains shall be connected to one (1) number of RCC Neutralization pit (in two (2) sections) with acid/alkali resistant lining. Each section of the pit shall hold 150% of waste water generated during regeneration of UF, RO & MB exchanger/one (1) stream of DM Plant or 150 Cu.M whichever is higher. Recycling/disposal pumps (3x100%) shall be provided, each pump capable of evacuating the capacity of each section of the pit within 3 hours.

j) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led to DM clarifier.

k) First fill of filter media for AC filters, First fill of resins for all Ion Exchange units to be provided.

OTHER DESIGN & CONSTRUCTION FEATURES

1) All the vessel internals of activated carbon filters, Ion Exchange units and Degasser units such as inlet distributor, regenerant distributor, under drain system etc. shall be of proven design.

2) The valves under automatic operation of ETP Plant shall be operated pneumatically by diaphragm actuator. Valves shall be spring to close or spring to open or double acting type as may be required by process

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consideration. The valves on effluent outlet as well as regenerant inlet of filters and ion-exchangers shall be of spring to close (Air to open) type only. Limit switches shall be provided for all the valves under automatic operation.

3) In case strainer-on-plate design is used for under drain system, additional manhole shall be provided to give access below the bed plate for all units of filters, Ion Exchange Units etc.

4) All valves used with vessels shall be suitably arranged in the front in accessible position, for manual operation in case of emergency.

5) All demineralising streams shall be designed to run continuously at its rated capacity and simultaneously under parallel operation.

6) Activated Carbon Filters (ACF)

a) Design and Fabrication of the vessel should be according to IS: 2825 or equivalent.

b) Maximum velocity of filtration shall be 15 m/hr at design capacity.

c) The activated carbon shall meet the following requirements:

(i) Total surface area (m^2/g) : Not less than 850.

(ii) Particle density (wetted in water) g/cc : 1.3-1.4

d) The selected Activated Carbon Filter (ACF) shall be able to operate continuously for a period not less than three years without any regeneration / activation.

e) Suitable (at least 75%) free board shall be provided over the filtering medium below the backwash outlet nozzle and in straight portion of vessel to facilitate backwashing.

f) Each filter shall be provided with AC filter media trap in effluent line. Media trap shall be provided on backwash outlet line also.

5.02.00 **ION EXCHANGE UNITS**

1) Design and Fabrication of the vessels should be according to IS : 2825 or equivalent.

2) Material of construction shall be mild steel with rubber lining (MSRL) and rubber covered (RC).

3) Under drainage system shall be header lateral or strainer-on-plate type. In case of header lateral system, header shall be mild steel "rubber lined inside and rubber covered outside" (MSRL & RC) and lateral of polypropylene.

4) For Mixed-Bed Exchanger, separate distributor shall be provided for influent and regenerant entry. The influent and alkali regenerant distributor and acid regenerant distributor shall be MSRL & RC. The interface collector & distributor shall be of suitable acid/alkali resistant material. The under

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drain collector system shall be header lateral or strainer-on-plate type and shall be adequately designed to ensure uniform distribution of flow.

5) The regenerant distributor and middle collector shall be mild steel rubber lined inside and rubber covered outside. All internal studs /nuts/washers shall be of AISI 304 L for alkali service and Hastelloy-B for acid service.

6) At least 100% free board shall be provided over resin bed below the backwash outlet nozzle and in straight portion of vessel to allow for expansion during backwashing and for addition of extra resin, if required.

7) Each exchanger unit shall be provided with resin traps on treated water outlet line. Resin traps shall also be provided both on the backwash and regenerant outlet lines.

5.03.00 **SURFACE FLOW RATE FOR ION–EXCHANGERS**

The following shall be maximum surface flow rates for the various Ion-Exchangers at the design capacity.

i) Cation unit – 35 $m^3/hr/m^2$ (for both weak and strong Cation)

ii) Anion unit – 35 $m^3/hr/m^2$ (for both weak and strong Anion)

iii) Mixed bed unit – 40 $m^3/hr/m^2$.

1) In case the contractor offers both weak and strong Ion-exchange units (for Cation and/or Anion unit), the surface flow rate for the strong ion exchange unit(s) only may be increased as indicated below, if contractor has adequate experience of designing Demineralisation plants of such higher surface flow rate .

Maximum surface flow rate:-

i) Strong Cation unit – 40 $m^3/hr/m^2$.

ii) Strong Anion unit – 40 $m^3/hr/m^2$.

5.04.00 **REGENERATION SYSTEM**

1) The ion exchange resin shall be regenerated by employing optimum regeneration level to prevent leakage of ions. Cation resins shall be regenerated by hydrochloric acid (30-33% w/v technical grade IS: 265) and anion resins by sodium hydroxide (48% w/v rayon grade in flakes or lye form as per IS: 252).

2) Regeneration system should be designed such that AC filter, cation, anion and mixed bed units of a particular stream can be regenerated simultaneously/ separately at a time.

3) For calculation of anion capacity and silica leakage the temperature of alkali regenerant shall be taken as 25 deg.C. Co-current or counter-current regeneration technique shall be adopted provided the same technique of regeneration was adopted in other plants executed by the contractor. The chemical consumption figures must be supported by relevant published

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data such as performance of the resin system and /or actual field performances of plants using a similar technique, indicating the quantity of chemicals required for regeneration, in particular, besides other parameters.

4) The process calculation shall be furnished indicating the various steps of regeneration, regeneration level employed, total and used exchange capacity of resins in various exchangers, resin quantity provided in ion exchange vessel etc. The relevant resin literature & curves indicating various parameters and exchange capacity and regeneration levels selected shall also be furnished during detailed engineering.

5) Regeneration facilities offered shall be complete with acid/alkali measuring tanks, ejectors for dosing of chemicals.

6) For heating of alkali diluent water, 2x50% electrical heating coil in a tank of mild steel rubber lined construction shall be provided. Design and fabrication of the tank should be according to technical specification for Pressure and Storage vessel. The tank shall be sized based on 125% of the regeneration water requirement of one anion and one mixed bed unit

7) The heaters shall be sized for heating the water from a minimum temperature of 15 deg. C to such a temperature that a maximum temperature 50°C can be achieved at the outlet of Alkali ejector. The duration of filling and heating the tank shall not be more than four hours.

5.05.00 **EXCHANGE RESIN**

1) Cation and anion resin shall be of reputed make and must have been in use in demineralising plants capable of producing water of quality as specified or better, for a period of not less than three (3) years.

2) The cation exchanger resin used in the strong cation unit and mixed bed exchanger shall be strongly acidic, high capacity polystyrene resin in the bead form.

3) The anion exchanger resin used in strong anion unit & mixed bed shall be strongly basic, high capacity resin (Type-I) in bead form. The anion resin shall be able to withstand a temperature of 60 deg. C (minimum) continuously. Type-II anion resin shall not be accepted. Strong Base Anion resin (or weak base Anion in case of hookup) shall be MACROPOROUS type only.

4) Weak & strong resins may be regenerated in thoroughfare. Weak and strong resins contained in same vessel will not be accepted.

5) DM water chains shall be designed in such a way that any chain can be regenerated without the necessity of other chain being put into operation.

5.06.00 **WASTE WATER NEUTRALIZING ARRANGEMENT (DM plant)**

1) The demineralising plant shall be designed in such a way that the regenerant effluent is self neutralising. Provision shall however be made to

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dose acid, alkali and lime to neutralise the effluent, whenever required. One (1) no. of twin compartment RCC pit for waste neutralization (N-pit) shall be provided. Effluent disposal pumps shall be provided for recirculation as well as disposal of waste.

2) Suitable proven agitation system (e.g. air agitation/venturi mixing etc.) shall be provided for proper mixing and maintaining uniform pH value of the waste water in addition to recirculation system.

5.07.00 **CONTROL & OPERATION OF THE DM PLANT**

1) The control & operation of various systems described below is indicative only and the actual control & operation philosophy shall be finalized with during detailed engineering.

2) Actual logic shall be built in the control system during detailed engineering. Operation of the complete DM Plant (both Service cycle & regeneration cycle) for all streams shall be through the control system.

3) Only basic type of control required is specified. The Contractor has to submit the complete details of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, drives/instrument list etc.

4)The sequence startup mode shall be of the following types

i) Automatic Mode:-In this mode of operation, the sequence shall progress without involving any action from the operator. The sequence start/stop command shall be issued from the LVS/OWS.

ii) Semi-Automatic Mode:-In this mode of operation, once the sequence is initialized, the step progressing shall be displayed on the LVS/OWS. But the step execution command shall be prevented and shall be sent by the operator via the mouse. It shall be possible to bypass and/ or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled because of defective switching device, etc., while the plant condition is satisfactory. All the criteria bypassed shall be logged and displayed. It shall be possible to put the system on the Auto-mode after operating it on semi-automatic mode for some steps or vice-versa, without disturbance to the sequence operation.

iii) Operator Guide Mode/Test Mode:- It shall be possible to use the sequential control in operator guide mode/ test mode i.e. the complete system runs and receives input from the plant and the individual push button stations (where provided)/ mouse but its command output is blocked. The whole program in this case shall run in manual mode. This mode shall allow the operator to practice manual operation using step and criteria indications. The actual protection should remain valid during this mode of operation also.

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5) Complete DM Plant operation shall be through mimics on OWS/LVS. The mimics shall indicate the operating status of different filters, exchange units, pumps, tanks, valves, blowers etc. Colour coding, (as per ENGINEER'S standard coding system which will be furnished) shall be used to differentiate lines for different service such as normal water line, backwash line, rinse line, acid alkali line etc.

6) The system shall have necessary safety system, locking system and manual emergency system. The Safety system for any sequence/step shall check the opening of the required valves and closure of remaining valves of the plant to avoid mal operation. During automatic sequential operation, if any pre-requisite criteria is not fulfilled or is missing for a pre-determined time interval, the steps should not proceed further and an alarm shall be annunciated to let the operator know that the system is blocked.

7) In case of control supply failure, valves of the stream being regenerated shall close automatically and on restoration of supply, further sequence of regeneration shall proceed through operator initiated command.

8) In case of failure of control system, the DM plant valves shall be operated manually by means of manual operator of solenoid valves (as well as by hand wheel of valves) locally.

9) Acid and alkali unloading pumps, agitators of alkali preparation tanks & day tanks and alkali transfer pumps shall have provisions of local start also.

10) Complete stream shall be isolated automatically from SERVICE in case any of the following take place and an alarm displayed.

11) Differential conductivity of the effluent is less or totalised flow and sodium leakage from the cation is high.

12) Conductivity of the effluent or totalised flows from anion is high.

13) Conductivity or silica content of the effluent or totalised flow from mixed bed is high.

14) The operation of alkali/acid inlet valves at ejectors shall be interlocked with the availability of dilution water in the respective ejectors.

15) Common conductivity meter shall be employed for measuring conductivity in the effluent line and rinse lines for anion and mixed bed exchangers. During rinsing of anion and mixed bed unit, the respective analyzer shall be connected to rinse line automatically, in the end of the rinse cycle.

16) During rinsing of mixed bed unit, the analyzer of silica shall automatically be connected to the stream which is under regeneration to ascertain the completion of rinsing operation.

17) Only one stream shall be regenerated at a time. However, all the streams can be put to service simultaneously.

18) The alkali diluent heater shall be controlled by measuring the temperature of water in the heater.

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19) For all the pumps, blowers etc. which form part of the automatic operation, facilities through control system shall be provided for Auto/remote manual/Local mode selection wherever specified. Wherever standby equipments are provided, selection of the same shall be possible from the control system. The selected standby equipments shall start automatically in case of failure of working equipment. For, other drives which are not involved in continuous running or automatic operation, facilities through control system shall be provided for remote/local selection.

20) The agitators of the alkali tanks shall be interlocked with the required level in the respective tanks.

21) All the pumps shall be interlocked with the required level in the tanks.

5.07.01 **BACKWASH PIT AND PUMPING SCHEME**

At a specific water level in the sump, selected pump(s) shall start and backwash waste water shall be recycled back to the clarifiers. Upon reaching predetermined low level, one of the operating pumps shall be stopped and further reduction in level shall result into stoppage of all the operating pumps. The pit level shall be available to operator and in case of very high level, the operator shall be alerted to avoid starting of backwash/rinse operation so that the pit do not overflow.

6.00.00 **NEUTRALISATION PIT AND PUMPING SCHEME**

1) At a specific water level in the sump, selected pump (s) shall start and backwash waste water shall be recycled back to the pit and after achieving desired pH level, the waste water shall be pumped out to CMB. Upon reaching predetermined low level, operating pumps shall be stopped and further reduction in level shall result into stoppage of all the operating pumps.

2) The pit(s) level status shall be available to operator and in case of very high level; the operator shall be alerted to avoid starting of regeneration operation so that the pits do not overflow.

7.00.00 **DM PLANT (RO BASED PLANT)**

1) Complete UF+RO+MB combination Plant (Skid mounted) shall comprise of UF skids (2x50%), UF permeate water tanks, automatic type simplex strainers, UF permeate transfer pumps (2W+1S), UF backwash pumps (2x100%), CEB and CIP system complete with tanks and dosing system, micron cartridge filters (3x50%), RO High pressure pumps (3x50%), Complete skid mounted RO blocks (2W+1S) (3x50%), Degasser tower(s), Degassed/RO permeate water storage tanks, RO permeate transfer pumps (2W+1S), RO chemical dosing system consisting of anti-oxidant dosing tanks & pumps, anti-scalant dosing tanks & pumps, RO Chemical cleaning skid (CIP), Mixed bed (MB) exchangers (3x50%) along with regeneration system including acid/alkali unloading Pumps (2x100%), Acid/Alkali storage tanks (2), Acid measuring tanks (2) & Acid/Alkali dosing pumps (2x100%),

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APPLICABLE FOR LIQUID EFFLUENT TREATMENT (LET/ETP SYSTM)

2) For design purpose, minimum feed pressure at inlet of UF shall be considered as 2.5 Kg/cm^2 with feed temperature 10-35 Deg C,

3) CEB system for UF shall be decided by the contractor. However, minimum two (2) nos. of dozing tanks shall be provided along with 2 (2x100%) (1W+1S) dosing pumps for the chemicals envisaged for the system.

7.01.00 **REVERSE OSMOSIS SYSTEM**

1) Each RO stream shall be provided with a dedicated HP pump and one (1) HP pump shall be provided as a store stand-by. The HP pump shall be able to discharge reject against a backpressure without the need for additional pumping equipment. At the discharge side of the HP feed pump a pressure control valve shall be installed to regulate the feed pressure to the membrane assembly according to the salinity of the feed water. The HP pump shall be designed to operate in the entire range of operation of the feed system.

2) Brine leaving the permeate outlet connection at a pressure close to the feed pressure shall be controlled by a flow control valve. The permeate water is discharged to product water system where it is treated for removal of excess CO_2, correction of pH, correction of alkalinity (for Potablisation, if applicable) etc. and stored.

3) Permeate shall be delivered to respective Degassifier thru suck-back arrangement (as applicable)

4) Cleaning and Flushing systems shall be provided for membrane protection. While the cleaning system facilitate cleaning of the fouled membranes and the flushing system flushes the membranes off high TDS water with low TDS water during shutdown operation.

5) Each RO train or stream shall be a self-contained section, with its own feed, brine and product flow control equipment, operable thru control system. Each train /stream shall be cleaned and treated separately, independent of other trains/streams production. Each block (membrane assembly unit) shall be provided with necessary valves and piping to facilitate block wise isolation, monitoring and cleaning facility.

6) A train/stream is composed of one or more blocks (membrane assembly unit) connected in parallel and each block comprise group of modules in parallel. Each RO module is basically cylindrical pressure vessel containing membrane elements. The term element means a single RO membrane element (permeators). Each block (membrane assembly unit) shall be provided with necessary valves and piping to facilitate block wise isolation, monitoring and cleaning facility.

The RO skid shall contain all necessary supports, fixings and clamps required to support the permeators, headers and related piping.

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7) Each stream shall be capable of operating either independently or in combination with the other ones. The streams shall be skid-mounted and be furnished complete with all headers and related piping, mounted on the skid. The skid shall contain all necessary supports, fixings and clamps required to support the permeators, headers and related piping. The skid shall be designed to provide ample room for servicing and monitoring the equipment.

8) The removal of a single permeator or a major piece of the equipment must be possible, without removing surrounding equipment. The isolation or removal of an individual permeator for testing or servicing shall be possible while the RO-train is in operation, by means of flexible, self-closing couplings.

9) Stream/train to be divided into certain number of equal blocks which independently can operate facilitating the following advantages:

   i) Repair/maintenance of permeators/pipes/valves and chemical cleaning in a particular block can be carried out without shutdown the whole stream.

   ii) For easier Performance monitoring of permeators, simpler fault identification to render permeators replacement activities easier.

10) Turn Down Capability- One or both the trains shall be operable as per requirement.

7.02.00 **RO MEMBRANE**

1) The Reverse osmosis membrane shall be Polyamide, spiral wound type. The membrane shall be non-telescopic, non-flexing and leak free. Diameter and length shall be as per manufacturer's standard. Average flux rate shall be less than 20 L/M^2h.

2) Number of Membrane (Block) per Train shall be two or more as per design. Number of Membranes per module shall be 6-8.

3) Fouling Allowance for design shall be considered as minimum 5% per year and salt passage increase is minimum 10% per year. End connectors shall be Victaulic coupling (SS) or approved equivalent.

4) The RO membranes shall be supplied from manufacturers well experienced in RO plant design (Brackish water RO) of train/stream capacity comparable that of this project. This shall be demonstrated by the contractor with adequate references of his selected membrane manufacturer(s). Contractor shall furnish design calculation of the RO plant by his preferred manufacturer(s).

5) The membrane system process design shall be provided by the Contractor and such calculation shall be vetted by the membrane manufacturer. The process design shall take into consideration specified fouling allowance and salt passage during the guaranteed (specified) life of the membrane. The process design shall adopt to produce the specified capacity of permeate

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with an average flux rate as specified. Further, all the calculations of RO elements shall be justified with the software projections. The membranes shall be supplied from one of the following membrane manufacturers:

DowChemicals-Filmtec/Hydronautics/KOCH/Toray/GE/Approved Equivalent.

6) The average flux rate shall be calculated on the basis of effective membrane area considering standard length & diameter element. Contractor shall ensure that standard Length & diameter of membrane used for design should be available at least three of the above mentioned manufacturers so that during operation stage of the plant, employer may install membranes from other manufacturers. Further, during detail engineering, the contractor shall furnish design calculation from at least three membrane manufacturers to confirm the availability & compatibility of alternate membranes. The design calculation shall furnish data regarding change in parameters of the RO plant such as design net output, recovery, energy consumption etc. in case such alternate membranes are used later by Employer in the Membrane Assembly supplied by Contractor.

7.03.00 **PRESSURE VESSELS**

1) Pressure vessels shall have a diameter and length so as to contain required numbers standard diameter, standard length spiral wound elements.

2) Materials to be selected shall meet the following minimum requirements:

a.	MembranesAs per manufacturer
b.	Pressure vesselsPP or proven material as per manufacturer
c. End caps or plates:	Non-metallic material of proven Reliability may also be used subject to approval; Fliberglass epoxy as minimum requirement
d. Segmental rings, to	Corrosion resistant material conforming
Connectors	SS-316 L or equivalent

3) Details of the design, fabrication, and testing requirements for the pressure vessels shall be in accordance with ASME Section X to allow a code stamp or meet the minimum requirements of ASME Section X.

4) Vessels shall be designed to allow membrane elements to be connected to a permeate port at both ends of the vessel so that permeate can be taken from either ends. The unused pressure vessel permeate port shall be available and piped to permit probing. End closures shall be approved for use in pressure vessel construction to the code requirements.

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7.04.00 **HIGH PRESSURE PUMP**

1) The HP feed pump (SS-316) shall be of a centrifugal type. The high-pressure pump shall be designed not to introduce flow and/or pressure pulsation in the feed or brine stream. The reverse osmosis system has to be operated with fluctuating feed salinity and feed temperature. An appropriate regulation of the feed pressure for each reverse osmosis train separately by a corresponding design of the high-pressure pumps with VFD and automatic feed pressure control is required.

2) Energy recovery units permeate booster pumps and associated system may be provided as required. The Contractor shall take care of the concentrate back pressure requirement at downstream of the energy recovery unit as applicable.

3) Selection of parameters (Capacity & Head) of HP Pump, its drive shall take into account requirements of membrane manufacturer and shall be designed to deliver required parameters throughout the design life of membrane. The power consumption to be guaranteed for the HP Pump shall be based on its parameters at the end of guaranteed membrane life.

4) The contractor shall take care of the concentrate back pressure requirement at downstream of the energy recovery unit.

5) The complete unit shall include the pump, motor drive and the lubrication system on a common base plate.

7.05.00 **CLEAN- IN- PLACE SYSTEM**

1) The cleaning system shall be designed for cleaning and sterilizing of in minimum one train of the RO system separately.

2) The RO-plant shall be provided with fixed pipe connections. The flexible couplings from the cleaning pipework to the RO-trains shall be reached from the ground level or sufficient and safe facilities for easy handling of the coupling of the permanently installed cleaning pipework at the RO-racks and the flexible cleaning pipework of the cleaning equipment is to be provided.

3) The cleaning system shall be of skid-mounted type and comprise all necessary equipment for control of the necessary flow rate and pressure during cleaning and enable the recycling of brine and product to the cleaning tank, or alternately, the discharge of these two effluents during the cleaning procedure.

4) The tank volume shall be sufficient to clean in minimum one RO train/stream by utilization of only a single batch of cleaning solution.

5) Sizing considerations also shall include the minimization of batch temperature and variation in solution concentration caused by blending cleaning solution with displaced feedwater contained in the RO permeators.

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6) One set cartridge filter (3 micron) shall be provided in the cleaning system to prevent the reintroduction of any insoluble material into the membranes. A temperature control system shall be provided to prevent re-circulated fluid temperature from exceeding the maximum recommended operating temperature of the membrane.

7) The cleaning tanks shall be provided with level measurement for safe operation ie tripping of cleaning system pumps under low water level.

8) For easy, safe and efficient handling of chemicals, a service platform shall be provided if necessary. Sufficient venting equipment also is to be included in the scope of delivery. Sufficient safeguard provisions shall be included, to prevent the accidental over pressurization of cleaning system piping due to inherent interconnections with high pressure RO feed and brine piping.

9) Provisions must be made for the neutralization and disposal of chemical cleaning waste via the brine reject.

10) Two (2x100%) (1W+1S) Chemical cleaning pumps (SS-316), one (1) Cartridge filter (Casing SS-316) shall be provided.

7.06.00 **FLUSHING SYSTEM**

1) Flushing system consisting flushing pumps (2x100%)(1W+1S) (SS-316) shall be provided to enable flush-out of the RO unit stream including HP pump with Low TDS permeate water during shut down of the stream.

2) During flushing the rinse water discharge from the permeator shall be drained into the reject water tanks. The flushing water feed pipeline and the drain lines shall be designed for the high flow rate that is expected during flushing.

3) The flushing water feed lines shall be connected upstream of the each HP pump inlet and the flushing feed line shall be provided with a motorized flush feed valve. The shutdown program shall automatically initiate the flushing feed valve to open and flush the RO train when required.

7.07.00 **SAMPLE PANEL**

a) Each RO unit/train shall be fitted with a fiberglass sample board, which shall be mounted adjacent to the unit. The panel and supports shall have all fiberglass constructions with a minimum 8” wide trough under the sample cocks with 1” PVC drainpipe routed to the trenches. Sample tubing shall be black tubing. The sample panel shall use ¼” SS sample cocks to sample the following

   i) Feed (locate on common manifold)

   ii) Concentrate (locate on common manifold)

   iii) Permeate (locate on common manifold)

   iv) Permeate from each pressure vessel

b) Sample valves shall be SS white snap-action valves and shall be fitted with

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plastic nozzles tubes as approved by the engineer.

7.08.00 **DEGASSER SYSTEM**

1) Degasser tower shall be designed to reduce dissolved Carbon-dioxide (CO_2) in treated water. Fill Material of degasser tower shall be Polypropylene or equivalent. Blowers shall be provided to remove CO_2 from water. Degasser tower shall be provided with storage tank to store degassed water. Degasser tower & degassed water tank shall be internally rubber lined of minimum thickness of 4.5 mm and externally painted with epoxy as defined elsewhere. Degassed water pumps shall be provided to supply water to the downstream exchangers in the chain.

7.09.00 **MIXED BED (MB) POLISHER UNITS**

1) Design surface flow rate at design flow shall not be more than 35 $m^3/m^2/hr$

2) Resins-strongly acidic and strongly basic Type-I, both the resin shall be of high capacity polystyrene resins in bead form. Total resin bed depth shall be 1.0 M (min)

3) Two (2x100%) Air-blowers for mixed beds shall be provided.

4) Mixed Bed shall be regenerated after minimum 24 hours of operation followed by regeneration period not exceeding 4 hours.

8.00.00 **UF & RO SYSTEM (CONTROL & OPERATION PHILOSOPHY)**

1) It is not the intent to specify here the complete details of the control system. Basic type of controls required has been specified below. The contractor shall submit the complete detail of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions.

2) Normally drawl of product water (either raw water or DM water) requirement plant shall be from a single tank while the other tanks shall be in filling mode from the RO streams/trains as the case may be. Operation of pumps which draw water from the storage tanks shall be interlocked with the tank level and /or pressure at the suction header, high pressure at the discharge header as the case may be. The field instruments provided by Contractor along with tanks & suction header shall be used for implementation of such logic.

3) It shall be possible by the Operator one or more tanks for drawl mode and other for filling mode. In auto mode, the tank (s) under drawl mode shall switch over to filling mode at a pre-set level in tank and drawl for the plant shall be continued from the tanks which were under filling mode. Upon reaching high level in all the storage tanks, the running streams/trains shall be shut-down in sequence. Similarly the low level in all the tanks shall initiate starting of stream(s) in sequence which are under standby mode/stopped.

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4) **POST TREATMENT OF RO**

a) Water flow to degassers shall be interlocked with the level in RO Permeate Storage Tank as well as pH of permeate.

b) Degasser blowers operation shall be interlinked with the operation of associated degasser tower. The standby blower associated with the tower in operation shall come into operation in the event of failure of running blower.

c) The operation of pumps shall be interlocked with the level of the degassed water tank.

d) The performance of respective degasser shall be monitored thru measurement of conductivity & pH of product water.

5) **RO SYSTEM.**

a) RO plant shall be operated and controlled thru control system. All necessary field instruments, analyzers and controls shall be provided by Contractor. Facility for starting and stopping of pumps, selection of stream shall be provided in the control system.

b) The system shall provide the following:

i) Alarms for high permeate conductivity of each skid, Low pH of feed water, High pH of feed water, high feed water temperature, availability of chemical dosing system such as low level in dosing tanks, status of dosing pumps etc.

ii) Continuous monitoring for Feed temperature, Feed pH, conductivity of feed water & permeate, SDI of Feed water, pressure of Feed water, permeate & concentrate, flow of feed water, Permeate & concentrate, residual chlorine of feed water.

c) The HP pumps shall be operated thru control system. Start/ Stop of HP pump shall be interlocked with opening & closing of suction & discharge valves. The pump shall start with its discharge valve closed and on stop/trip command the discharge shall be interlocked to close before the pump stops. Low pressure in the pump suction and high pressure in the pump discharge shall raise an alarm and trip the pump.

d) The operation and control philosophy & instrumentation of Variable Frequency Drive (VFD) and Energy recovery units (ERU) (if applicable) shall be as per the recommendation of the manufacturer.

6) **PERMEATE TRANSFER PUMPS.**

The pump shall be provided with interlocks to trip the pump on Low suction level. The low-pressure signal from pressure transmitter in the discharge header shall start the standby pump, when the system is in auto mode.

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a) Motor drives provided with winding temperature measurement & bearing temperature shall sense high & very high temperature for alarm and tripping receptively thru control system.

b) The HP pumps and motor bearings shall be provided with vibration monitoring for measuring vibration levels and vibration “High” and “High-High” alarm shall be annunciated.

c) Additionally HP pump shall be tripped/shutdown under High conductivity in the RO permeate line, high pH in the Feed water line, high feed water temperature, low level in chemical dosing tank, high feed pressure, high differential pressure across permeators, high residual chlorine of feed water, high SDI in feed water and failure of flow control valve,

7) The following control and instrumentation shall be provided in each of the permeator assembly unit:

a) A pressure control valve on the pump discharge line to control feed pressure during operation, during start-up and control salinity during normal operation.

b) Flow control valve on the concentrate line to set the recovery and for ratio control.

c) Conductivity analyzer in permeate and concentrate line to sense, indicate of TDS & salt passage and to derive the recovery of the unit.

d) The RC analyzer signal shall activate an alarm and can used to shutdown the HP pump when chlorine is detected

e) A pressure element transmitter in the permeate line to measure, indicate pressure.

f) pH analyzer in permeate and concentrate lines to sense, indicate pH values.

g) Flow element/transmitter in the permeate line to measure, indicate and provide analysis flow in the permeate line and provide the control signal for the control valve in the concentrate line.

h) Flow element/transmitter in the feed line to measure feed flow.

i) Automatic drain valve/dump valve in the permeate line to provide permeate drain when the TDS in permeate exceed the design limits.

j) Automatic valves in the feed and concentrate lines to connect a clean-in-place and flushing system.

k) Differential pressure element/transmitter mounted with connection on the concentrate brine and feed line to measure, indicate pressure drop in the permeator i.e. to measure severity of fouling.

l) Local Pressure indicator in the feed, concentrate and the permeate