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KARNATAKA POWER CORPORATION LIMITED

(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP-1X370MW)
ZERO LIQUID DISCHARGE PLANT (ZLD)

ABSTRACT BID NOTIFICATION

No: KPCL/2018-19/PS/WORK_INDENT8374 **Date:27/02/2019**

Karnataka Power Corporation Limited invites bids through GOK e-procurement platform www.eproc.karnataka.gov.in from the qualified bidders for the following brief scope of work:

1.0 "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

2.0 Those who have not registered in e-procurement portal www.eproc.karanataka.gov.in may do so in order to participate in the bid.

3.0 The brief bid notification containing the pre-qualifying criteria for the bidders, EMD, Calendar of bid activities and other details can be accessed from e–procurement portal.

Further details can be had from:

Chief Engineer (Thermal Designs),
Karnataka Power Corporation Ltd.,
#22/23, Sudarshan Complex,
2nd Floor, Sheshadri Road,
BENGALURU - 560 009.
Tel: 080-22206223,

E-mail: cetd@karnatakapower.com
eemyccpp@gmail.com
zld.yccpp@gmail.com

Web site: www.karnatakapower.com

KARNATAKA POWER CORPORATION LIMITED

(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP-1X370MW)
ZERO LIQUID DISCHARGE PLANT (ZLD)

BRIEF BID NOTIFICATION

No: KPCL/2018-19/PS/WORK_INDENT8374 **Date:27/02/2019**

1.0 KARNATAKA POWER CORPORATION LIMITED invites bids through GOK e-procurement platform **www.eproc.karnataka.gov.in** from the qualified bidders for "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with UF-RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, Integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

BRIEF SCOPE OF WORK FOR ZERO LIQUID DISCHARGE PLANT (ZLD)

The scope of this enquiry covers the following:

"Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over with all civil, structural, mechanical, electrical, control & instrumentation works, Integrating ZLD scheme with main power plant and Essential Spares of ZLD plant comprising of the following facilities:

a) Pre-treatment and Tertiary treatment facilities which comprises of Flash mixer, HRSCC, Filter feed tank, Pressure sand filter, UF feed tank, UF system, RO feed tank, RO system, RO permeate tank, RO reject collection tank, Back wash treatment tank etc., to process the total waste water collected in the existing Central Monitoring Basin.
b) Zero Liquid discharge plant complete in all respect including Evaporator, Crystallizer, Salt Centrifuge system etc.
c) Chemical dosing facilities for pre-treatment, UF-RO system and ZLD system.
d) Sludge dewatering plant.

e) Service water / Make-up Water system.
f) Laying of piping to distribute recovered water from the ZLD system to CW Make-Up Water system.
g) Civil and Structural Works.
h) Extension of Power required for the ZLD plant from the existing 6.6kV switchgear.
i) Extension of Steam required for the plant from LP steam line of HRSG of main Power Plant.
j) Extension of Potable water and firefighting water from the nearest tapping point and distribution of the same inside/outside the ZLD plant.
k) Supply of Essential Spares.
l) Supply of Erection and Commissioning Spares.
m) Associated electricals (HT & LT switchgears, MCCs, Cables, Laying of cables etc.) and Controls & Instrumentation / Automation.
n) Firefighting facilities/ Fire detection & Alarm system.
o) Air Conditioning and Ventilation.
p) Hoisting and Material handling system.
q) Illumination facilities for the entire premises including roads.
r) Operation & Maintenance of plant and equipment on 24x7 basis for a period of one year after handing over / issue of Notice To Proceed (NTP) as the case may be. Consumables and Chemicals are in the scope of KPCL during O&M period.
s) Road connection / interconnection road from Network of Road in the ZLD plant interconnecting different buildings/ units and connection to nearest Road.
t) ZLD plant building/ Sludge drying plant/ RO plant building/ Chemical house comprising pump sets, filters, treatment plant, handling facilities, valves, pipe & fitting, along with associated electricals, instruments, material handling, Air conditioning/ Ventilation system for each buildings and control room / MCC room.
u) Office cum store, maintenance shed at ZLD plant with furniture and A/C facilities.
v) A mini Laboratory with testing facility for analysis of important parameters like pH, residual chlorine, conductivity etc. shall be provided with necessary equipment. All chemicals, consumables shall be in the scope of the bidder till handing over.
w) Facilities to hook up the required data of the ZLD system / water parameters with Pollution Control Board or any other statutory authority.
x) Statutory Clearances required for the successful establishment and operation of the ZLD Plant, if any.
y) Area drainage/storm water drainage system of complete ZLD Plant. The drainage, sewerage shall be connected to the nearest respective plant network/STP.
z) Fecal/sanitary sewer disposal from toilets/wash basin to nearest respective plant network/STP.
aa) Back wash water tank & waste water tank comprising pumps, handling equipment, valves, pipe & fitting along with associated electricals, controls & instruments.

bb) All necessary connections for hook up with KPCL system at specified Terminal points/nearest available network.

cc) Other miscellaneous systems required for completeness of work.

dd) ZLD Plant shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant will be deemed to be included under the scope of work of the Tenderer. Detailed scope of work for electro-mechanical, Control & Instrumentation, Automation, Civil, Architectural, Structural, Material Handling, Firefighting facilities, Air Conditioning and Ventilation etc. have been specified in the relevant chapters of this specification.

Scope of work given is only indicative. Detailed scope has been described in the bid document which is binding on all the bidders. Any other item not covered herein but essential for successful installation and commissioning of the system and integration of the system shall be included in the scope by the bidder.

1.0 INSTRUCTIONS REGARDING E-PROCURMENT.

a. The bid is to be submitted in the GOK e-procurement platform www.eproc.karnataka.gov.in system only.

b. Bidders, who have not registered in e-procurement portal, may do so by registering through web site www.eproc.karnataka.gov.in

c. The bidders can access and download bid documents on the web site, fill them and submit the completed bid documents into electronic tender on the website itself within the stipulated date. The blank bid documents can be accessed through e-procurement portal web site www.eproc.karnataka.gov.in

d. Bidders shall attach scanned copies of all the certificates pertaining to the Pre- qualification requirement as mentioned under "Minimum Qualification Requirements" clause. Whenever required, bidders shall furnish the original certificates to the KPCL authorities, failing which, the bidder will be disqualified.

e. Conditional bids, incomplete bids, bids without EMD, bids not properly uploaded and bids submitted late shall be rejected.

f. Bidders shall refrain from altering/modifying/revising the price bids after the date and time fixed for submission of bids in the calendar of events even though if it is accepted by the portal. Date and time stamp of the portal shall be final in deciding the time and date of submission of bid. Decision of the Corporation in this regard is final.

ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories.

2.0 MINIMUM QUALIFYING REQUIREMENTS:

The intending bidder shall satisfy the following minimum qualifying requirements.

The intending bidder should have Designed, Engineering, Manufactured/Supplied, Constructed, Erected and Commissioned.

a) Waste water pre-treatment plant with RO system of capacity not less than **75** Cum/hr.

and

b) Crystallizer cum Evaporator system & Salt Centrifuge with Mechanical vapour Recompression system (Zero Liquid Discharge plant) of capacity not less than **3** Cum/hr.

The bidder shall have executed the above works in any Power Plant/ Industrial Projects/ Water supply Board/ Municipal Corporation (including Civil works) in preceding **Five years** reckoned from last date for submission of bids and the same shall be satisfactorily and demonstrably performed continuously for a minimum period of **One year** as on last date for submission of bids.

As a proof of the above, the intending /Lead bidder and his consortium partner shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board etc. certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.

2.1 The intending bidder shall fulfill all the qualifying requirements as indicated in 2(a) and 2(b).

2.2 In case the bidder, as stated in para 2.1, does not fulfill all the minimum qualifying requirement as indicated in 2(a) and 2(b) but qualifies for the minimum qualifying requirements as mentioned in para 2(a) only, can participate in the bid with a consortium partner.

In such case:

2.2.1 The bidder who fulfills the minimum qualifying requirement as indicated in 2(a) shall be the **Lead bidder**.

2.2.2 The **Consortium Partner** shall fulfill the minimum qualifying requirement as indicated in 2(b) and the Proof of same shall be in the name of consortium partner only.

2.2.3 The number of partners in consortium including the lead bidder shall not be more than 2 (two).

2.3 The lead bidder and the consortium bidder shall enter into one single consortium agreement as per KPCL format covering the criteria 2(a) and 2(b) above and submit the same while submitting the bid.

2.4 The lead bidder shall be responsible for the overall execution of work.

2.5 In case, the lead bidder withdraws, the whole contract shall be considered cancelled and short closed and the balance work will be executed at the risk & cost of the bidders (lead bidder + consortium partner).

2.6 In case, the consortium partner backs out, such of the work/s handled by such consortium partner will be executed by the Lead bidder through alternate similar agency who satisfies respective minimum qualifying requirements for such works as applicable in a reasonable time without affecting contract completion period. If the Lead bidder fails to take remedial measure in this regard, then KPCL reserves right to withdraw such works and get executed at the risk and cost of the lead bidder.

2.7 The consortium partner shall separately submit SD equivalent to 1% of the total contract value directly to KPCL in the KPCL format in addition to the SD to be submitted by the lead bidder.

2.8 Credentials of works executed by consortium partner and lead bidder shall be submitted separately for their respective area of work executed by them. **The qualifying experience as claimed by the bidder (s) shall be filled up in the format enclosed.**

2.9 The intending bidder and his consortium partner shall not have been subject to forfeiture of EMD/foreclosure/termination of their contract in KPCL/government or any other utility/ blacklisting/ procedure initiated for blacklisting for participation in tender issued by KPCL or government or any other utility in India during the past 3 years.

3.0 **Financial Criteria**:

i. The bidder (as per para 2.1) in his name should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum annual financial turnover of Rs. **140.00 Crore**. As a proof, the bidder shall furnish Copies of audited P&L Account and audited balance sheet duly certified by a Chartered Accountant to establish annual turnover requirement stipulated above.

ii. In case of consortium bid, Lead bidder and consortium partner (as per para 2.2.1 & 2.2.2) in their names should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum annual financial turnover of **Rs.84.00 Crore** and **Rs. 56.00 Crore** respectively. As a proof, the bidders shall furnish Copies of audited P&L Account and audited balance sheet duly certified by a Chartered Accountant to establish annual turnover requirement stipulated above.

4.0 Notwithstanding anything stated above, KPCL reserves the right to assess the capability and capacity of the bidder and or consortium partners to perform the contract, should the circumstances warrant such assessment in the overall interest of the KPCL. If such an assessment calls for rejection of any or all bids, KPCL reserves right to reject any or all bids.

5.0 Any agency whose performance in the ongoing projects of KPCL is observed to be not satisfactory such agency shall be liable for rejection.

6.0 Following documentary evidence for the minimum qualifying requirements shall be up-Loaded.

i. As a proof of the above, the intending /Lead bidder and his consortium partner shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.

ii. For financial qualifying requirement, Copies of audited P&L Account / annual report/audited balance sheet duly certified by the Chartered Accountant to establish annual turnover requirement stipulated under para no. 3(i) or 3(ii) shall be submitted along with PF registration (Independent PF code), Income tax, PAN No, GST /Service tax Registration certificate, Labour certificate.

iii. Consortium agreement (as per KPCL format) between Lead bidder and consortium bidder.

iv. Scanned copy of the BG towards EMD.

v. Undertaking in the form of a notarized affidavit declaring that during the past 3 years:

(a) Their EMD has not been forfeited.
(b) None of their contracts have been terminated/foreclosed on account of their default in KPCL or elsewhere.
(c) They have not been blacklisted/subject to procedure initiated for blacklisting for participation in tender issued by KPCL or government or any other utility in India and would not attract terms and conditions relating to rejection of bids.

7.0 The qualifying requirement as claimed by the Bidder(s) shall be filled up in the format enclosed in section A5, Volume-I, Part-I of General Conditions of the Contract. Non submission of this format will make the bid liable for rejection.

8.0 **Consequent to implementation of GST the following shall be furnished by the bidder:**

8.1 Name, address along with the state name and GSTIN of the supplier.

8.2 Name, address along with the State Name and GSTIN or UIN.

8.3 Name and address of the recipient and the address of delivery along with the name of State and its code, if such recipient is unregistered and where the value of taxable supply is fifty thousand rupees or more.

8.4 Description of goods along with HSN code and services along with the SAC code.

8.5 Applicable GST i.e. CGST and SGST in case of local supply and IGST in case of inter-state supply. Applicable rate of GST also to be mentioned.

9.0 **DISQUALIFICATION OF BIDDERS**

9.1 Bidders whose contracts have been terminated/foreclosed by KPCL /Government or other utility in India or whose performance has not been satisfactory while executing the contracts for KPCL/ Government or other utility in India within the last Three (3) years are liable for disqualification. Bidder shall furnish the notarized undertaking as indicated in Annexure 4 of "Instruction to bidders".

9.2 Notwithstanding anything stated above, KPCL reserves the right to assess the capability and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the KPCL. If such an assessment calls for rejection of any or all bids, KPCL reserves the right to reject any or all bids.

9.3 Any agency whose performance in the ongoing projects of KPCL is observed to be not satisfactory, such agency shall be liable for rejection.

9.4 Corporation reserves the right to accept or reject any/ or all bids. However, reasons for rejection will be recorded as per KTPP act.

9.5 Part and incomplete bids/Telegraphic bids/bids not accompanied by EMD/belated bids will not be accepted.

10.0 Bids received from Bidders whose EMD has been Forfeited or contracts have been terminated or foreclosed on account of their Default in KPCL or elsewhere during the past 3 (Three) years will not be considered. The bidder shall give declaration that EMD has not been forfeited and none of his contracts have been terminated / foreclosed on account of their default in KPCL or elsewhere during the past 3 (Three) years.

11.0 The intending bidder shall quote in Indian Rupees only.

12.0 Bids duly filled in shall be submitted through e-procurement portal only. The bids shall be submitted in two cover format.

i. Cover-I shall contain EMD, Technical and Commercial bid documents to establish qualifying requirements, schedule F3 (Schedule of Guaranteed parameters) and will be opened first, document furnished will be scrutinized to determine the bidders meeting qualifying criteria. Bidder shall not enclose price schedule with Cover – I and shall be submitted along with Cover – II only.
ii. Cover-II shall contain only Price Bid. The date of opening of the cover-II would be intimated in advance to those bidders who are qualified.

13.0 The EMD furnished by the bidders will be forfeited in case the bidder withdraws the offer during the validity or violates any clause stipulated in the bid.

The EMD will be returned to the unsuccessful bidders after the contract is awarded and entering into an agreement with the successful bidder.

14.0 The intending Bidders shall upload all the documents along with the application.

15.0 Tenders (Cover - 1 & Cover - 2) must be electronically submitted (online through internet) within the date and time published in e-procurement portal. Cover -1 of Tender will be opened at prescribed time and date in the e-procurement portal and **Opening of Cover -2** will be intimated later.

16.0 The following are the Calendar of bid events for two cover tender system.

1.	Date of Publishing of ABN and BBN in **i)www.karnatakapower.com ii)www.eproc.karnataka.gov.in**	27.02.2019
2.	*Last date for receipt of queries if any through **e-procurement cell only.***	16.03.2019 upto 17.00 Hrs
3.	*Date of pre-bid meeting, if required for technical clarification at KPCL, CE(TD)office, Bengaluru.*	22.03.2019 at 11.00 Hrs
4.	*Uploading replies to queries*	01.04.2019
5.	*Last date and time for submission of technical bid cover-I along with EMD and Price bid cover-II through e-procurement cell.*	12.04.2019 upto 17.00 Hrs
6.	*Opening of Technical bids (cover-I)*	15.04.2019 at 11.00 Hrs
7.	*Opening of Price bids (cover –II)*	Will be intimated later.

17.0 **BID VALIDITY:** The validity of the bid shall be 180 days from the date of opening of the Technical bid (Cover-I) or extended period.

18.0 **EARNEST MONEY DEPOSIT:**

i. **EMD: Rs.70.00 Lakh (Rupees Seventy Lakhs only).** The e-payment shall be made for **Rs 1.00 lakh (Rupees One Lakh only)** (direct debit, credit card & National Electronic Fund Transfer (NEFT) or Over The Counter (OTC) only through AXIS/ICICI Bank and remaining **Rs.69.00 Lakh (Rupees Sixty Nine Lakhs only)** either in the form of crossed demand draft in favor of **KARNATAKA POWER CORPORATION LIMITED, payable at Bangalore** or Bank Guarantee from a Nationalized/Scheduled Bank on Rs 200/- stamp paper as per the KPCL Proforma. The Bank Guarantee submitted towards EMD shall be valid for a period of 210 days from the schedule date of opening of the technical bid (Cover-I). In case, the validity of the Bid is required to be extended, the validity of the BG furnished towards EMD shall be extended up to 30 days beyond such extended bid validity period. The Bank guarantee shall be furnished in the prescribed format. Only on receipt of full EMD of **Rs.70.00 Lakh** along with technical bid, Price bid will be opened and considered for evaluation.

ii. **Confirmation of BG through Structured Financial Messaging system (SFMS) shall be done as follows:**
The bank guarantee issued by the issuing Bank on behalf of Bidder in favour of "Name of the Company" shall be in paper form as well as issued under the

"Structured Financial Messaging System". The details of beneficiary for issue of BG under SFMS platform is furnished below:

Name of Beneficiary	Karnataka Power Corporation Limited
Unit/Area/Division	Chief Engineer (Thermal Design)
Beneficiary Bank, Branch & Address	State Bank Of India, Industrial Finance Branch, Residency Plaza, Residency Road, Bangalore – 560 001
IFSC Code	SBIN0009077

While issuing the Physical BG, the bidders Bank shall also send electronic message to Employers Beneficiary Bank whose details are provided above through secure SFMS.

19.0 **CONTRACT PERFORMANCE SECURITY:** The successful bidder has to furnish a Bank Guarantee from a Scheduled Bank towards Contract Performance, equivalent to **10%(TEN)** of the contract value with an appropriate validity period (including guarantee period of one year in addition to the completion period of the work envisaged), at the time of entering into contract agreement. The BG shall be furnished in the prescribed format only.

20.0 **COMPLETION PERIOD:**
Completion period is 12 months including monsoon for the entire scope of work as specified elsewhere from the date of issue of LOA.

21.0 Corporation reserves the right to award whole or part of the work should the situation so warrants.

22.0 KPCL reserves the right to verify the information / document furnished by the bidder, should the circumstances so warrant in the overall interest of the corporation. In case the information or the documents furnished are found to be incorrect or invalid, then the EMD furnished by such bidders will be forfeited.

23.0 The prospective bidder should not coerce any other bidders to derail the healthy and competitive bidding process. Such acts entail the disqualification for participating in the tender process. The prospective bidder shall not resort to anti-competitive practices like price rigging, cartelization, ring formation or adopt unfair practices both civil and criminal aimed at preventing other bidders from quoting for the bid, any act inhibits competition or any act that will be detrimental to the interest of the KARNATAKA POWER CORPORATION LIMITED. If the bidder is found to have resorted to such practices as specified above, he and others who act in concert with him shall be debarred from quoting for this bid and for future bids for a period of three years.

24.0 Corrigendum/Modification/Corrections, if any will be published in the website only. For any clarification on e-procurement, request for e-procurement training, Bidders can contact HELP DESK at 080-25501216 / 25501227.

25.0 Any other information required may be obtained from the office of the undersigned during office hours.

Chief Engineer (Thermal Designs),
KARNATAKA POWER CORPORATION LTD.,
22/23, 2nd FLOOR, SUDARSHAN COMPLEX,
SHESHADRI ROAD, BENGALURU – 560009
KARNATAKA – INDIA.
Tel:080-22206223;
Email:
cetd@karnatakapower.com
eemyccpp@gmail.com
zld.yccpp@gmail.com

Website:http://www.karnatakapower.com

KARNATAKA POWER CORPORATION LIMITED
(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP)

(1x370 MW)

BID DOCUMENTS

FOR

"ZERO LIQUID DISCHARGE PLANT COMPRISING OF WASTE WATER PRE-TREATMENT PLANT WITH RO SYSTEM AND CRYSTALLIZER SYSTEM AND ACCESSORIES"
FOR YCCPP-1X370MW

VOLUME-I

PART I

General Conditions of Contract

OFFICE OF THE CHIEF ENGINEER (THERMAL DESIGNS)
KARNATAKA POWER CORPORATION LIMITED
No. 22/23, SUDHARSHAN COMPLEX, 2nd FLOOR
SESHADRI ROAD, BANGALORE-560 009

VOLUME – I

PART-I

GENERAL CONDITIONS OF CONTRACT (GCC)

SL. NO	SECTION	DESCRIPTION
1	A1	SCOPE OF ENQUIRY
2	A2	INSTRUCTION TO BIDDERS
3	A2	ANNEXURES
4	A3	NOTICE INVITING BIDS & QR
5	A4	GENERAL CONDITIONS OF CONTRACT
6	A5	PRE QUALIFYING CRITERIA

1.0 This enquiry is for "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with existing BHEL supplied main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year.

2.0 230m3/hr waste water from CMB (CT Blow Down, Neutralization Pit water and RO Reject) at about 2,084 ppm of total dissolved solids (TDS) shall be pumped by transfer pumps. Out of 230 m3/hr of blended water, the waste water recycling cum zero liquid discharge (ZLD) system is designed to handle 150 m3/hr. The balance 80m3/hr. water shall be bypassed to CW make up water tank where it is blended with RO permeate water and distillate for reuse as cooling tower make-up with TDS of ≤ 800 ppm by transferring it via CW makeup transfer pump to CW fore bay.

The Blended - Equalized water in CMB is treated in Lime soda softening High Rate Solid Contact Clarifier (HRSCC) for reducing TSS, Hardness & Alkalinity present in the waste water. The clarified and softened water is further treated in Ultra Filtration and RO systems.

The RO reject from the RO system shall be processed in the ZLD system of 6m3/hr capacity. Excess RO reject if any shall be collected in RO reject tank of 500m3 capacity for processing later during idle hour of the power plant.

The RO reject stream is sent to forced circulation Crystallizer cum Evaporator with Mechanical Vapour Recompression (MVR). The Crystallizer concentrates the brine and precipitates mixed salts for disposal in a landfill. High quality distillate (TDS < 100 ppm) is recovered and returned to the power plant for reuse

3.0 Contractor's basic scope shall also include all insurance covering:

a. Material damage.
b. Construction machinery and equipment / vehicles (including those owned by the sub- contractor).
c. Insurance against accident to workmen.
e. Third party liability insurance.
f. Sub-contractor insurance.

4.0 It is not the intent to specify completely herein all details of design and construction of the equipment and / or structures / works covered under this Contract. However,

all equipment and works shall conform in all respects to high standards of design, engineering, materials of construction, workmanship and be capable of performing in continuous commercial operation up to the Contractor's guarantees in a manner acceptable to the Owner.

5.0 The extent of supply and works under this contract includes all items indicated in the specification, notwithstanding the fact that such items may have been omitted from the drawings or schedules. Similarly, the extent of supply also includes all items mentioned in the drawings notwithstanding the fact that such items may have been omitted in the specifications and / or schedules.

6.0 All services including specialized services necessary for proper erection, commissioning and performance testing of all items of the System covered under this Contract shall be arranged by the Contractor.

7.0 All necessary co-ordination with regard to sub-contracted equipment and with other contractors of owner shall be carried out by the Contractor.

8.0 All equipment shall be new and field proven quality of reputed make. The make of all bought out equipment shall be subject to approval by the Owner after award of Contract, prior to the award of sub-contracts.

1.0 INTENT OF ENQUIRY:

1.1 This enquiry is for setting up ZLD Plant comprising of waste water pre-treatment plant with UF-RO system and Crystallizer system with Mechanical vapour Recompression, forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works and Integrating ZLD scheme with existing BHEL supplied main power plant including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

The bidder shall also include in his scope Start-up & Commissioning spares required for the system.

1.2 The enquiry specification comprise three volumes as described below:

Volume I:

Part-I: General Conditions:
Scope of enquiry, Instructions to Bidders, Notice inviting Tender & Qualification requirements, General Conditions of Contract.

Part –II: Special Conditions:
Codes and Standards, Project information, Broad scope, Terminal points & exclusions, Project schedule, Planning and Monitoring, Quality Assurance Requirement, Pollution control & other statutory, Performance guarantee and Liquidated Damages, Spares and Site Services, Pre-operational Testing, Painting, Contract coordination procedure, Operation and Maintenance of ZLD, Data to be furnished along with the bid and data to be furnished after award of contract.

Part –III: Technical Specifications

Volume II: Drawings.

Volume III: Schedules.

All the volumes and drawings have to be considered together for a correct understanding and interpretation of the specifications / conditions.

1.3 The enquiry specification explains in detail the scope of the Contractor. The statements and explanations contained in this regard are intended to provide a proper understanding to Bidders, but should not be construed as limiting Contractor's responsibilities and / or Owner's right to amend/ change the scope or the terms. It shall be clearly understood that the intent of the Owner is that the Bidder shall execute this project subject to the terminal points explicitly identified and consequently, any omissions, conflicts or contradictions in these specifications shall be noted, interpreted and applied appropriately to give effect to this intent. Claims or disputes on account of wrong interpretation or wilful misinterpretation of this intent by Bidder after the award of Contract will not be entertained by Owner

nor will they be legally binding on Owner.

2.0 GENERAL INSTRUCTIONS:

2.1 The Owner will receive bids in respect of the Plant to be furnished by the Bidder in accordance with the terms set out herein. All bids shall be prepared and submitted in accordance with these instructions to the Bidders.
Bids will not be accepted after the time and date fixed for their receipt as set out in the Brief Bid Notification.

2.2 The 'Works' referred herein shall cover the entire scope of the proposal which includes design, engineering, procurement, manufacture, supply, transportation to site and intrasite, storage at site, insurance, construction, erection, testing, commissioning, initial operation and PG test before take over with all civil, structural, mechanical, electrical, control & instrumentation works.

2.3 Prices quoted for Contract **shall be firm** throughout the completion period up to and including take-over and guarantee period.

2.4 Bidders are free to submit the most tax efficient Bid, provided it does not in any way or manner dilute the guarantee, warrantee and other obligations of the Contractor.

3.0 TIME SCHEDULE

3.1 Bidder shall indicate the shortest possible completion schedule for the Project which in any case shall not exceed the Owner's requirements of completion schedule.

3.2 The basic consideration and essence of the Contract is the strict adherence to the time schedules stipulated in the Brief bid notification.

4.0 BRAND NAMES

Specific reference in these specifications and documents to any material by trade name, make or catalogue number shall be binding and to be followed strictly.

5.0 COST OF PREPARATION OF BID

Bidder shall bear all costs associated with preparation and submission of bid as defined in the Scope of Enquiry and Owner will not in any case be responsible or liable for these costs, regardless of the conduct or outcome of bidding process.

6.0 SUBMISSION OF BIDS

6.1 The bids shall be prepared and submitted through GOK e-procurement platform www.eproc.karnataka.gov.in only.

6.2 The bids sent through telegraph / FAX / E-mail or any other form will be rejected.

6.3 Any bid which is not submitted according to the instruction stipulated above is liable for rejection.

6.4 KPCL will not accept any deviations either in Technical specifications or Commercial terms and conditions. Commercial terms and conditions shall be as per tender document.

6.5 All the clarifications on technical specification shall be got cleared by the bidder through e – portal only. Clarifications in the other forms will not be accepted.

6.6 There shall not be any deviations either in technical specification or commercial terms and conditions with respect to tender document and subsequent discussions/correspondence, in the offer submitted by the bidder.

6.7 The offer shall be submitted in **two Covers**.

Cover-1 shall contain EMD, Technical offer and Schedules.

Cover-2 shall contain only Price bid (Schedule F-1).

On the date of opening of the bid, (as per calendar of events) only Cover-1 will be opened. PQR documents & EMD will be verified. Technical offer and Schedules will be evaluated with respect to the specification, conditions and subsequent correspondence to establish the responsiveness of the offer submitted.

6.8 Price bid (Cover-2) of only those bidders who meet qualifying requirements and whose offers are found to be responsive will be opened at a later date which will be intimated to all the responsive bidders.

6.9 KPCL reserves the right to verify all statements / information submitted to confirm the Bidder's claim on experience, on the performance of equipment offered and capabilities of the Contractor to perform the Contract. KPCL may inspect the similar facilities of Contractors. Bidder shall co-ordinate and arrange for visit. However all expenses of Owner's Officials / Owner's Representative will be borne by Owner.

6.10 Bids not meeting the requirements as stated above and without bid security shall be rejected.

6.11 KPCL reserves the right to accept / reject any or all bids without assigning any reason thereof at any stage. However, reason for rejection will be recorded as per KTPP act. No further correspondence shall be entertained in this regard.

6.12 If the name of the eligible / selected Bidder(s) is required to be changed for any legal reason, prior to entering into of the Contract, Owner may permit the same subject to the condition that the Bid remains the same in every respect except for the change of the name and relevant documents in this regard are submitted to Owner by the Bidder immediately and before the last date for execution of the Contract.

7.0 SIGNATURE OF BIDS

7.1 The Bid must contain the name, residence and place of business of the person or persons making the bid and must be signed with seal by the Bidder/Bidders. The name of the person signing should be typed or printed below the signature.

7.2 Bids by Corporation/Company shall be signed with the legal name of the company by the President or Managing Director or Secretary or other person authorized by President/Managing Director/Board of Directors.

7.3 The bidders name stated in the proposal shall be the exact legal name of the tenderer.

7.4 Erasures or other changes in the bid shall be initialed by the person signing the bid along with the seal of the company.

7.5 Bids not conforming to the above requirements of signing may be disqualified.

8.0 LANGUAGE OF THE BID

All information in the Bid shall be in English. Information in any other language shall be accompanied by its certified translated version in English. Failure to comply with this would disqualify a Bid. In the event of any discrepancy in meaning, the English language copy of all documents shall govern.

9.0 INFORMATION REQUIRED WITH THE BID

9.1 Bid must clearly indicate the name of the manufacturer, the type or model of each principal item of equipment proposed to be furnished and erected. The Bid should also contain drawings and descriptive materials indicating general dimensions,

material from which the parts are manufactured, principles of operation and the extent of pre-assembly involved. The various drawings, data, documents, catalogues, brochures as well as the technical schedule and other schedules that need to be included in the Bid as per Bid specifications shall be submitted along with the Bid.

9.2 Any Bid not containing descriptive material to describe accurately the equipment proposed may be treated as incomplete. The Owner will retain such descriptive materials and drawings submitted by the Bidder. Any major departure from these drawings and descriptive material submitted will not be permitted.

9.3 Oral statements made by the Bidder at any time regarding quality, quantity or arrangement of the equipment or any other matter will not be considered.

9.4 Standard catalogue pages and other documents of the Bidder may be used in the Bid to provide additional information and data as deemed necessary by the Bidder.

9.5 Bidder shall furnish the Bid with all relevant information as called for in the tender specification. Bids with incomplete information are liable to be rejected.

9.6 A comment against specific Clause “Noted” or “Understood” will not be acceptable. A categorical response e.g. an affirmative reply like “we comply” against each Clause is necessary.

9.7 If at any later date, it is found that documents, information, averments and data submitted by the Bidder in the Bid and based on which the Bidder has been considered eligible or successful or has been awarded the Contract is incorrect or false to the extent that had the correct or true information been made available to the Owner at the time of tender evaluation, the bid would have been declared ineligible or unsuccessful, the Bidder shall be forthwith disqualified or, as the case may be, the contract awarded based on such incorrect or false information shall be cancelled and the Bid security deposited shall be forfeited.

10.0 UNDERSTANDING AND CLARIFICATIONS ON DOCUMENTS AND SPECIFICATION’S

10.1 The Bidder is required to carefully examine the specifications and documents and fully ascertain himself as to all the conditions and matters, which may in any way, affect the works to be performed or the cost thereof.

10.2 Verbal clarifications and information given by the Owner / Consultant or his employees(s) or his representative(s) shall not in any way be binding on the Owner.

10.3 Owner shall not in any circumstances, way or manner whatsoever be liable to the

successful Bidder for any consequential loss or damage including loss of profits.

11.0 LOCAL CONDITIONS

11.1 Bidder shall inspect the site, examine and obtain at his cost and responsibility, all information required and satisfy himself regarding all matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather and other hydrometer logical data, flood levels, sub-soil conditions, natural drainage and all information that may be necessary for preparing his bid, performance of work and other obligations and related matters. Ignorance of the Site and other said conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time or loss of profits etc. and the Owner shall not be liable for the same in any manner whatsoever.

11.2 The submission of a Bid by the Bidder will be construed as evidence that such an examination was made and the Bidder shall not raise later any claims/disputes against the Owner and the Owner shall not be liable for the same in any manner whatsoever.

11.3 Areas allocated to the Successful Bidder for executing this work shall be provided with security fencing at his cost.

11.4 Successful Bidder shall plan areas required for the enabling works of theirs and their sub-vendors/sub-contractors within the battery limits.

12.0 FIXED PRICE

12.1 Price quoted by the Bidders **shall be firm/fixed during the performance of the contract and not subject to any variation on any account. Bids submitted with price variation formula are liable to be rejected.**

12.2 There shall be no price adjustment on account of currency exchange rate variation during the currency of the contract.

13.0 BID OPENING

13.1 The owner will open the bids in the presence of the representatives of the Bidders who choose to attend at the date, time and at the address indicated in the invitation for bid Notification.

13.2 If the bid opening turns out to be a holiday for some reason, the bids will be opened on the following working day at the same time and location address.

13.3 The Bidder's name, price, discount offered, presence and absence of bid security (EMD) and such other details as the 'Corporation' may consider appropriate will be read out.

14.0 PRELIMINARY EXAMINATION

14.1 The owner will examine the bids to determine whether they are complete, whether any computational error have been made, whether required sureties have been furnished, whether the documents have been properly signed and whether the bids are generally in order.

14.2 Arithmetical errors will be rectified on the following basis.

a) If there is any discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, unit price shall prevail and the total price will be corrected.

b) If there is any discrepancy between the total bid amount and the sum of total price of items forming the total bid amount, the sum of the total prices of items shall prevail.

c) In case of discrepancy between the prices quoted in words and figures, lower of the two shall be considered.

14.3 **OFFER PRICE QUOTED SHALL BE LUMPSUM, AND ENTERED IN E-PORTAL ONLY.**

14.4 Prior to the detailed evaluation, the owner will determine the substantial responsiveness of each bid and those that are considered incomplete will be rejected. A substantial responsive bid is one which conforms to all the terms and condition of the Bidding document without material deviation.

15.0 POLICY FOR BIDS UNDER CONSIDERATION

Bids shall be deemed to be under consideration immediately after they are opened and until such time official intimation of award/rejection is made by the owner to the Bidders. While the Bids are under consideration, Bidders and/or their representatives or other interested parties are advised to refrain from contacting by any means, the "Corporation"/"Engineer" and/or its employees on matters related to the bids under consideration. The 'Engineer' if necessary will obtain clarifications on the bids by requesting such information from any or all the bidders as may be

necessary. The bidder will not be permitted to change the substance of the bids after the bid has been opened.

16.0 EFFECT AND VALIDITY OF BID

16.1 The submission of any bid connected with these documents and specifications shall constitute an agreement that the Bidder shall have no cause of action or claim against the owner for rejection of his Bid. The owner shall always be at liberty to reject or accept any Bid or all the Bids at his sole discretion and any action will not be called in to question and the Bidder shall have no claim in this regard against KPCL. Reasons for rejection will be recorded as per KTPP act.

16.2 The bids should be kept valid for a period of 180 calendar days from the date set for opening the bids (Cover-1) unless otherwise specified. The Bank Guarantee submitted towards EMD shall be valid for a period of **210 days** from the schedule date of opening of the technical bid **(Cover-I)**. In case, the validity of the Bid is required to be extended, the validity of the BG furnished towards EMD shall also be extended up to **30 days** beyond such extended bid validity period. The Bank guarantee shall be furnished in the prescribed format.

17.0 EVALUATION AND COMPARISON OF BIDS

17.1 The Bids which are found substantially responsive and accepted will be evaluated by KPCL to ascertain the lowest and technically acceptable bid.

17.2 The bids will be evaluated and ranked based on the competitive quote indicated for the Plant. Criteria for evaluation of proposal are detailed in Annexure 7 enclosed.

18.0 CONTRACT PERFORMANCE GUARANTEE (SECURITY DEPOSIT)

18.1 The successful bidder shall furnish Bank guarantee from a Nationalized/Scheduled bank towards contract performance, equivalent to 10% (Ten percent) of the Contract value for due and faithful performance of the contract, valid for the entire period of the contract till the end of guarantee period and any extensions thereof, at the time of entering into contract agreement. In case of consortium, each consortium partner shall submit additional SD equivalent to 1% (One percent) of the total contract value directly to KPCL in addition to the SD to be submitted by the lead bidder for the total contract value. The B.G. furnished shall be through a Nationalized/Scheduled Bank on Rs.200/- stamp paper as per KPCL format (Annexure-2).

18.2 The performance guarantee (security deposit) will be returned to the contractor on successful performance of the contract after the expiry of guarantee period/contract closing.

18.3 No interest is payable on the contract performance guarantee.

19.0 ARBITRATION

Any disputes or difference of claim arising out of or in connection with, or relating to the present contract or the breach, termination or invalidity thereof shall be referred and settled under the Arbitrations Centre – Karnataka (Domestic and International) Rules 2012 by one or more Arbitrators appointed in accordance with its rule.

20.0 CONTRACT AGREEMENT

The successful bidder shall sign the contract agreement within 30 days from the date of issue of letter of award, on **Non Judicial stamp paper value,** where the amount or consideration in the agreement exceed Rupees Ten lakhs **'Then Rupees one hundred and in addition Rupees one hundred for every Rupees Ten lakhs, subject to maximum of Rupees five lakhs purchased in Karnataka strictly in the KPCL format'** (will be furnished to the successful Bidder) for due fulfilment of the contract, failing which Bid Security shall be forfeited.

Agreement will be signed in one original only. Original would be **kept** with the C**orporation** and certified copy given to the contractor.

Subsequent to signing of the contract, the contractor shall provide the KPCL with 12 copies (hard copy) of contract agreement duly bound and soft copies in CDs at his cost.

21.0 DISQUALIFICATION OF BIDDERS

Bidders whose contracts have been terminated/foreclosed by KPCL /Government or other utility in India or whose performance has not been satisfactory while executing the contracts for KPCL/ Government or other utility in India within the last Three (3) years are liable for disqualification. Bidder shall furnish the notarized undertaking as indicated in Annexure 4.

21.1 Notwithstanding anything stated above, KPCL reserves the right to assess the capability and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the KPCL. If such an assessment calls for rejection of any or all bids, KPCL reserves the right to reject any or all bids.

21.2 Any agency whose performance in the ongoing projects of KPCL is observed to be not satisfactory, such agency shall be liable for rejection.

21.3 Corporation reserves the right to accept or reject any/ or all bids. However reasons for rejection will be recorded as per KTPP act.

21.4 Part and incomplete bids/Telegraphic bids/bids not accompanied by EMD/belated bids will not be accepted.

21.5 Bids received from Bidders whose EMD has been Forfeited or contracts have been terminated or foreclosed on account of their Default in KPCL or elsewhere during the past 3 (Three) years will not be considered. The bidder shall give declaration that EMD has not been forfeited and none of his contracts have been terminated / foreclosed on account of their default in KPCL or elsewhere during the past 3 (Three) years.

22.0 VARIOUS AUTHORITIES

Chief Engineer (Thermal Designs), Bangalore will be the Tender Inviting Authority. Contract Management Group of KPCL will be the Tender Scrutinizing Authority. Managing Director/Board will be the Tender Accepting Authority.

23.0 PERFORMANCE LIQUIDATED DAMAGES

The Bidder shall indicate the Performance Guarantee values towards all equipments. In the event that the equipments fail to meet the performance guarantees as per clause 10.1 of Section A4, Contractor will pay to Owner Performance Liquidated Damages in accordance with clause 11 of Section A4.

24.0 IMPLEMENTATION PERIOD:

The implementation period is stipulated as **12 (Twelve) months**-including monsoon period for design, engineering, manufacture, testing, supply FOR site, erection, testing/trail run and conducting PG test of complete Zero Liquid Discharge Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories from date of LOA.

However, the bidder shall indicate the shortest possible completion schedule which shall not be more than the period indicated by the Owner.

25.0 KPCL GST details: Tax payer Trade / Legal Name: KARNATAKA POWER CORPORTION LIMITED, Provisional ID Number: 29AAACK8032D1ZQ.

26.0 Confirmation of BGs through Structured Financial Messaging system (SFMS) shall be done as follows:

The bank guarantee issued by the issuing Bank on behalf of Bidder in favour of "Name of the Company" shall be in paper form as well as issued under the

"Structured Financial Messaging System". The details of beneficiary for issue of BG under SFMS platform is furnished below:

Name of Beneficiary	Karnataka Power Corporation Limited
Unit/Area/Division	Chief Engineer (Thermal Design)
Beneficiary Bank, Branch & Address	State Bank Of India, Industrial Finance Branch, Residency Plaza, Residency Road, Bangalore – 560 001
IFSC Code	SBIN0009077

While issuing the Physical BG, the bidders Bank shall also send electronic message to Employers Beneficiary Bank whose details are provided above through secure SFMS.

27.0 CORRESPONDENCE AND COMMUNICATION

All correspondence and communication shall be addressed to:
Chief Engineer (Thermal Designs),
Karnataka Power Corporation Limited,
No 22/23, 'Sudarshan Complex', 2nd Floor,
Sheshadri Road,
Bangalore – 560 009
Tel- 080 – 22206223 Fax: 080-22386517

Email:
cetd@karnatakapower.com
eemyccpp@gmail.com
zld.yccpp@gmail.com
Website:http://www.karnatakapower.com

ANNEXURE I

FORMAT FOR BANK GUARANTEE FOR BID SECURITY

(To be executed on a non-judicial Paper of Rs.200/-)

Ref. No

1. IN CONSIDERATION of Karnataka Power Corporation Limited having its Registered Office at No.22/23 Sudarshan complex, Sheshadri Road, Bengaluru – 560 009 (hereinafter called 'The Corporation' which expression shall unless repugnant to the subject or context includes its successors and assigns having agreed to exempt _____(hereinafter called 'the said Bidders)' which expression shall unless repugnant to the subject or context includes his successors and assigns) from the demand under the terms and conditions. of Bid No _____ (hereinafter called 'the said Bid') of such Earnest Money for the due fulfilment and compliance by the said Bidder(s) of the terms and conditions contained in the said Bid _____ for _____ on production of Bank Guarantee for ---------- (----------only), we _____ Bank (hereinafter referred to as 'the Bank') do hereby irrevocably unconditionally and without reservation guarantee the due and faithfully fulfilment and compliance of the terms and conditions of the Bid by the said Bidder(s) and unconditionally and irrevocably undertake to pay forthwith to the Corporation an amount not exceeding _____ (_____only) without any demur, reservation, recourse, contest or protest and without reference to the Bidder(s), if the Bidder(s) fail to fulfil or comply with any of the terms and conditions contained in the said Bid . A letter from the Corporation stating that the Bidder(s) is in default in the due and faithful fulfilment and compliance with the terms and conditions contained in the said Bid shall be final, conclusive and binding on the Bank.

2. WE, _____ Bank do hereby unconditionally undertake to pay the amounts due and payable under this Guarantee without any demur reservation, recourse, contest or protest and reference merely on first demand from the Corporation stating that the amount claimed is due to the Corporation by reason of failure of the said Bidder(s) to fulfill and comply with the terms and conditions contained in the said Bid including failure of the said 'Bidder('s) to keep his Bid open during the Bid validity period as setforth in the said Bid for any reason whatsoever . Any such demand made on the Bank shall be conclusive as regards amount due and payable by the Bank under this Guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding_____ (_____only).

3 Subject to the above, any claim for payment under this Guarantee shall be in the form of a written declaration by the Corporation specifying the sum claimed hereunder and indicating the event or events purely for our information which entitle the Corporation to payment of the amount claimed.

4. We ---------- Bank further agree that the Corporation shall be the sole judge to decide as to whether the Bidder(s) is in default of due and faithful fulfilment and compliance with the terms and conditions contained in the said Bid including inter alia, the failure of the said Bidder(s) to keep its bid open during the bid validity period set forth in the said Bid and

   the decision of the Corporation that the said Bidder(s) is in default as aforesaid shall be final and binding on us, notwithstanding any differences between the Corporation and the said Bidder(s) or any dispute pending before any Court, Tribunal, Arbitrator or any other authority.

5. WE, _____ Bank further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the finalisation of the said Bid and that it shall continue to be enforceable till the said Bid is finally decided and order placed on the successful Bid(s) and *I* or till all the dues of the Corporation under *I* or by virtue of the said Bid have been fully

paid and its claims satisfied or discharged or till a duly authorised officer of the Corporation certifies that the terms and conditions of the said Bid have been duly, faithfully, fully and properly carried out by the said Bid(s) and discharges this Guarantee**,** or ---------- plus a claim period of 6 (six) months from the said ---------- whichever is later. Unless a demand or claim under this guarantee is made on us in writing on or before the _____, unless extended, plus a claim period of 6 months from the said ----------, We shall be discharged from all liability under this guarantee thereafter.

6. The Corporation shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee from time to time vary any of the terms and conditions of the said Bid or to extend time of the Bid or the period for fulfilment and compliance with the terms and conditions contained in the said Bid by the said Bidder(s) or to postpone for any time and from time to time any of the powers exercisable by it against the said Bidder(s) and either to enforce or forbear from enforcing any of the terms and conditions contained in the said Bid or the securities available to the Corporation and the bank shall not be released from its liability under these presents by any exercise by the Corporation of the liberty with reference to the matters aforesaid or by reason of time being given to the said Bidder(s) or any other forbearance, act or omission on the part of the Corporation or any indulgence by the Corporation to the said Bidder(s) or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of a releasing the Bank from its such liability.

7. Any notice by way of request, demand or otherwise hereunder shall be sent by courier or by registered mail to the Bank, addressed as aforesaid.

8. We undertake to make the payment on receipt of notice of claim from the corporation on us addressed to ---------- (name of Bank along with branch address) and delivered at our above branch who shall be deemed to have been duly authorised to receive the said notice of claim.

9. It shall not be necessary for the Corporation to proceed against the said Bidder(s) before proceeding against the bank and the Guarantee herein contained shall be enforceable against the bank, notwithstanding any other security which the Corporation may have obtained from the said Bidder(s), shall at the time when proceedings are taken against the bank hereunder, be outstanding or unrealised.

10 WE _____ Bank lastly undertake not to revoke this guarantee during its currency except with the previous express consent of the Corporation in writing

and agree that any change in the constitution of the Bank or the said Bidder(s) shall not discharge our liability hereunder.

11 The Bank declares that it has the power to issue this guarantee and the undersigned have full powers to do so on behalf of the Bank.

Dated_____day of_____20____

Signature of the Issuing Authority with seal

CORPORATE SEAL

For_____Bank

ANNEXURE – 2

FORMAT FOR PERFORMANCE SECURITY OR PERFORMANCE BANK GUARANTEE

(To be executed on a non-judicial paper of Rs 200/-)

Ref.No…….

THIS GUARANTEE is made on this _____day of _____(month) 20 __ _____(Year) by_____

_____

(Hereinafter called the "Bank which expression shall unless repugnant of the context or contrary to the meaning thereof include its successors in favour of Karnataka Power Corporation Ltd (hereinafter called the 'Owner' which expression shall include the successors, assignees).

WHEREAS the Owner has entered into a Contract dated _____("The Contract") with _ _____having its Registered Office at _____(hereinafter called the "Contractor") for setting up plant ("The Works") at the total cost of _____of (_____ _____only) ("Contract Fee")

AND WHEREAS it is one of the terms of the Contract that the Contractor shall furnish to the Owner a Guarantee of a Bank which shall be for _____% of the Contract Fee and shall be valid for the term the Contract and the entire period of defect liability in respect of the said work and till all claims of the owner are satisfied or discharged in terms of the Contract ("BG period") AND

WHEREAS the Bank has, at the request of the Contractor, agreed to give in favour of the Owner a Guarantee in manner hereinafter appearing, which the Owner has agreed to accept.

THIS DEED WITNESSETH as follows:

1. In pursuance of the Contract and in consideration of having entered into the Contract with the Contractor, the Bank hereby guarantee to the Owner due observance and fulfilment by the Contractor, of the terms of the Contract relating to the Work and of the performance warranty which is a part of the Contract and agrees and irrevocably unconditionally undertakes that if the Contractor fails to observe and fulfil the said terms of the Contract and / or the performance warranty, then the Bank shall immediately pay to the Owner on demand such sum or, sums of money to the extent of ……only) being ……% of the Contract. If the Contractor fails to comply with

and fulfil all or any of its obligations contained in the Contract the Bank shall also indemnify the Owner against all losses and damages suffered by the Owner as aforesaid and against all costs, in connection herewith and against all costs, charges, expenses which may be incurred by the Owner in connection herewith.

The Bank shall pay the said amount without demur or protest or without recourse protest and without reference to the Contractor. Any such demand of the Owner placed on the Bank shall be final, conclusive and binding on the Bank as regards the amount due and payable by the Bank under this Guarantee.

2. This Guarantee is a continuing guarantee and not revocable except with the previous written consent of the Owner and save as aforesaid it will continue in force until the Contractor has maintained the schedule of delivery of the said work under the said contract and observed and fulfilled the said performance warranty and all other terms and conditions of the said contract and all claims of the Owner are satisfied by the Contractor,

3. The Owner shall have the fullest without affecting in any way the liability of the bank under this Guarantee from time to time to vary any of the terms and conditions of the said contract or to extend time of the Contract or the period for fulfilment and compliance with the terms and conditions contained in the said contract by the said Contractor or to postpone for any time and from time to time any of the powers exercisable by it against the Contractor and either to enforce or forbear from enforcing any of the terms and conditions contained in the said Contract or the securities available to the Owner and the Bank shall not be released from its liability under these presents by any exercise by the Owner of the liberty with reference to the matters aforesaid or by reason of time being given to the Contractor of any other forbearance, act or omission on the part of the Corporation or any indulgence by the Owner to the said Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect a releasing the Bank from its such liability.

4. This Guarantee shall not be affected by any change in the constitutions of the Owner by absorption with any other body or corporation and this guarantee will be available / or enforceable by such body or corporation.
5. All compositions and payments received by the Owner from or on behalf of the Contractor shall be regarded as payments in gross and in the event of the Contractor being wound up, the Owner will be entitled to prove against the properties of the Contractor in respect of the whole of the Contractor's Indebtedness to the Owner, without any right on the part of the Bank to stand in the Owner's place in

respect of or to claim the benefits of such composition and payment or any security held by the Owner until the Owner shall have received the full amount of the claims against the Contractor.

6. In order to give effect of this Guarantee, the Owner will be entitled to act as if the Bank were the Principal debtor and the Bank hereby waives all and any of its rights of surety ship.
7. The Guarantee shall continue to be in force notwithstanding the discharge of the Contractor by operation of law and shall cease only on payment of the full amount by the Bank to Owner of the amount hereby secured and on the claim of the Owner against the Contractor in respect of the said Contract being satisfied.
8. This Guarantee shall be in addition to and not in substitution for any other guarantee or security for the Contract given or to be given to the Owner in respect of the said Contract by the Bank(whether alone or jointly with others.)
9. The Bank further agrees that the Owner shall be the sole judge to decide as to whether the Contractor is in default of due and faithful fulfilment and compliance with the terms and conditions contained in the Contract and the decision of the Owner that the said Contractor is in default as aforesaid shall be final and binding on us, notwithstanding any differences between the Owner and Contractor or any dispute pending before any Court, tribunal, Arbitrator or any other authority.
10. These present shall be governed by and construed in accordance with Indian Law.
11. Subject to Clause 2.0 hereof this guarantee remain enforce for completion period of i.e., up to any notice by way of request, demand or otherwise hereunder may be sent by post to the Bank addressed as aforesaid and if sent by post it shall be deemed to have been given at the time when it would be delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an Officer of the Owner that the envelope was so posted shall be conclusive.
12. It shall not be necessary for the Owner to proceed against the Contractor before proceeding against the bank and the Guarantee herein contained shall be enforceable against the Bank, notwithstanding any other security which the Owner may have obtained or obtained from Contractor, shall at the time when proceedings are taken against the Bank hereunder, be outstanding or unrealized
13. Notwithstanding anything contained herein before, our liability under this guarantee is restricted to (_____only) and it will remain in force till _____Unless a claim or demand in writing is made with us under this guarantee on or before _____all your rights under the said Guarantee shall be forfeited and we shall be relieved liabilities there under.
14. Bank undertakes not to revoke this guarantee during its currency except with the previous express consent of the Owner in writing and agrees that any change in the constitution of the Bank or the Contractor shall not discharge our liability hereunder.

15. The Bank declares that it has the power to issue this guarantee under and the undersigned has full powers to do so on behalf of the Bank.

Signature of the issuing Authority with seal

CORPORATE SEAL

For _____Bank

ANNEXURE-3

CONSORTIUM AGREEMENT

CONSORTIUM AGREEMENT BETWEEN …… FOR ZERO LIQUID DISCHARGE PLANT OF YCCPP (1X370MW) AS PER BID NOTIFICATION NO KPCL/2018-19/PS /WORK_INDENT8374 Dtd: 27/02/2019

(To be executed on a non-judicial paper of Rs. 200/-)

Ref.No**…….**

This agreement is made this ……. Day of …….. between ……., a body corporate organised and existing under the laws of ---------- and having its Registered Office at …… (herein after referred to as "Lead Bidder" which expression shall, unless repugnant to the context or meaning thereof, include its successors and permitted assigns), having its Registered Office at …… of the first part.

AND

……. a body corporate organised and existing under the laws ---------- and having its registered office at ---------- (hereinafter referred to as "Consortium Bidder") which expression shall, unless repugnant to the context or meaning thereof, include its successors and permitted assigns) having its Registered Office at ……. of the second part.

AND

WHEREAS Karnataka Power Corporation Ltd., a Company organised and existing under the laws of India and having its Registered Office at Bengaluru (hereinafter referred to as the "Company")has invited bids Zero Liquid Discharge Plant of YCCPP (1X370MW) indicated in the bid document (herein after referred to as "PROJECT');

AND WHEREAS ABC and EFG, (hereinafter individually referred to as "Party and collectively jointly as "Parties") desire to have jointly agreed to form a consortium enter into a Consortium Agreement (herein after referred to as "Agreement') to bid for the PROJECT in response to the NIT and if the bid is accepted by KPCL to execute the PROJECT on terms & conditions jointly agreed with KPCL; and

WHEREAS it is deemed necessary and expedient to record the terms of the said agreement in writing.
NOW THEREFORE THE PARTIES IN CONSIDERATION OF THE PREMISES AND MUTUAL COVENANTS HEREBY AGREE AS FOLLOWS:

1. RELATIONSHIPS OF THE PARTIES
   1.1 The Parties hereby form a consortium (the "Consortium") for the sole and limited purposes of (i) preparing and submitting the bid of the Consortium in response to the NIT (the "Bid") (ii) negotiating and signing the Contract to be entered into between the Consortium and the Company in the event of acceptance of Bid (the "Contract") and (iii) implementing the work and obligations to be performed and goods to be supplied pursuant to the Contract, subject to and on the terms and conditions of the Agreement.

1.2 Nothing contained in this Agreement is intended nor shall it be construed as creating a partnership, a Joint Venture or a legal entity of any kind.

1.3 Any property that a Party may provide for use in connection with the performance of its scope of work shall remain the property of the Party and shall not be the property of the Consortium and the Consortium as such shall not have any property assets or employees.

1.4 Unless specifically provided otherwise herein, no Party (or its representative) shall be deemed to be a representative, agent, or employee or any other Party.

1.5 No Party hereto shall have the authority or right nor shall any Party hold itself out as having the authority or right to assume, create or undertake any obligation of any kind whatsoever, expressed or implied, on behalf of or in the name of the Consortium or of that other Party, as the case may be save and except as provided in this Agreement or otherwise mutually agreed in writing or in the Contract.

1.6 Unless otherwise mutually agreed in writing or save and except as may be set forth in this Agreement or the Contract, no Party shall have the right to (i) borrow money on behalf of or in the name or the Consortium or of any other Party hereto (ii) pledge the credit of the Consortium or of any other Party hereto without the express prior written consent of the Consortium or of such other Party hereto or (iii) incur any liabilities on behalf or in the name of the Consortium or any other Party hereto.

2. PROJECT SCOPE OF WORK

2.1 The “PROJECT" scope of work and terms & conditions will be as per NIT Notification No. **KPCL/2018-19/PS/WORK_INDENT8374 Dtd:27/02/2019** and deviations / clarifications incorporated in the Parties Bid and accepted by KPCL.

2.2 The Bid of the Parties who bid for the Project pursuant hereto shall be on the and following basis:

(a) ……shall be the Consortium Leader (the Consortium Leader”). The division of Work shall be allocated and divided between the Parties shall generally be as listed in accordance with Annexure hereto appended herewith.
[Note: Annexure shall be provided by the Bidder]

(b) The Bid will be predicated on the premise that in the event the Bid is accepted by the KPCL, each Party shall perform its work strictly in accordance with the Contract and commits itself fully to comply with the terms and conditions of the Contract. KPCL shall award the Contract to Consortium of …….. and ……..

(c) As between the Parties each Party will be responsible and solely liable for performance of their scope of work and as between the Parties and the Company. The leader shall be liable to the company for the performance of the work under the contract including the portion of the work of other members of consortium.

(d) The Parties recognize that all of the supplies and services intended to be within the scope of work of each Party shall be deemed to include those supplies and services not specified which reasonably may be inferred to be within the scope of work of such Party and to be furnished by the Party to whose scope of work such supplies or services are reasonably applicable, at no cost to the other Parties. In the event that there is no agreement, the Consortium Leader may assign such omitted supplies or services to one or some or all of the Parties, which shall promptly carry out such work.

(e) Subject to the provisions of the Contract, each Party shall be responsible for obtaining and maintaining all permits, licenses and other authorisations required for the performance of its scope of work except those which are required by the Contract to the Company. The Parties shall co-operate with each other in obtaining any of the foregoing permits, licenses, and authorisations in order to minimise the costs thereof.

(f) Inquiries for a procurement of equipment, material, or services by one Party from another Party as subcontractor shall be channelled through the Project Manager of such member.

Each Party shall use its best efforts to complete its scope of work and to cause it to be completed in a manner which minimises costs to the other Parties by full co-operation and co-ordination, directly and through the Leader, during all stages of the Project to its completion as described in the Contract and according to the Schedule.

2.3 The Parties shall fully co-operate with each other to full fill their respective obligations with respect to the said PROJECT during the term of this Agreement.

2.4 This Agreement shall in no way be considered by the Parties to constitute an entity having independent legal personality whatsoever. The Parties except as provided herein, shall act as independent Contractors and their mutual relations shall in no way be construed to be that of principal and agent. Nothing shall in this Agreement entitle any of the Parties to pledge the credit of or incur any liabilities or obligations binding upon the other Party, except in so far as may have been expressly agreed to in writing.

3. BID SUBMISSION AND MANAGEMENT

3.1. The Consortium Leader shall prepare the bid to be submitted to the Owner being formed on or before the due date and time, with diligent support from …… All the Parties shall base their prices on terms & conditions as per the NIT Notification No. **KPCL/2018-19/PS /WORK_INDENT8374 Dtd: 27/02/2019**

3.2. Bid bond, if any required to be furnished by the bidders pursuant to the NIT shall be furnished by the Consortium Leader provided however the costs of the Bid bond and all the costs incurred in attempting to obtain the Contract, including costs incurred during negotiations and till the signing of the Contract shall be borne by the Parties in the manner and proportion as set out in ANNEXURE hereto.(bidder to provide)

3.3 The Bid shall be in the name of the Consortium on behalf of the Parties and shall be jointly signed by them on behalf of the Consortium. Each Party's commitment to and acceptance of the Bid shall be deemed upon the signing of the Bid by it.

3.4 Should the Consortium being formed be invited to negotiate the Contract with the owner, such negotiations will be conducted jointly by…….. and …… ……. in consultation with each other negotiating team comprising of one duly authorised representative each of the Parties with the Consortium Leader's representative a chairman of such negotiating team (the "Negotiating Team"). Decisions and commitments made by the Negotiating Team shall be binding on the Parties.

3.5 In the event the bid is successful and the Contract is awarded to the Consortium:
The consortium leader (lead bidder) shall enter into an agreement with the corporation on behalf of the consortium and agreement shall be signed by all the members of the consortium.

(a) The Consortium Leader shall appoint the General Project manager, who shall be the interface of the Consortium with the Company.
(b) All Parties will interface with each other for day to day project management. Consortium Leader will keep the KPCL fully informed on a continuous basis with the progress of the work.
(c) All Parties shall participate in periodic project review meetings with the Owner.
(d) Consortium Leader is authorised to incur liabilities and receive instructions for and on behalf of any and all the parties and the entire execution of contract including payment shall be done exclusively with Consortium Leader.
(e) Consortium Leader shall correspond directly with Owner with regard to all matters in connection with the execution of the PROJECT and the Contract.
(f) Consortium Leader will be responsible for the Project and Contract management during entire duration of Contract and for any co-ordination with local governmental / statutory authorities relating to the as related to the execution of the Contract excepting such obligations which are to be carried out each Party separately.
(g) All parties shall provide, without recourse to the other, all financing, personnel and resources of any kind whatsoever which are required for the, proper execution and completion of contract scope of work under the Contract.
(h) Subject to any relevant provisions in the Contract and subject to the requirements of the bid specification, each party shall be entitled to subcontract any part of its scope of work subject to the requirements of the bid specification after obtaining consent of the owner. No Party shall however, by reason of such subcontract, be relieved from its obligations and responsibilities under this agreement or the Contract and each party shall be individually responsible for any acts and omissions (whether negligent or not) of its subcontractors and their agents, and employees as fully as if they were the acts or omissions of the Party's own employees or agents.
(i) Each Party shall adhere to the time schedule agreed to by the Parties in the Contract for the completion of the scope of work and shall, throughout the term of this Agreement, co-operate with the Consortium Leader to avoid any delays in completion of the PROJECT.

4. RESPONSIBILITIES AND LIABILITIES

(a) The Parties shall be liable and responsible to the Company for the performance of the portion of their Work. No Party shall vary, or seek to vary the same or caused in any way or manner the Contract, without prior written consent of the other Parties and the Owner. However the lead bidder shall be responsible for the overall execution of work.

(b) No Party shall initiate or make any changes and additions in its scope of work under the Contract without firstly advising the Consortium leader in writing and obtaining through him the following:

(i) Appropriate adjustment and allocation of cost responsibility considering the extent to which the Company has assumed cost responsibility for such changes and additions, and
(ii) Written consent of all the other parties, it being understood that such consent will not be unreasonably withheld, and
(iii) Written consent of the Company where required by the contract.

(c) The Parties agree that notwithstanding any terms and conditions which may be contained in the contract relating to their liabilities to the Owner in relation to the PROJECT, as between the Parties they shall each bear the responsibilities and liabilities imposed on them in terms of this Agreement.

(d) The parties shall be responsible for executing the scope of work in accordance with the Contract, In executing the scope, each party shall ensure that all the Plant, Equipment used by it and the design thereof, is fit for the purpose for which it is required and the work undertaken by that Party is executed in good workman like manner.

5. Not withstanding any Disputes and Arbitration on any disputes or differences shall arises among the Parties arising out of or relating to this Agreement including interpretation of any provision hereof, all the parties shall continue performance of their respective obligations under the Contract and shall avoid any action which might hinder the proper performance of the Parties' obligations under the Contract. All parties shall sincerely endeavour to resolve the dispute amicably by discussions. If however, the dispute cannot be resolved within 30 days of receipt of notice given by any party to the other party, such dispute shall be finally settled at the request of any Party by arbitration under the Rules of provisions of the Indian Arbitration and Conciliation Act, 1996 by three arbitrators (appointed in accordance with the provisions of the said Act). Award made in such arbitration, the Arbitrators decision will be binding on both the parties.
The venue of Arbitration shall be Bengaluru, Karnataka.

6. LANGUAGE
The English language shall be the official language to be used under this Agreement and shall be used by the Parties in all communications, notices, statements and any technical or commercial documentation to be prepared and presented under this Agreement.

7. AMENDMENTS

This Agreement shall not be amended or modified in anyway, other than by an agreement in writing, executed by the duly authorised representatives of the Parties. In any case, liabilities of the Parties under the Contract remain unchanged.

8. GOVERNING LAW AND JURISDICTION

The Agreement shall in all respects, be construed and interpreted in accordance with the laws of India. Only the Court of competent jurisdiction in India shall have jurisdiction over any cause of action arising under this Agreement.

9. EXCHANGE OF INFORMATION

All parties shall exchange with the other parties, information which may be reasonably required to effect the smooth execution of this Agreement. Such information may include, but not be limited to, an advance plan relating to the programme of the PROJECT, progress of the PROJECT and other data and information relevant for the scope of work of the other Party.

10. OTHER TERMS AND CONDITIONS.

The terms and conditions applicable to each Party for bidding and execution of the PROJECT (in the event of an award), are as under:

(a) The liquidated damages for delay if levied under the Contract shall be paid up by the Consortium Leader who shall be entitled to recover the same from the party responsible for delay resulting in such liquidated damages.

(b) All the Parties shall be responsible for attending to the equipment supplied under the Contract for their portion of work, in case any damage / deficiency occur during the Guarantee period. However, the Parties may, with mutual consent, agree to share the work with a view to reduce the overall cost of repair / replacement of the damaged / deficient part.

(c) Consortium leader (Lead bidder) shall be liable to the other parties for any direct, indirect, special, incidental or consequential loss or damage.

(d) No Party shall have the right to assign, or, in any way transfer any of its rights or obligations under this Agreement, without the written consent of the other Parties and Owner.

11. VALIDITY OF THIS AGREEMENT

This Agreement shall remain valid till the expiry of the Guarantee / Warranty Period of the identified PROJECT (in case of award to the Parties) or till the earliest occurrence of any one of the following events whichever is earlier:

(a) Date of award of the PROJECT to some other party.

(b) Date when KPCL decides not to progress any further with the PROJECT.

(c) Date when both the Parties confirm that the Bid proposal has been finally rejected by KPCL /

Owner.

(d) If any Party becomes bankrupt or insolvent, or makes an assignment for the general benefit of its creditors, or is unable to pay its debts as they become due or has a trustee, liquidator, receiver or a receiver appointed to its or any part thereof, or commits an act of bankruptcy.

(e) If the Parties fail to submit their proposal by the final date of bid submission, for any reasons whatsoever.

12. COMMUNICATION:
All correspondences, notices and communications required or permitted to be given under this Agreement or the Contract to any Party shall be sent to Consortium Leader at the following address:

_____
_____
_____

IN WITNESS WHEREOF …… and…… have caused this Agreement to be duly executed in …… on the date first mentioned, as evidenced by the signature of their authorised representatives.

Agreed and accepted

For and on behalf of

_____
Name (s)
(Lead bidder)

Agreed and accepted

For and on behalf of

_____
Name (s)
(Consortium bidder)

ANNEXURE-4

PROFORMA OF UNDERTAKING
[NOTARISED AFFIDAVIT]

We hereby declare that in respect of Tender / contract with KPCL / Government or other utility in India.

i. Our EMD has not been forfeited.

ii. None of our contracts have been terminated / foreclosed on account of our default in KPCL or elsewhere

iii. We have not been blacklisted / subject to procedure initiated for blacklisting for participation in tender issued by KPCL or Government or any other utility in India and would not attract terms & conditions relating to rejection of bids.

Lead bidder/ Consortium bidder

ANNEXURE-5

BANK GUARANTEE VERIFICATION CHECKLIST

	CHECKLIST	YES	NO
I.	Does the Bank Guarantee compare verbatim with standard Employer Proforma for BG		
II. a)	Has the Executing Officer of BG indicated his Name Designation & Power of Attorney No./Signing Power Number, etc. on BG		
b)	Is each page of BG duly signed/initialled by the executants, and last page is signed will full particulars as required in the Employer's standard proforma of BG and under the seal of the Bank.		
c)	Does the last page of the BG carry the signatures of two witnesses alongside the signatures of the executing Bank Manager.		
III a)	Is the BG on non-judicial stamp paper of appropriate value		
b)	Is the date of sale of non-judicial stamp paper shown on the BG and the stamp paper is issued not more than six months prior to the date of execution of BG		
IV a)	Are the factual details such as Bid Specification No., LOA No., Contract Price, etc. correct.		
b)	Whether overwriting / cutting, if any, on the BG authenticated under signature & seal of executant.		
V.	Is the amount and validity of BG in line with Contract provisions?		
VI. a)	Is the Bank Guarantee issued from a Bank's branch located outside India?		
(b)	Has the Bank Guarantee been routed through the correspondent branch in India for due verification of the signature(s) of the executant(s)? (Applicable only if the answer to VI (a) is 'YES')		
VII.	Whether the BG has been issued by a Bank as per relevant provisions of the Bidding Documents		
VIII	Whether Bidder's Banker have confirmed issue of BG through SFMS to KPCL Bankers.		

Date : (Signature)...

Place : (Printed Name)...

(Designation)

(Common Seal)...

Note : Bidder / Consortium partner(s) is required to fill up this form and enclose along with the Bank Guarantee.

ANNEXURE - 6

FORM OF VALIDITY EXTENSION OF BANK GUARANTEE

(To be executed on a non-judicial paper of Rs. 200/-)

Ref.No. Dated:

To:

[Owner's Name and Address]

Dear Sirs,

Sub: Validity Extension of Bank Guarantee No. ..... dtd... for .favouring yourselves, expiring on...on account of M/s*... ... in respect of Contract for (Insert package name) . . . ... for (Insert Project name) ... project, Contract No. dated... (hereinafter called original Bank Guarantee).

At the request of M/s*... ..... we. Bank having branch office at..... and having Head Office at .. do hereby extend our liability under the above mentioned Bank Guarantee No... ..... dt . for a further period of..... ...Years/Months from ... . to expire on Except as provided above, all other terms and conditions of the original Bank Guarantee No... ..... dt... ...shall remain unaltered and binding on us.

Please treat this as an integral part of the original Guarantee to which it would be attached.

Your Faithfully

For.

*Manager/Agent/Accountant Power of Attorney No... Dated...

ANNEXURE – 7
CRITERIA FOR EVALUATION AND COMPARISON OF BIDS:

1.0 The bidders proposal will be evaluated as per the following:

BID EVALUATION

The bidder shall comply with the Zero Liquid Discharge system and equipment parameters and specifications of equipment specified in the specification. No credit will be given during bid evaluation if parameters better than those specified are offered by bidder.

1.1 Price evaluation will be based on the fixed price and Power loading at duty point.

The price for evaluation shall be

a. the total lump sum FIRM price offered by the bidder for the entire scope of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, and Essential Spares including GST and any other taxes, freight and insurance (F.O.R. Destination including all taxes and duties) and O&M for one year period (as per schedule of prices – schedule- F1 volume III)

and

b. Loading for Power input at duty point. For bid evaluation of power consumption only the total power input at duty point for all continuously working pumps/equipment indicated in the schedule of Motor / Guaranteed power consumption (Schedule –F-4) (Intermittent operating equipments shall not be considered) will be considered. The lowest quoted Guaranteed power consumption will form the base value for evaluation. An amount of **Rs. 3,96,719/-** for each kW differential in the quoted total Guaranteed power consumption at the duty point will be loaded for **bid evaluation.**

Bidder shall indicate the minimum guaranteed overall pump efficiency and motor efficiency which shall not be subject to any tolerance and the guaranteed power input to motor corresponding to their efficiencies, shall be indicated.

The Total Quoted Price of the Bidder will be offered price including applicable loading for power consumption. This shall be called as the **Total Quoted Price** of the Bidder. The lowest of the "**Total Quoted Price"** among the bidders shall be considered as the Lowest offer (L1).

2.0 Penalty Factor

At the time of Performance Guarantee tests, for each kW differential in the actual motor input over the guaranteed motor input at duty point indicated by the bidder in the schedule of performance guarantee (without any further tolerance), penalty will be levied at **Rs. 7,93,439/-** per kW differential over and above the total guaranteed power consumed by all working pumps/equipment as indicated in the schedule of Motor / Guaranteed power consumption (Ref Section-F4). Power consumption by individual pump / equipment will not be compared for this purpose. For penalty purpose, the total power input measured for all working equipments (Sum of all the individually measured values) considered for differential power loading during bid evaluation and measured during the performance guarantee test conducted at YCCPP site, before handing over the system to KPCL will be considered.

Note: The bidder should furnish filled up schedule of Motors / guaranteed power consumption vide Section-F4 without fail. Bid documents without this schedule filled up is liable for rejection

ANNEXURE – 8
PROFORMA OF PRE BID QUERIES

Sl.no.	Cl. Ref.	Tender Description	Bidder's Query	Clarification

NOTE: ALL PRE BID QUERIES SHALL BE UPLOADED IN THE FORMAT FURNISHED ABOVE THROUGH E-PORTAL ONLY. WRITTEN OR ORAL QUERIES IN ANY OTHER FORMS WILL NOT BE ENTERTAINED / ACCEPTED.

ANNEXURE – 9
FORM OF BID

(To be furnished along with the Bid)

To,

The Chief Engineer (Thermal Designs),
Karnataka Power Corporation Limited.,
No. 22/23, Sudarshan Complex, Second Floor,
Sheshadri Road, BENGALURU - 560 009.

Sir,

We hereby bid for the Zero Liquid Discharge plant for YCCPP-1X370MW in the Schedule subject to the under mentioned conditions of Contract:

1. This bid will holds good for a period of 180 days from the date fixed for opening of Cover-1 of bids.
2. "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.
3. We note that withdrawal from this tender within the period referred to in Clause (1) above or failure to provide services offered in the bid, which is accepted by the Chief Engineer (Thermal Designs), KARNATAKA POWER CORPORATION Ltd., after the order is placed will entail the forfeiture of Bank Guarantees and shall also be debarred either permanently or for a fixed period at the discretion of purchaser from participating in any of the purchaser's tenders.
4. Further, we also note that the Chief Engineer (Thermal Designs) KARNATAKA POWER CORPORATION Ltd., does not bind himself to accept the lowest or any bid and reserves the right to consider/reject any or all the bids.

We hereby agree to all the terms and conditions of the bid except those which are specifically commented upon by us. We also note that Chief Engineer (Thermal Designs) reserves the right to place orders for a portion of the items and/or quantities.

Bidders faithfully,

Station:
Dated :

Signature : _____
Full address : _____
With seal _____

ANNEXURE – 10

DECLARATION-I

1. **Name of work:** "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

***

I / We have studied the site conditions and read the Bid documents and related matters carefully and diligently and that I/We have submitted the Bid having studied understood and accepted the full implications of the Bid document. The requirements of the BID documents as stated above will be fulfilled by me/us to the satisfaction of the Corporation.

I / We hereby declare that the bid submitted by me / us has no conditions contravening the commercial conditions of the bid.

Name of the BIDDER
Signature with seal
Date:

ANNEXURE – 10

DECLARATION - II

Memorandum

I/We hereby tender for execution for the KARNATAKA POWER CORPORATION LIMITED, (herein before and herein after referred to as the Corporation) of the work specified in the under mentioned memorandum within the time specified in such memorandum at the rates quoted for each item specified in the Price Bid (memorandum showing the items of work to be carried out) and in accordance in all respects with specifications in writing.

a)	Name of work	"Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.
b)	Earnest money deposit	Rs. 70,00,000/-(Seventy lakhs Rupees only)
c)	Contract performance Guarantee	The Successful bidder shall furnish a Contract performance guarantee (CPG) equivalent to 10% (Ten percent) of the contract amount in the form of BG from any scheduled or nationalized bank acceptable to the Corporation in the prescribed format before entering into agreement. In case of consortium, consortium partner shall submit additional SD equivalent to 1% (One percent) of the total contract value directly to KPCL in addition to the SD to be submitted by the lead bidder for the total contract value in the form of BG from any scheduled or nationalized bank acceptable to the Corporation in the prescribed format before entering into agreement.
d)	Completion period	**12(Twelve) months**—including monsoon period for design, engineering, manufacture, testing, supply FOR site, erection, testing/trail run and conducting PG test of complete Zero Liquid

		Discharge Plant & accessories from date of LOA.

Should this tender be accepted I/We agree to abide by and fulfill all the terms and provisions of the conditions of the contract annexed hereto and all the terms and provisions contained in the Notice inviting tenders so far as applicable and in default thereof to forfeit and pay to Corporation, the sum of money mentioned in the said conditions.

A sum of **Rs. 70,00,000/-(**Seventy lakhs Rupees only) is paid as Earnest money deposit.

I/We agree that should I/We fail to execute the agreement or to commence the work specified in the above memorandum, Earnest Money shall be forfeited to the Corporation.

I/We hereby distinctly and expressly declare and acknowledge that before the submission of this tender, I/We have carefully followed the instructions, read the relevant Indian Standard Specifications, and I/We have made examination of the contract documents and plans, specifications and quantities and of the locations where such work is to be done and have made myself/ourselves aware of the scope and specifications of the work to be done and availability of the quantities of materials required.

I/We distinctly agree that I/We would hereafter make no claim or demand upon the Corporation based upon or arising out of any alleged misunderstanding or misconceptions or mistake on my/our part of the said covenants, agreements, stipulations, restrictions and conditions.

Any notice required to be served on me/us shall be delivered to me/us personally or forwarded to me/us by post (registered or ordinary) or left on my/our address given in the tender.

I/We fully understand the terms and conditions of the contract to be entered into between me/us and the Corporation and the written contract shall be foundation of the rights of the both the parties.

Name of the BIDDER
Signature with seal
Date:

ANNEXURE-11

FORM OF CONTRACT AGREEMENT

(On Stamp paper to be purchased in Karnataka State only)

(To be stamped in accordance with the Karnataka Stamp Act Article no. 5(i-d)

The agreement entered into this day of……..Two thousand and ---------- between……M/s……..(Name and address …… ……(hereinafter referred to as the 'Contractor' which terms shall include their successors and legal representatives) and Karnataka Power Corporation Limited, a company registered under the Companies Act, 1956(hereinafter referred to as the 'Corporation' which term shall include its successors and assigns).

WHEREAS

1. The bid No ……..of the Contractor submitted against the Chief Engineer (Thermal Designs) Karnataka Power Corporation Ltd., Bengaluru, enquiry No……. for the work of "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India. and handing over to the Purchaser an operating plant was accepted by the said Chief Engineer on behalf of Karnataka Power Corporation Limited, subject to the Terms and Conditions detailed in the said Chief Engineer (Thermal Designs) letter of award No……(hereinafter referred to as order).

2. The Contractor having accepted the order was required to execute agreement and to furnish a Bank Guarantee towards the security Deposit for the due fulfillment of the agreement.

3. The Contractor has furnished a Bank Guarantee bearing No……. dated…….. in favour of the Corporation for sum of…….. only towards the Security deposit, for the due fulfillment of the agreement from the……Bank and has further agreed to renew it to the extent required to cover the full guarantee period under the agreement.

Now this indenture witnessed and it is hereby agreed and declared as follows, that is to say, in consideration of the payments to be made to the Contractor by the Corporation as herein after mentioned, the Contractor hereby covenants with the Corporation, that the Contractor shall perform the works and things in the agreement subject to the terms and conditions and stipulations mentioned in the agreement that is to say General Conditions of contract, and Technical Specification, annexed to this agreement and deemed to be part of the agreement.

In witness whereof the parties (1) KPCL and (2)…… (Bidder) .to this agreement have signed this indenture in the presence of the following witnesses.

Contractor's Signature (with seal) for KARNATAKA POWER CORPORATION LTD.
Witnesses:

1. 1.

2. 2.

1. Instruction for filling the Proforma: Only stamp paper purchased in Karnataka State and in the name of the Contractors should be used.
2. All blank spaces should be filled in with appropriate information, any additions, deletions or corrections done subsequently should be countersigned.

KARNATAKA POWER CORPORATION LIMITED

(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP-1X370MW)
ZERO LIQUID DISCHARGE PLANT (ZLD)

ABSTRACT BID NOTIFICATION

No: KPCL/2018-19/PS/WORK_INDENT8374 **Date:27/02/2019**

Karnataka Power Corporation Limited invites bids through GOK e-procurement platform www.eproc.karnataka.gov.in from the qualified bidders for the following brief scope of work:

1.0 "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

2.0 Those who have not registered in e-procurement portal www.eproc.karanataka.gov.in may do so in order to participate in the bid.

3.0 The brief bid notification containing the pre-qualifying criteria for the bidders, EMD, Calendar of bid activities and other details can be accessed from e–procurement portal.

Further details can be had from:

Chief Engineer (Thermal Designs),
Karnataka Power Corporation Ltd.,
#22/23, Sudarshan Complex,
2nd Floor, Sheshadri Road,
BENGALURU - 560 009.
Tel: 080-22206223,

E-mail: cetd@karnatakapower.com
eemyccpp@gmail.com
zld.yccpp@gmail.com

Web site: www.karnatakapower.com

KARNATAKA POWER CORPORATION LIMITED

(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP-1X370MW)
ZERO LIQUID DISCHARGE PLANT (ZLD)

BRIEF BID NOTIFICATION

No: KPCL/2018-19/PS/WORK_INDENT8374 **Date:27/02/2019**

1.0 KARNATAKA POWER CORPORATION LIMITED invites bids through GOK e-procurement platform **www.eproc.karnataka.gov.in** from the qualified bidders for "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with UF-RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, Integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

BRIEF SCOPE OF WORK FOR ZERO LIQUID DISCHARGE PLANT (ZLD)

The scope of this enquiry covers the following:

"Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over with all civil, structural, mechanical, electrical, control & instrumentation works, Integrating ZLD scheme with main power plant and Essential Spares of ZLD plant comprising of the following facilities:

a) Pre-treatment and Tertiary treatment facilities which comprises of Flash mixer, HRSCC, Filter feed tank, Pressure sand filter, UF feed tank, UF system, RO feed tank, RO system, RO permeate tank, RO reject collection tank, Back wash treatment tank etc., to process the total waste water collected in the existing Central Monitoring Basin.
b) Zero Liquid discharge plant complete in all respect including Evaporator, Crystallizer, Salt Centrifuge system etc.
c) Chemical dosing facilities for pre-treatment, UF-RO system and ZLD system.
d) Sludge dewatering plant.

e) Service water / Make-up Water system.
f) Laying of piping to distribute recovered water from the ZLD system to CW Make-Up Water system.
g) Civil and Structural Works.
h) Extension of Power required for the ZLD plant from the existing 6.6kV switchgear.
i) Extension of Steam required for the plant from LP steam line of HRSG of main Power Plant.
j) Extension of Potable water and firefighting water from the nearest tapping point and distribution of the same inside/outside the ZLD plant.
k) Supply of Essential Spares.
l) Supply of Erection and Commissioning Spares.
m) Associated electricals (HT & LT switchgears, MCCs, Cables, Laying of cables etc.) and Controls & Instrumentation / Automation.
n) Firefighting facilities/ Fire detection & Alarm system.
o) Air Conditioning and Ventilation.
p) Hoisting and Material handling system.
q) Illumination facilities for the entire premises including roads.
r) Operation & Maintenance of plant and equipment on 24x7 basis for a period of one year after handing over / issue of Notice To Proceed (NTP) as the case may be. Consumables and Chemicals are in the scope of KPCL during O&M period.
s) Road connection / interconnection road from Network of Road in the ZLD plant interconnecting different buildings/ units and connection to nearest Road.
t) ZLD plant building/ Sludge drying plant/ RO plant building/ Chemical house comprising pump sets, filters, treatment plant, handling facilities, valves, pipe & fitting, along with associated electricals, instruments, material handling, Air conditioning/ Ventilation system for each buildings and control room / MCC room.
u) Office cum store, maintenance shed at ZLD plant with furniture and A/C facilities.
v) A mini Laboratory with testing facility for analysis of important parameters like pH, residual chlorine, conductivity etc. shall be provided with necessary equipment. All chemicals, consumables shall be in the scope of the bidder till handing over.
w) Facilities to hook up the required data of the ZLD system / water parameters with Pollution Control Board or any other statutory authority.
x) Statutory Clearances required for the successful establishment and operation of the ZLD Plant, if any.
y) Area drainage/storm water drainage system of complete ZLD Plant. The drainage, sewerage shall be connected to the nearest respective plant network/STP.
z) Fecal/sanitary sewer disposal from toilets/wash basin to nearest respective plant network/STP.
aa) Back wash water tank & waste water tank comprising pumps, handling equipment, valves, pipe & fitting along with associated electricals, controls & instruments.

bb) All necessary connections for hook up with KPCL system at specified Terminal points/nearest available network.

cc) Other miscellaneous systems required for completeness of work.

dd) ZLD Plant shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant will be deemed to be included under the scope of work of the Tenderer. Detailed scope of work for electro-mechanical, Control & Instrumentation, Automation, Civil, Architectural, Structural, Material Handling, Firefighting facilities, Air Conditioning and Ventilation etc. have been specified in the relevant chapters of this specification.

Scope of work given is only indicative. Detailed scope has been described in the bid document which is binding on all the bidders. Any other item not covered herein but essential for successful installation and commissioning of the system and integration of the system shall be included in the scope by the bidder.

1.0 INSTRUCTIONS REGARDING E-PROCURMENT.

a. The bid is to be submitted in the GOK e-procurement platform www.eproc.karnataka.gov.in system only.

b. Bidders, who have not registered in e-procurement portal, may do so by registering through web site www.eproc.karnataka.gov.in

c. The bidders can access and download bid documents on the web site, fill them and submit the completed bid documents into electronic tender on the website itself within the stipulated date. The blank bid documents can be accessed through e-procurement portal web site www.eproc.karnataka.gov.in

d. Bidders shall attach scanned copies of all the certificates pertaining to the Pre- qualification requirement as mentioned under "Minimum Qualification Requirements" clause. Whenever required, bidders shall furnish the original certificates to the KPCL authorities, failing which, the bidder will be disqualified.

e. Conditional bids, incomplete bids, bids without EMD, bids not properly uploaded and bids submitted late shall be rejected.

f. Bidders shall refrain from altering/modifying/revising the price bids after the date and time fixed for submission of bids in the calendar of events even though if it is accepted by the portal. Date and time stamp of the portal shall be final in deciding the time and date of submission of bid. Decision of the Corporation in this regard is final.

ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories.

2.0 MINIMUM QUALIFYING REQUIREMENTS:

The intending bidder shall satisfy the following minimum qualifying requirements.

The intending bidder should have Designed, Engineering, Manufactured/Supplied, Constructed, Erected and Commissioned.

a) Waste water pre-treatment plant with RO system of capacity not less than **75** Cum/hr.

and

b) Crystallizer cum Evaporator system & Salt Centrifuge with Mechanical vapour Recompression system (Zero Liquid Discharge plant) of capacity not less than **3** Cum/hr.

The bidder shall have executed the above works in any Power Plant/ Industrial Projects/ Water supply Board/ Municipal Corporation (including Civil works) in preceding **Five years** reckoned from last date for submission of bids and the same shall be satisfactorily and demonstrably performed continuously for a minimum period of **One year** as on last date for submission of bids.

As a proof of the above, the intending /Lead bidder and his consortium partner shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board etc. certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.

2.1 The intending bidder shall fulfill all the qualifying requirements as indicated in 2(a) and 2(b).

2.2 In case the bidder, as stated in para 2.1, does not fulfill all the minimum qualifying requirement as indicated in 2(a) and 2(b) but qualifies for the minimum qualifying requirements as mentioned in para 2(a) only, can participate in the bid with a consortium partner.

In such case:

2.2.1 The bidder who fulfills the minimum qualifying requirement as indicated in 2(a) shall be the **Lead bidder**.

2.2.2 The **Consortium Partner** shall fulfill the minimum qualifying requirement as indicated in 2(b) and the Proof of same shall be in the name of consortium partner only.

2.2.3 The number of partners in consortium including the lead bidder shall not be more than 2 (two).

2.3 The lead bidder and the consortium bidder shall enter into one single consortium agreement as per KPCL format covering the criteria 2(a) and 2(b) above and submit the same while submitting the bid.

2.4 The lead bidder shall be responsible for the overall execution of work.

2.5 In case, the lead bidder withdraws, the whole contract shall be considered cancelled and short closed and the balance work will be executed at the risk & cost of the bidders (lead bidder + consortium partner).

2.6 In case, the consortium partner backs out, such of the work/s handled by such consortium partner will be executed by the Lead bidder through alternate similar agency who satisfies respective minimum qualifying requirements for such works as applicable in a reasonable time without affecting contract completion period. If the Lead bidder fails to take remedial measure in this regard, then KPCL reserves right to withdraw such works and get executed at the risk and cost of the lead bidder.

2.7 The consortium partner shall separately submit SD equivalent to 1% of the total contract value directly to KPCL in the KPCL format in addition to the SD to be submitted by the lead bidder.

2.8 Credentials of works executed by consortium partner and lead bidder shall be submitted separately for their respective area of work executed by them. **The qualifying experience as claimed by the bidder (s) shall be filled up in the format enclosed.**

2.9 The intending bidder and his consortium partner shall not have been subject to forfeiture of EMD/foreclosure/termination of their contract in KPCL/government or any other utility/ blacklisting/ procedure initiated for blacklisting for participation in tender issued by KPCL or government or any other utility in India during the past 3 years.

3.0 **Financial Criteria**:

i. The bidder (as per para 2.1) in his name should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum annual financial turnover of Rs. **140.00 Crore**. As a proof, the bidder shall furnish Copies of audited P&L Account and audited balance sheet duly certified by a Chartered Accountant to establish annual turnover requirement stipulated above.

ii. In case of consortium bid, Lead bidder and consortium partner (as per para 2.2.1 & 2.2.2) in their names should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum annual financial turnover of **Rs.84.00 Crore** and **Rs. 56.00 Crore** respectively. As a proof, the bidders shall furnish Copies of audited P&L Account and audited balance sheet duly certified by a Chartered Accountant to establish annual turnover requirement stipulated above.

4.0 Notwithstanding anything stated above, KPCL reserves the right to assess the capability and capacity of the bidder and or consortium partners to perform the contract, should the circumstances warrant such assessment in the overall interest of the KPCL. If such an assessment calls for rejection of any or all bids, KPCL reserves right to reject any or all bids.

5.0 Any agency whose performance in the ongoing projects of KPCL is observed to be not satisfactory such agency shall be liable for rejection.

6.0 Following documentary evidence for the minimum qualifying requirements shall be up-Loaded.

i. As a proof of the above, the intending /Lead bidder and his consortium partner shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.

ii. For financial qualifying requirement, Copies of audited P&L Account / annual report/audited balance sheet duly certified by the Chartered Accountant to establish annual turnover requirement stipulated under para no. 3(i) or 3(ii) shall be submitted along with PF registration (Independent PF code), Income tax, PAN No, GST /Service tax Registration certificate, Labour certificate.

iii. Consortium agreement (as per KPCL format) between Lead bidder and consortium bidder.

iv. Scanned copy of the BG towards EMD.

v. Undertaking in the form of a notarized affidavit declaring that during the past 3 years:

(a) Their EMD has not been forfeited.
(b) None of their contracts have been terminated/foreclosed on account of their default in KPCL or elsewhere.
(c) They have not been blacklisted/subject to procedure initiated for blacklisting for participation in tender issued by KPCL or government or any other utility in India and would not attract terms and conditions relating to rejection of bids.

7.0 The qualifying requirement as claimed by the Bidder(s) shall be filled up in the format enclosed in section A5, Volume-I, Part-I of General Conditions of the Contract. Non submission of this format will make the bid liable for rejection.

8.0 **Consequent to implementation of GST the following shall be furnished by the bidder:**

8.1 Name, address along with the state name and GSTIN of the supplier.

8.2 Name, address along with the State Name and GSTIN or UIN.

8.3 Name and address of the recipient and the address of delivery along with the name of State and its code, if such recipient is unregistered and where the value of taxable supply is fifty thousand rupees or more.

8.4 Description of goods along with HSN code and services along with the SAC code.

8.5 Applicable GST i.e. CGST and SGST in case of local supply and IGST in case of inter-state supply. Applicable rate of GST also to be mentioned.

9.0 **DISQUALIFICATION OF BIDDERS**

9.1 Bidders whose contracts have been terminated/foreclosed by KPCL /Government or other utility in India or whose performance has not been satisfactory while executing the contracts for KPCL/ Government or other utility in India within the last Three (3) years are liable for disqualification. Bidder shall furnish the notarized undertaking as indicated in Annexure 4 of “Instruction to bidders”.

9.2 Notwithstanding anything stated above, KPCL reserves the right to assess the capability and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the KPCL. If such an assessment calls for rejection of any or all bids, KPCL reserves the right to reject any or all bids.

9.3 Any agency whose performance in the ongoing projects of KPCL is observed to be not satisfactory, such agency shall be liable for rejection.

9.4 Corporation reserves the right to accept or reject any/ or all bids. However, reasons for rejection will be recorded as per KTPP act.

9.5 Part and incomplete bids/Telegraphic bids/bids not accompanied by EMD/belated bids will not be accepted.

10.0 Bids received from Bidders whose EMD has been Forfeited or contracts have been terminated or foreclosed on account of their Default in KPCL or elsewhere during the past 3 (Three) years will not be considered. The bidder shall give declaration that EMD has not been forfeited and none of his contracts have been terminated / foreclosed on account of their default in KPCL or elsewhere during the past 3 (Three) years.

11.0 The intending bidder shall quote in Indian Rupees only.

12.0 Bids duly filled in shall be submitted through e-procurement portal only. The bids shall be submitted in two cover format.

i. Cover-I shall contain EMD, Technical and Commercial bid documents to establish qualifying requirements, schedule F3 (Schedule of Guaranteed parameters) and will be opened first, document furnished will be scrutinized to determine the bidders meeting qualifying criteria. Bidder shall not enclose price schedule with Cover – I and shall be submitted along with Cover – II only.
ii. Cover-II shall contain only Price Bid. The date of opening of the cover-II would be intimated in advance to those bidders who are qualified.

13.0 The EMD furnished by the bidders will be forfeited in case the bidder withdraws the offer during the validity or violates any clause stipulated in the bid.

The EMD will be returned to the unsuccessful bidders after the contract is awarded and entering into an agreement with the successful bidder.

14.0 The intending Bidders shall upload all the documents along with the application.

15.0 Tenders (Cover - 1 & Cover - 2) must be electronically submitted (online through internet) within the date and time published in e-procurement portal. Cover -1 of Tender will be opened at prescribed time and date in the e-procurement portal and **Opening of Cover -2** will be intimated later.

16.0 The following are the Calendar of bid events for two cover tender system.

1.	Date of Publishing of ABN and BBN in **i)www.karnatakapower.com ii)www.eproc.karnataka.gov.in**	27.02.2019
2.	*Last date for receipt of queries if any through **e-procurement cell only.***	16.03.2019 upto 17.00 Hrs
3.	*Date of pre-bid meeting, if required for technical clarification at KPCL, CE(TD)office, Bengaluru.*	22.03.2019 at 11.00 Hrs
4.	*Uploading replies to queries*	01.04.2019
5.	*Last date and time for submission of technical bid cover-I along with EMD and Price bid cover-II through e-procurement cell.*	12.04.2019 upto 17.00 Hrs
6.	*Opening of Technical bids (cover-I)*	15.04.2019 at 11.00 Hrs
7.	*Opening of Price bids (cover –II)*	Will be intimated later.

17.0 **BID VALIDITY**: The validity of the bid shall be 180 days from the date of opening of the Technical bid (Cover-I) or extended period.

18.0 **EARNEST MONEY DEPOSIT**:

i. **EMD: Rs.70.00 Lakh (Rupees Seventy Lakhs only).** The e-payment shall be made for **Rs 1.00 lakh (Rupees One Lakh only)** (direct debit, credit card & National Electronic Fund Transfer (NEFT) or Over The Counter (OTC) only through AXIS/ICICI Bank and remaining **Rs.69.00 Lakh (Rupees Sixty Nine Lakhs only)** either in the form of crossed demand draft in favor of **KARNATAKA POWER CORPORATION LIMITED, payable at Bangalore** or Bank Guarantee from a Nationalized/Scheduled Bank on Rs 200/- stamp paper as per the KPCL Proforma. The Bank Guarantee submitted towards EMD shall be valid for a period of 210 days from the schedule date of opening of the technical bid (Cover-I). In case, the validity of the Bid is required to be extended, the validity of the BG furnished towards EMD shall be extended up to 30 days beyond such extended bid validity period. The Bank guarantee shall be furnished in the prescribed format. Only on receipt of full EMD of **Rs.70.00 Lakh** along with technical bid, Price bid will be opened and considered for evaluation.

ii. **Confirmation of BG through Structured Financial Messaging system (SFMS) shall be done as follows:**
The bank guarantee issued by the issuing Bank on behalf of Bidder in favour of "Name of the Company" shall be in paper form as well as issued under the

"Structured Financial Messaging System". The details of beneficiary for issue of BG under SFMS platform is furnished below:

Name of Beneficiary	Karnataka Power Corporation Limited
Unit/Area/Division	Chief Engineer (Thermal Design)
Beneficiary Bank, Branch & Address	State Bank Of India, Industrial Finance Branch, Residency Plaza, Residency Road, Bangalore – 560 001
IFSC Code	SBIN0009077

While issuing the Physical BG, the bidders Bank shall also send electronic message to Employers Beneficiary Bank whose details are provided above through secure SFMS.

19.0 **CONTRACT PERFORMANCE SECURITY:** The successful bidder has to furnish a Bank Guarantee from a Scheduled Bank towards Contract Performance, equivalent to **10%(TEN)** of the contract value with an appropriate validity period (including guarantee period of one year in addition to the completion period of the work envisaged), at the time of entering into contract agreement. The BG shall be furnished in the prescribed format only.

20.0 **COMPLETION PERIOD:**
Completion period is 12 months including monsoon for the entire scope of work as specified elsewhere from the date of issue of LOA.

21.0 Corporation reserves the right to award whole or part of the work should the situation so warrants.

22.0 KPCL reserves the right to verify the information / document furnished by the bidder, should the circumstances so warrant in the overall interest of the corporation. In case the information or the documents furnished are found to be incorrect or invalid, then the EMD furnished by such bidders will be forfeited.

23.0 The prospective bidder should not coerce any other bidders to derail the healthy and competitive bidding process. Such acts entail the disqualification for participating in the tender process. The prospective bidder shall not resort to anti-competitive practices like price rigging, cartelization, ring formation or adopt unfair practices both civil and criminal aimed at preventing other bidders from quoting for the bid, any act inhibits competition or any act that will be detrimental to the interest of the KARNATAKA POWER CORPORATION LIMITED. If the bidder is found to have resorted to such practices as specified above, he and others who act in concert with him shall be debarred from quoting for this bid and for future bids for a period of three years.

24.0 Corrigendum/Modification/Corrections, if any will be published in the website only. For any clarification on e-procurement, request for e-procurement training, Bidders can contact HELP DESK at 080-25501216 / 25501227.

25.0 Any other information required may be obtained from the office of the undersigned during office hours.

Chief Engineer (Thermal Designs),
KARNATAKA POWER CORPORATION LTD.,
22/23, 2nd FLOOR, SUDARSHAN COMPLEX,
SHESHADRI ROAD, BENGALURU – 560009
KARNATAKA – INDIA.
Tel:080-22206223;
Email:
cetd@karnatakapower.com
eemyccpp@gmail.com
zld.yccpp@gmail.com

Website:http://www.karnatakapower.com

1.0 THE TERMS AND CONDITIONS OF CONTRACT

1.1 Definitions

1.1.1 In construing these **General Conditions of Contract** and the annexed specification, the following words shall have the meanings here in assigned to them unless there is something in the subject or context inconsistent with such construction.

1.1.2 "Owner" shall mean Karnataka Power Corporation Limited and shall include its successors and assignees.

1.1.3 "Corporation" shall mean Karnataka Power Corporation Limited (KPCL) on whose behalf the enquiry is issued by its representative, the Engineer and shall include its successors, assignees as well as its authorized officer / representative.

1.1.4 **"Contractor"** shall mean the SUCCESSFUL BIDDER whose BID has been accepted by the CORPORATION and who has entered into an agreement with the CORPORATION for the fulfilment of the CONTRACT and shall include his heirs, legal representatives, successors.

1.1.5 **"Contract"** means this "Design, Engineering, Supply, Erection and Commissioning Contract" comprising of the Bid Document, the Final Proposal, Letter of Award, the Letter of Acceptance, the Contract Agreement executed, the Terms and Conditions of Contract, the Schedules and Appendices and such further documents as may be expressly incorporated in the Contract Agreement by reference and all amendments in writing made to any of them in accordance with the provisions contained in this behalf in the Contract and executed by duly authorized representatives of the Parties.

1.1.6 **"Owner's Representative or Engineer"** means the concerned Chief Engineer or the person appointed by the Owner from time to time and notified as such to the Contractor to act as Owner's Representative for the purposes of the Contract.

1.1.7 **"Owner's Instructions" or "Owner's Representative's Instructions"** shall mean any instructions**,** drawings**,** specifications, details, directions and explanations in writing issued by them from time to time during the subsistence of the Contract.

1.1.8 **"Consultant"** shall mean the person or firm named in the contract to work as consultant or such other person as may be duly authorized and appointed by the 'Corporation' to act as consultant for the purpose of contract.

1.1.9 **"Party"** means Owner or Contractor individually and "Parties" means Owner and Contractor collectively.

1.1.10 **"Annexure"** means all appendices, annexures and schedules annexed to this Contract or incorporated by reference herein and shall include all amendments and revisions thereto made by mutual agreement of Owner and Contractor in accordance with the provisions contained in this Contract.

1.1.11 **"Applicable Laws"** means all laws, treaties, ordinances, rules, regulations and amendments thereto made from time to time and in force and effect, judgments, decrees, injunctions, writs and orders of any court, arbitrator or governmental agency or authority, rules, regulations, orders and interpretations of any Governmental Instruments, court or statutory or other body having jurisdiction over construction of the Facility at Site, Performance of the Work, operation and maintenance of the Plant, including Applicable Permits, as may be in effect at the time of performance of work hereunder by the Contractor, provided, however, that if any time the Applicable Laws are less stringent than the standards set forth in the Contract hereto, Contractor shall not be excused from meeting the standards set forth in said Contract hereto.

1.1.12 **"Applicable Permits"** means all Permits required to be obtained or maintained in connection with construction of the Plant on the Site, Performance of Work and the operation of the Plant and its maintenance, as may be in effect at the time of Contractor's performance of Work hereunder; provided, however, that if any time the standards under Applicable Permits are less stringent than the standards set forth in Contract, Contractor shall not be excused from meeting the standards set forth in Contract.

1.1.13 **"APPROVED and `APPROVAL"**, where used in the 'Specification' shall mean, respectively, approved by and approval of the OWNER or the ENGINEER. When the words `Approved', `Approval', `Subject to Approval', `Satisfactory', `Equal to', `Proper', `Requested', `As directed', `Where Directed', `When Directed', `Determined by', `Accepted', `Permitted', or words and phrases of like import are used, the approval, judgments, direction, etc., is understood to be a function of the OWNER or the ENGINEER

1.1.14 **"Bid"** means the offer of the bidder to the Owner in response to the Bid Enquiry as set forth in the Final Proposal. Bidder/Tenderer shall mean the Firm/party who quotes against this enquiry.

1.1.15 **"Others"** shall mean other successful Bidders whose contracts have been accepted by the 'Corporation' and to whom orders have been placed by the 'Corporation' for the supply of other 'Plant/works' and shall include their heirs, legal representatives' successors and permitted assigns.

1.1.16 **"Certificate of Taking-Over"** shall mean the certificate issued by the Owner after completion of 'Tests before Take Over'.

1.1.17 **"Change in Law"** means the occurrence of any of the following after the effective date of the Agreement.

a. The enactment of any new Indian law.
b. The repeal, modification or re-enactment of any existing Indian law;
c. The commencement of any Indian law which has not yet entered into effect,
d. A change in the interpretation or application of any Indian law by an Indian Government instrumentality having direct authority for its interpretation or application.
e. The imposition (other than for Cause) of a requirement for an approval which did not exist as on the date of the Agreement.
f. Change in the manner in which an Indian Permit granted to the Company or Applicable Law or Applicable Permit is applied or interpreted by any Government Instrumentality having authority for the interpretation, application or enforcement of such Indian Government Permit or Applicable Law or Applicable Permit (including any change in the interpretation of best available control technology or other environmental standard) on or after the date of this Agreement or the issuance of the relevant Applicable Law or Applicable Permit, whichever is later.
g. The revocation or cancellation (other than for Cause) of any Permit.
h. Any other change in or other alteration of the application to the Owner in relation to the Project of GST, or Depreciation Schedules or imposition of any Surcharge or similar Duty or depreciation schedules.

1.1.18 **"AWARD OF CONTRACT"** shall mean issue of the Letter of Award (LOA).

1.1.19 **"Commencement Date"** means the date on which the Contractor is to commence the work or its obligations under the Contract as specified in LOA, delivered by the Owner to the Contractor under and in accordance with the Contract.

1.1.20 **"Commissioning"** shall mean integrated activity covered under "Preliminary Operation", "Initial Operation", "Trial operation", and carrying out "Tests before Taking-over" of Plant under the Contract.

1.1.21 **"Completed Performance Test"** means with respect to the Plant, the Performance Test conducted in accordance with the Contract during which the Plant and the operation thereof comply with all Applicable Laws and the Performance Guarantees and which are established as completed Performance Test in accordance with the provisions of the Contract in this behalf herein.

1.1.22 **"General Conditions of Contract"** means the 'Terms and Conditions of Contract' as amended in accordance with the provisions contained in this behalf herein.

1.1.23 **"CONTRACT PERIOD"** shall mean period of **Twenty four (24)** calendar months commencing from date of issue of Letter of Award comprising **Twelve (12)** calendar months of completion period or to the extent of valid extension permitted by the OWNER and **12 calendar months** of Guarantee Period thereafter during which the 'CONTRACT' shall be executed as agreed between OWNER and BIDDER.

1.1.24 **"COMPLETION PERIOD"** shall mean a period of **Twelve (12)** calendar months including monsoon period for completion of entire scope of works from the date of issue of Letter of Award.

1.1.25 **"Contractor's Works"** or "Manufacturer's Works" shall mean the places which are used by the Contractor or any of its sub-vendor / Sub-Contractor for the manufacture of equipment for the Plant or performance of Work.

1.1.26 **"Contractor's Equipment"** means all machinery, apparatus, equipment, appliances, materials, items and other things (other than temporary works) of whatsoever nature required for the execution and completion of the Works, performance of the Contractor's obligations under the Contract including Work, establishing of performance Guarantees and the remedying of any defects and deficiencies, but does not include equipment, machinery, materials and other things intended to form or forming part of the Plant.

1.1.27 **"Contractor permits"** means all Permits, required by the Contractor from any Government Instrumentality for the performance of any of the obligations of and Work by the Contractor under the Contract including without limitation, all registrations and licenses required to permit the Contractor to do business in the jurisdiction where it has to perform any part of the Work but excluding Permits including authorizations, consents and approvals required solely for the operation of the Plant.

1.1.28 **"Contractor's Representative"** means the person named as such in the Contract or other person appointed from time to time by the Contractor in his place in accordance with the Contract.

1.1.29 **"Contractual Time for Completion"** shall mean the time for completing all the Works under the Contract and completion successfully of all Performance Tests and of 'Tests before Taking Over' as per clause 9.3 of this Section.

1.1.30 **"Cost"** means all expenditure properly incurred (or to be incurred) by the Contractor, whether on or off the Site, including overhead and similar charges, for

the full complete and proper performance of Work including discharge of the Contractor's obligations under and in accordance with the Contract but does not include profit.

1.1.31 **"Documents"** means all design documents, engineering documents, drawings, calculations, computer software (programs), computer diskettes and tapes, audio and video tapes, samples, patterns, models, construction documents, erection documents, operation and maintenance manuals and other manuals and all other data and information to be submitted by the Contractor and shall include without limitation engineering, design and construction drawings, data sheets, specifications, plans, bills of materials and estimates.

1.1.32 **"DRAWINGS"** shall mean all;

a. Drawings furnished by the OWNER or the ENGINEER as a basis for proposals.
b. Drawings furnished duly approved by the OWNER.
c. Supplementary drawings furnished by the OWNER or the ENGINEER to clarify and to define in greater detail the intent of the `CONTRACT';
d. Drawing submitted by the BIDDER with his proposal provided, such drawings are acceptable to the OWNER or the ENGINEER;
e. Drawings furnished by the OWNER or the ENGINEER to the BIDDER during the progress of the work and
f. Engineering data and drawings submitted by the BIDDER during the progress of the work, provided such drawings are acceptable to the OWNER.

1.1.33 **"EFFECTIVE DATE OF CONTRACT":** The Contract shall be deemed to have come into force and effect from the date of issue of Letter of Award by the Owner to the Contractor.

1.1.34 **"SITE"** shall mean and include all the area in which operations in respect of the work are carried out. This term shall also include materials stacking yard and the area where temporary structures are put up for installing machinery etc. SITE shall also mean the actual place of the proposed Project as detailed in the Specification or other place where Work has to be executed under the CONTRACT.

1.1.35 **"Performance Acceptance"** means the actual acceptance by the Owner of the Plant as a whole in accordance with clause No.6.0 of Section - C8 of Volume-I - PART-II-SCC of Conditions of Contract. After completion and it being placed in operation in accordance with the Contract.

1.1.36 **"Final Payment Certificate"** means the payment certificate issued by the Owner or his Representative under Clause 13.6 here of to the Contractor.

1.1.37 **"Final Proposal"** means the document containing the final technical proposal of Contractor for the Plant as modified and agreed to in writing by the Owner and shall include but not be limited to technical information, data, documents and drawings forming part thereof annexed hereto and marked as Appendix.

1.1.38 **"Force Majeure Event"** shall have the meaning set-forth in clause no. 20 of these Conditions of the Contracts.

1.1.39 **"Currency"** means Indian Rupees and the Contract Price is payable in Indian Rupees ONLY.

1.1.40 **"ACT OF INSOLVENCY"** shall mean any Act of Insolvency as defined by the Presidency Towns insolvency Act or the Provisional Insolvency Act or any amending statute.

1.1.41 **"Guarantee and Warranty"** means all guarantees and warranties provided or agreed to be provided under the Contract for and in respect of the equipment, work, components, materials, supplies and parts and Works forming part of or incorporated in the Plant or the project or relating thereto supplied or provided by the Contractor and shall include any guarantee or warranty provided or furnished by a Sub-Contractor under a Sub-Contract.

1.1.42 **"Good Engineering Practice"** means those practice, methods, acts, techniques and standards as may be followed or employed in the performance of the Work and discharge of its obligations by the Contractor and which (i) are generally accepted internationally for use in the electric utility industry, taking into account conditions in India, in connection with power stations of the same or similar size and type as the Plant (ii) are commonly used in prudent electric utility engineering, construction, project management and operations and (iii) would be expected to result in performance of the Services and completion of Works in a manner consistent with Applicable Laws, Applicable permits, reliability, safety, environmental protection, economy and expediency.

1.1.43 **"Government Instrumentality"** means the Government of India, the Government of Karnataka and any other State, or any political subdivision, ministry, department, agency, Corporation, commission or any regional, local or municipal authority or governmental body thereof or any other governmental or statutory body under the direct or indirect control of the Government of India or Government of Karnataka or of any other State, or of any political subdivision, ministry, department, agency, Corporation, commission, or any regional, local or municipal authority or governmental body thereof and shall include without limitation any other governmental or statutory body having jurisdiction over the Facility or over the

performance of any part of Work or the Works or any obligation of the Contractor or the Owner under the Contract.

1.1.44 **"Initial Operation"** with respect to the Plant means all operations undertaken as part of "Commissioning" after completion of "Preliminary Operation".

1.1.45 **"Hazardous Materials"** means (i) hazardous materials, hazardous wastes, hazardous substances, toxic substances of contaminants as those terms are defined under any environmental law or regulation, including , but not limited to, applicable laws, and in the regulations adopted or promulgated pursuant there to: (ii) petroleum and petroleum products including crude oil and any fraction s thereof: (iii) any other hazardous, radioactive, toxic or noxious substance material, pollutant, or solid, liquid or gaseous waste; and (iv) any substance that, whether by its nature or its use is subjected to regulation under any environmental law or with respect to which any applicable environmental law or any governmental instrumentality requires environmental investigation, monitoring or remediation.

1.1.46 **"Inspector"** shall mean the authorized representatives appointed by the Owner or the Consultant or Owner's Third Party Inspection Agency for purpose of the inspection of materials / Equipment / Works / Services.

1.1.47 **"Latent Defect"** for the purpose of the clause no.12.1 (j) of the Conditions of Contract means a defect which was in existence during the applicable Warranty period but was not reasonably discoverable during such Warranty period.

1.1.48 **"Letter of Award" or "LOA"** means the formal communication in writing by the Owner to the Contractor of the acceptance of the Contractor's Bid. **The date of issue of Letter of Award will be reckoned as "zero date" of the contract for the purpose of monitoring the Plant schedule/ Milestones of the contract.**

1.1.49 **"Currency"** means the Indian Rupees only.

1.1.50 **"Manuals"** means all the various manuals to be provided as per the Contract by the Contractor and shall include Manuals described in Specifications to take Conditions of Contract and Operating Manual and Manuals to be provided by a Manufacturer.

1.1.51 **"Manufacturer"** means any entity or firm who is the producer and furnisher to the Contractor of any material or designer and fabricator of any equipment / a system which is to be incorporated in or forms part of the Plant / Works.

1.1.52 **"Materials"** means things of all kinds (other than the Equipment) to be provided and incorporated in the permanent Works / Plant by the Contractor, including the

supply-only items (if any) which are to be supplied by the Contractor under the Contract.

1.1.53 **"Mechanical Completion"** means with respect to the Plant, the completion of all Works by the Contractor including completion of construction, erection, installation and calibration and construction testing services with respect to all mechanical, electrical, structural, instrumentation and control systems (including Equipment) of the Plant, and the Plant has achieved a state of readiness for "Preliminary Operation". The existence of Punch List items which do not prevent or adversely affect the Plant, from being in a state of readiness for "Preliminary Operation" shall not be construed as preventing the Plant from achieving Mechanical Completion.

1.1.54 **'Month'** shall mean the calendar month and 'Day' shall mean the calendar day.

1.1.55 **"Monthly Progress Report"** or "Progress Report" means a progress report meeting the requirements set forth in sub - clause 3.16.4 of the specification hereto.

1.1.56 **"Notice of Performance Acceptance"** shall have the meaning set-forth in clause No. 6.7 of Section - C8 of Volume-I - PART-II- SCC.

1.1.57 **"Notice of Project Completion"** shall have the meaning set forth in clause no. 10.2 hereof.

1.1.58 **"Notice in Writing" or "Written Notice"** shall mean a notice in writing, typed or printed or hand written characters**,** sent (unless delivered personally or otherwise proved to have been received) by registered post or by any agreed system of electronic transmission to the last known private or business address or registered office of the addressee and shall be deemed to have been received when in the ordinary course of post it would have been delivered.

1.1.59 **"Operating Manual"** shall have the meaning set forth in Specification hereof.

1.1.60 **"Permanent Works"** means the permanent works, equipment and materials including all civil and electro-mechanical works to be designed, engineered, manufactured, installed, erected, supplied, executed, commissioned or tested in accordance with the Contract and which form part of the Facility.

1.1.61 **"Performance Certificate"** means the certificate issued by the Owner under clause no. 12.12.

1.1.62 **"Performance Guarantee test"** shall mean the tests as prescribed in the specification to be done by the 'Bidder' to prove the efficiency, operating and

acceptance parameters as guaranteed in the contract document & shall have the meaning set forth in this Section and Section F3 thereof.

1.1.63 **"Permit"** means any valid permit, authorization, license, registration, approval, consent, waiver, exemption, variance, franchise or any similar order of or from of any Government Instrumentality, court or other body having jurisdiction over the matter in question.

1.1.64 **"Person"** means any individual, Corporation, partnership, association, Joint Stock Company, unincorporated organization, joint venture, government or political subdivision or agency thereof.

1.1.65 **"Project / Plant Completion"** means when the Plant /System is complete in all respects and after commissioning, initial operation, testing and proving of Performance Guarantees in accordance with the Contract, the Owner has issued to the Contractor a Take-over certificate.

1.1.66 **"Preliminary Operation"** means all activities undertaken as part of Commissioning after Mechanical Completion up to commencement of Initial Operation and shall include mechanical and electrical checkouts, calibration of instruments and protection devices, commissioning of sub / supporting systems.

1.1.67 **"Project Schedule"** shall have the meaning set forth in clause No. 3.17 hereof.

1.1.68 **"Prudent Utility Practice"** means those practice, methods, equipment specifications and standards of safety and performance, as the same may change from time to time, as are generally accepted for use in electricity generating utilities taking into account conditions in India and commonly used in prudent electricity generation utility engineering and operations including design, engineering construction, erection, commissioning, operation and maintenance of power generating stations and equipment comprised therein lawfully, safely, efficiently and economically for facilities of the type and size similar to the Project and that generally conforms to the Equipment manufacturer's operation and maintenance guidelines.

1.1.69 **"Punch List"** means the list prepared by Owner during the time of Performance Acceptance test, there after periodically revised by Owner as necessary and in any case updated by Owner within 20 days following Owner's receipt of a Notice of Performance Acceptance, in each case with the full co-operation of Contractor, which list shall set forth certain items of work which remain to be performed by the Contractor in order to ensure that the Plant fully complies with all of the standards and requirements set forth in the Contract. The Punch List shall not include any

items of work, alone or in the aggregate, the non-completion of which prevents the Plant as a whole from (a) being used for its intended purposes as described in the Contract in accordance with Applicable Laws and Applicable Permits or (b) being legally, safely and reliably placed in commercial operation. For the purposes of the Contract including Conditions of Contract, the expression "legally, safely and reliably placed in commercial operation" means that the Facility, will operate in the manner intended as described in the Contract, in accordance with all Applicable Laws and Applicable Permits, and without undue risk of damage or injury to the Plant or Persons.

1.1.70 a) **"Risk Transfer Date"** is the date of "Take Over" of the Plant by the Owner.

b) **"Trial Operation"** shall have the meaning as per Clause 6 of Section C8 of specification.

1.1.71 **"Schedule of Payments"** means the Payment as per clause 13.3.

1.1.72 **Scope Change or Change Orders"** means any addition to, deletion from, suspension of or other modification to the requirements of the Contract which necessitates a change in one or more of the Contract Price, a Guaranteed Completion Date, the Project Schedule or the Performance Guarantees in accordance with the terms of clause no. 14.0 hereof.

1.1.73 **"Scope Change Order or Change Order Notice"** means a written notice to Owner issued by Contractor indicating that a Scope Change Order is required in connection with the performance of the Services.

1.1.74 **"Scope Change Order Request or Change Order Notice Request"** means a written proposal issued and signed by Owner requesting a Scope Change, submitted to Contractor by Owner pursuant to the terms of clause no. 14.0 hereof.

1.1.75 **"Schedule"** means collectively all the schedules including Project Schedule, Milestone Schedule and other schedules pertaining to the Work and the Plant as detailed in the Contract.

1.1.76 **"Services" or "Work"** means all the work and obligations of the Contractor under the Contract without limitation of the Work and services briefly described in Specification.

1.1.77 **"Sub-Contractor"** means any person named in the Contract as a Sub-Contractor, manufacturer or supplier for a part of the Works or any person to whom a part of the Works has been subcontracted in accordance with clause no. 4.0 and the legal

successors in title to such person, but not any assignee of such person.

1.1.78 **"Specifications"** shall mean collectively all the terms and stipulations contained in those portions of the 'bid document' and such amendments, deletion, additions, revisions as may be made in the agreement in regard to the method and manner of performing the 'works' or to the quantities and qualities of the materials to be supplied under this 'contract'.
Project Schedule, all Appendices to the Contract, Appendices to these Conditions of Contract, Performance Guarantees, all terms and stipulations of the Contract, and such amendments and revisions, as may be made in the Bid Documents or to the Contract and all written agreements made after the execution of the Contract by the Parties, or which may pertain to the method and manner of performing the Work under the Contract as agreed to by the Owner.

1.1.79 **"Take Over" or "Taking Over"** shall mean taking-over of the Plant by the Owner for the purpose envisaged under the Contract or that for which the Plant is commercially capable, as certified upon completion of Trial Operation and Performance tests as specified in the Contract.

1.1.80 **"Take over Certificate"** means the certificate issued under clause No. 10.2.

1.1.81 **"Temporary Works"** means all temporary works of every kind (other than Contractor's equipment) required for the execution and completion of the works and the remedying of any defects.

1.1.82 **"Bid Documents"** means the Invitation to this Bid together with all amendments thereto and clarifications if any issued by the Owner from time to time in respect thereof.

1.1.83 **"Tests"** means all tests to be undertaken by the Contractor under or pursuant to the Contract including all the tests set-forth in Contract.

1.1.84 **"Tests before Take-Over"** means the tests prescribed in the 'Specification' and any other such tests as may be agreed between the Owner and Contractor or instructed as a Change Order, which has to be carried out by the Contractor before the Plant is taken over.

1.1.85 **"Guarantee Period"** for Plant or any Portion shall mean the period of 12 (twelve) months beginning from the date the Plant as a whole is taken as stated in the Certificate of Taking Over. During this Guarantee Period, the Contractor will be liable to rectify defects in the Plant / section / equipment due to Contractor's / manufacturer's / Sub-Contractor's faulty design, workmanship or defective materials

used / supplied by the Contractor / manufacturer / Sub-Contractor. This may be read with Clause No.12.

1.1.86 **"Works"** means the Plant and shall include all permanent works comprised in or forming part of the System and the temporary works or either of them as appropriate.

1.1.87 **"Writing"** shall include any manuscript, e-mail, typewritten or printed statement, under or over signature and / or seal as the case may be.

1.1.88 **"Codes** and standards" shall mean all the applicable codes and standards as indicated in the technical specification.

1.1.89 The term **equipment portion** or the supply portion of the contract price shall mean the all-inclusive FOR destination (site) value of the equipment / supplies to be made under the contract.

1.1.90 **"The term erection portion of the contract price**" shall mean the value of the field activities of the work including but not limited to the erection, testing, commissioning, etc. to be performed at site by the Contractor

1.1.91 **'Plant' or 'equipment'** or 'works' shall mean the goods to be supplied and service to be provided by the 'Bidder' under the contract.

1.1.92 The word **`CONTRACT PRICE'** shall mean the price stated in the letter of award and thereafter as adjusted in accordance with the provisions of the contract.

1.1.93 **'ENGINEER'S INSTRUCTIONS'** shall mean any drawings and/or instructions oral and/or in writing, details, directions and explanations issued by the ENGINEER or the OWNER from time to time during the `CONTRACT PERIOD'.

1.1.94 **'Correspondence'** shall mean any letter, telex, E-mail, or other written communication related to the contract but excluding 'notices'.

1.1.95 **'Services' means installation,** testing, commissioning, provision of technical assistance, training and other such obligations of the supplier covered under the contract.

1.1.96 Words imparting **'person'** shall include firm, company, Corporation and association or bodies of individuals whether incorporated or not.

1.1.97 Words imparting **'singular'** shall also include plural and vice versa where the context

so requires.

1.1.98 **"Goods"** shall mean the equipment machinery and/or other materials which supplier is required to supply under contract.

1.1.99 **'Prescribed'** shall mean those conditions, prescribed by the 'Corporation' or its authorized representatives.

1.1.100 **'Unit'** shall mean the power generating unit consisting of all auxiliaries and support system for which the Plant/equipment/works 'is supplied. The unit size and capacity is as indicated under Project title furnished in the project information in volume-1, part-II, section B of the bid document.

1.1.101 **'Final completion'** shall mean that all works indicated in the contract scope of work is completed as directed & the site is cleared to the satisfaction of the Corporation or the engineer.

1.1.102 **'Take-over of Equipment/system'** shall mean taking over of the Equipment/system as per clause 10.2

1.1.103 '**CAMP AREA'** shall mean the area in which the Bidder has temporarily housed his labour force deployed for the execution of work with the permission of the Engineer.

1.1.104 **'MACHINERY'** shall mean and include any or all Plant, machinery, tools and other implements of all description necessary for the execution of the work in safe and workman like manner.

1.1.105 The Words **`TENDERER' and `BIDDER'** shall have the same meaning wherever used in this contract.

1.1.106 The expression **`WORK' or `WORKS'** where used in this contract shall unless there be something in the subject or context repugnant to such construction be construed to mean the work or works to be executed under or by virtue of the contract, whether temporary or permanent, whether original, altered, substituted, additional or modified.

1.1.107 Wherever figures are given under the word **`Elevation' or** an abbreviation of it or where figures representing elevations are given, they shall mean the elevation relative to the arbitrary permanent bench mark fixed by the ENGINEER for the particular work, located as shown on site plan or a datum level established by the CORPORATION.

1.1.108 In case of any conflict relating to the meaning of the Terms and Conditions of Contract, Specification, Designs, Drawings and Instructions mentioned hereinafter and as to the quality of workmanship or materials used on the works, the decision of the ENGINEER shall be final, conclusive and binding on all parties to the "CONTRACT".

1.2 **Headings and Marginal Notes**

The section headings are not part of these Conditions and shall not be taken into consideration in their interpretation.

1.3 **Interpretation**

1.3.1 Words imparting persons or parties shall include firms, consortiums and Corporations and any organization having legal capacity. Words imparting the singular also include the plural and vice versa where the context requires. Words imparting one gender also include other genders.

1.3.2 Unless inconsistent with the provisions of the Contract, the meaning of any shipping terms and the rights and obligations of the parties thereunder shall be as set-forth in “INCOTERMS".

1.4.0 **Law and Language**

1.4.1 Applicable law to this Contract shall be the Indian Laws. The respective rights, privileges, duties and obligations of the Owner and the Contractor under this Contract shall be governed and determined by the Laws of State of Karnataka and of the Republic of India. All communication, correspondence and documentation pertaining to this Contract shall be in the English language only.

1.4.2 All measurements shall be in metric system.

1.5 **Contract**

The costs of stamp duties and similar charges imposed by law on the Contract or any part thereof Agreement shall be borne by the Contractor. However, stamp paper/ legal paper shall be purchased in the name of Owner.

1.6 **Effective Date of Contract**

The Contract shall be deemed to have come into force and effect **from the date of issue of the Letter of Award** by the Owner to the Contractor.

1.7 **Priority of Documents**

The documents forming the Contract are to be taken as mutually explanatory of one another. If there is an ambiguity or discrepancy in the documents, the Owner / Owner's Representative shall issue necessary clarifications or instructions to the

Contractor and as between the various documents forming part of the Contract, the priority of the documents shall be as follows:

(a) The Contract Agreement;
(b) Appendices to the Contract Agreement (to be finalized during Contract finalization)
(c) The Conditions of Contract
(d) The Letter of Acceptance
(e) The Final Proposal

For example in the event of any inconsistency between document at (a) above and other documents, document at (a) shall prevail and in the event of document at (b) above being inconsistent with document at (c) above, the document at (b) shall prevail over document at (c) above and so on.

1.8 **Documents on Site**

The Contractor shall keep on the Site one complete set of the Contract, the Documents, Change Orders, communications given and the documents referred to mention in sub-clause 1.7. The Owner, the Owner's Representative and his delegates (as referred to in sub-clause 2.5.5) shall have the right to use such Documents at all reasonable times.

1.9 **Communications**

1.9.1 Wherever provision is made for the giving or issue of any notice, instruction, communication, consent, approval, certificate or determination by any person, unless otherwise specified, such communication shall be in writing.

1.9.2 The expression "written" or "in writing", shall mean for the purposes of this Contract any hand-written, typed or printed communication, including the agreed system of electronic transmission followed by authenticated hard copy and fax.

1.9.3 All certificates, notices**,** communications or orders to be given to the Contractor by the Owner or the Owner's Representative, and all notices or communication, to be given to the Owner or to the Owner's Representative by the Contractor, shall be in writing and may either be delivered by hand against written acknowledgement of receipt, or be sent by airmail or one of the agreed systems of electronic transmission. The addresses for the receipt of such communications shall be as stated in the Contract as modified by notice given in accordance with this clause no. 1.9.

1.10 **Provision of Documents**

1.10.1 The Documents referred to in Section C11 of Vol-I of SCC shall be in the custody and care of the Contractor. The Contractor shall furnish adequate number of copies / prints of documents, drawings to the Owner / Owner's Representative as specified.

Distribution schedule for documents, drawings, correspondences shall be worked out at the contract stage.

1.10.2 In addition, and without prejudice to the foregoing the Contractor shall provide to the Owner as built drawings of the Plant within 30 days of Final Performance Acceptance.

1.11 **Contractor's Use of Owner's Documents**

Copyright in the Owner's requirements and other documents issued by the Owner or the Owner's Representative to the Contractor shall (as between the parties) remain the property of the Owner. Ownership in all documents provided by the CONTRACTOR to the Owner pursuant to the Contract including design, engineering, drawings and Plant layout (but excluding proprietary information and manuals provided by vendors of equipment for use of the Owner) shall be with the Owner. The Contractor may, at its cost, copy, use and communicate any such documents for the purposes of the Contract. They shall not, without the Owner's consent, be used, copied or communicated to a third party by the Contractor, except as necessary for the purposes of the Contract including performance of Work.

1.12 **Confidential Details**

The Contractor shall treat the details of the Contract as private and confidential, except to the extent necessary to carry out his obligations under it. The Contractor shall not publish, permit to be published, or disclose any particulars of the Contract in any trade or technical paper or elsewhere without the previous consent in writing of the Owner and at the Owner's sole discretion.

1.13 **Compliance with Statutes, Regulations and Laws**

The Contractor shall, in all matters arising in the performance of the Contract including performance of its obligations, comply with, give all notices under, and pay all fees required by, the provisions of any national or state statute, ordinance or other law, or any regulation of any legally constituted public authority having jurisdiction over the Works and as applicable to the Work and to the performance by the Contractor of its obligations under the Contract. The Contractor shall obtain all Contractor Permits and those permits as per Table - 1 of this section sufficiently well in time so to perform its obligations and complete the Works and the Project in accordance with the Project Schedule. Without prejudice and in addition to the foregoing the Contractor shall pay all fees, obtain all permits, licenses or approvals required for any part of the Works as per Table 1 of this Section, in reasonable time taking into account the delivery schedule of the Equipment and materials and the Project Schedule the Guaranteed Time Schedule including time schedule for completion of the Work. The Contractor shall comply with all the Applicable Laws and those laws and regulations which may apply to the Contractor.

1.14 **DELETED**

1.15 **Assignment**

1.15.1 The Contractor shall not without the prior consent of the Owner assign to any person any benefit of or obligation under the Contract in whole or in part. Such assignment, if approved by Owner, shall not relieve the Contractor from any obligations, duty or responsibility under the Contract.

1.15.2 Any Sub-Contracts entered into by Contractor pursuant to clause no. 4.0 of these Conditions of Contract shall provide that, pursuant to terms that are available on a commercially reasonable basis, the rights and obligations of the Contractor under each such sub-Contracts are assignable and delegable to Owner, its successors and assignees and shall be deemed to have been assigned to the Owner, upon Owner's written request without any further act, deed or thing and irrespective of termination or otherwise of the Contract.

2.0 THE OWNER

2.1 **Access and Right to use of the site: -**

2.1.1 The owner shall grant the contractor right of access to, and make available the site to the contractor in accordance with the terms of the owner's property rights immediately for the performance of the work pursuant to and in accordance with the contract. Such right and use of the Site may not be exclusive to the contractor.

2.1.2 If the contractor suffers delay and/or Incurs cost from failure on the part of the owner to grant right of access to or availability of the site, the contractor shall give notice to the owner. After receipt of such notice the owner/owner's representative shall proceed to determine:

a. Any extension of time to which the contractor is entitled under sub-clause 9.4
b. The amount of such reasonable direct cost, if any, which the contractor shall suffer or incur on this account by reason solely of breach by Owner of its obligations under this clause no.2.1 of these conditions of contract, shall be added to the contract price and shall notify the contractor accordingly.

2.2 **Permits Licenses or Approvals**

2.2.1 The Owner shall, at the request and cost of the Contractor assist him in applying for Contractor Permits. Such requests may also include requests for the Owner's assistance in applying for any necessary government consent for the export of Contractor's equipment when it is removed from the Site.

2.2.2 The Owner's assistance in applying for permits, licenses or approvals (for which the Contractor is responsible under the Contract) is not obligatory and the extent of such assistance shall be at the sole discretion of the Owner. In any case, the Contractor

shall be responsible for applying and obtaining the permits, licenses or approvals as required to be obtained by Contractor for completion of the Works as per the Project Schedule agreed in the Contract irrespective of the manner, outcome and extent of assistance from the Owner. All the necessary fees and any incidental charges required to be paid for obtaining all Contract permits **shall be borne by and be the liability of the Contractor**.

Owner shall be responsible for obtaining only those permits / approvals listed as Owner's responsibility in Table enclosed at the end of this section.

2.3 **Owner's Entitlement to Terminate**

The Owner shall be entitled to terminate the Contract in whole or in part at the Owner's convenience, at any time by giving 60 days' prior notice to the Contractor. Such notice of termination shall specify that termination is for Owner's convenience, the extent to which the performance of Works under the Contract is terminated and the date upon which such termination becomes effective. In the event of such termination, the Contractor:

a. Shall proceed in accordance with sub-clause 15.3 and
b. Shall be paid by the Owner in accordance with sub-clause 20.6.

2.4 **Owner's Other Obligations**

2.4.1 Owner shall

a. Designate a person as Owner's Representative (the "Owner's Representative") to be the contact person for Contractor with respect to the performance of the Works and Contractor's obligation under the Contract and shall be authorized to act for and on behalf of Owner and administer this Contract on Owner's behalf, agree up on procedures for coordinating Owner's efforts with those of Contractor and as appropriate, make information available to Contractor.
b. Provide at its expense electricity as reasonably required during Commissioning and during Performance Tests before Take-Over including Performance Test and other tests as set-forth in Section C5 of Volume -I Part-II-SCC hereto. The provisions of POL and consumables as required for other activities and Work of the Contractor including those as per Sub-clause no. 3.12 of the Conditions of Contract shall, however, be by the Contractor at his cost and expense. Electricity required for Construction activities (06 KVA) and all tests before Take Over will be provided by the Owner on Free of Cost basis.

2.5 **The Owner's Representative**

2.5.1 **Owner's Representative's Duties and Authority**

The Owner's Representative shall carry out the duties specified by Owner. The Owner's Representative shall have no authority to amend the Contract. It shall also include Consultant / Consulting Engineer or Third Party Inspection Agency as required or deemed appropriate by the Owner.

2.5.2 The Owner's Representative may exercise the authority specified in or necessarily to be implied from the Contract to the extent they are covered under the terms of his appointment by Owner. If the Owner's Representative is required, under the terms of his appointment by the Owner, to obtain the specific approval of the Owner before exercising such authority, such requirements shall be as stated in Contract. In respect of Work generally, review of the documents, access to the Site and the Work and all other similar rights of the Owner, the term Owner shall be deemed to include Owner's Representative.

2.5.3 Except as expressly stated in the Contract, the Owner's Representative shall have no authority to (a) amend, alter, modify or waive any provision or term of the Contract, or (b) relieve the Contractor of any of his duties, obligations or responsibilities under the Contract. Any proposal, inspection, examination, testing, consent, approval or similar act by the Owner's Representative (including absence or disapproval) shall not relieve or absolve in any manner whatsoever, the Contractor from any responsibility, liability or obligation under the Contract, including responsibility and liability for his errors, omissions, discrepancies, and non-compliance with the Specifications and any provisions of the Contract.

2.5.4 Communication with the Owner's Representative shall be as per Document Distribution Schedule which will be furnished to the successful bidder.

2.5.5 **Owner's Representative's Authority to Delegate**
The Owner's Representative may from time to time delegate any of his duties to any of his assistants (a “delegate”), and may at any time revoke any such delegation. Any such delegation or revocation shall be in writing and shall not take effect until a copy thereof has been delivered to the Owner and the Contractor.

2.5.6 Any determination, instruction, inspection, examination, testing, consent, approval or similar act by any such delegate of the Owner's Representative, in accordance with the delegation, shall have the same effect as though it had been an act of the Owner's Representative. However**,** any failure to disapprove any Plant, materials, design or workmanship shall not prejudice the right of the Owner's Representative to reject such Plant, materials, design or workmanship,

2.5.7 **Owner's Representative's instructions**
Unless it is legally not permissible, the Contractor shall comply with instructions given by the Owner's Representatives in accordance with the Contract.

3.0 WORK TO BE PERFORMED BY CONTRACTOR AND CONTRACTOR'S OBLIGATIONS.

3.1 General

3.1.1 The Owner has engaged the Contractor relying upon the representations, assurances and warranties made by the Contractor including the representation that the Contractor has the experience skill and resources to perform the work and to design, engineer, erect, construct, build and complete in all respects the Plant and fit for the purpose and deliver the same to the Owner on a turnkey basis in accordance with the Contract, and Contractor acknowledges such reliance by the Owner and the acceptance by the Contract or of such engagement. Owner and Contractor agree and acknowledge that notwithstanding anything to the contrary contained in this Contract, this Contract is a turnkey Contract and that Contractor's obligation is to provide Owner with a fully operational Plant, completed in every detail and in all respects according to the Contract, within the Guaranteed Time Schedule and to have the performance as per the Performance Guarantees set-forth in the Contract and for the purpose designated herein by Owner and to do and furnish everything necessary in connection therewith or required therefor.

3.1.2 Guarantees set-forth in the Contract and for the purpose designated herein by Owner and to do and furnish everything necessary in connection therewith or required therefor.

3.1.3 Without prejudice to the foregoing, except as otherwise expressly set forth in the Contract as within the scope of Owner's obligations under the Contract, the Contractor shall perform or cause to be performed all work and services required in connection with the design, engineering, supply of equipment, procurement (including, without limitation, all transportation services in connection therewith), construction, erection, start-up, commissioning, testing including conducting of Performance Tests and other works and services up to the Takeover of the Plant by the Owner and in connection therewith provide all materials, equipment, machinery, tools, labour, transportation, administration and other services and items required to complete the Facility in all respects up to the Taking Over and having the performance as guaranteed under the Contract by the Contractor on a total lump-sum, fixed price basis and otherwise in accordance with this Contract. If there are any supplies, work and services required in connection with the design, engineering, procurement, manufacture, supply, transportation to site, fabrication, construction, erection, testing, commissioning and up to Take-Over of the Plant which are not specifically mentioned in the Contract or which are not under the Contract expressly stated to be outside the Contractor's Scope of Work described in the Contract, but which are necessary to complete, commission and operate the Plant and have the performance as guaranteed under the Contract by the Contractor including for normal, safe and continuous operation of the Plant. The Contractor shall provide or cause the same to be provided as part of its services under the Contract. The Work to be performed by the Contractor under the Contract shall, without prejudice to the

generality of the foregoing include but not be limited to the following:

(a) All engineering and design services including necessary investigations required for a completely engineered Plant including necessary documentation.

(b) Provision of all equipment, systems and materials that will be merchantable, new and of first class quality, Contractor's equipment, temporary works and all other items, whether of a temporary or permanent nature including those required for the design, execution, completion and remedying of defects during Warranty Period.

(c) Transportation from works, Port of entry and import clearance and handling services in and into India and inland transportation from the relevant points of delivery required in connection with the completion of the Plant and the performance of the other Work.

(d) Project management.

(e) Receipt of (b) above at site including stores management.

(f) Construction infrastructure services, civil and structural construction; mechanical, electrical and instrumentation, erection and installation services; Mechanical Completion, testing and commissioning, start-up, Initial Operation, and conducting of Performance Tests and proving of Performance Guarantees before Take Over of the Plant including all relevant licensing and permitting including obtaining of all applicable Permits, with Contractor having responsibility for overall co-ordination of licensing and permitting under this Contract and all training activities.

(g) Provision of all necessary superintendence, labour, construction fuels and construction materials, (but not electricity for commissioning, testing and operating the Plant which Owner will provide to Contractor at no cost), construction and other Contractor's Equipment chemicals, utilities, tools, supplies and other consumables and services and Work.

(h) Rectification of defects and deficiencies including replacement to achieve Performance Guarantees and / or remedying of defects and deficiencies discovered or occurring during Guarantee Period.

(i) Performance of all Work as per Contract.

3.2 Engineering and Design

3.2.1 Contractor shall provide all design and engineering services necessary for design, engineering, construction / erection, supply of equipment and completion of the Plant in accordance and conformity with the Contract, Good Engineering Practices and Prudent Utility Practices including:

(a) Preparation of

(i) The conceptual design including the design basis of Plant; and

(ii) The engineering and design necessary to describe and detail the Plant and the Project.

(b) Provision of criteria for the detailed design by other suppliers of Equipment/ system/ structures for incorporation into the Plant.

(c) Preparation of design, engineering drawings, plans, bill of material, schedule and estimates for the Plant and the project and the performance by Contractor of its obligations hereunder so that the Plant constructed and commissioned by the Contractor is capable of meeting the Performance Guarantees and will be such as could be legally, safely and reliably placed in commercial operation by the Owner in accordance with Prudent Utility Practices.

(d) Contractor shall co-operate with the Owner's other Contractors and suppliers (if any) in the design, engineering, procurement, fabrication, supply, delivery, construction, commissioning, start-up, testing, operation, maintenance and repair efforts, and otherwise accommodate their reasonable interface and interconnection requirements within the limitations of Contractor's design and scope of work hereunder and for Owner's other Contractors and suppliers, Owner shall be responsible for co-ordination and other interface requirements. Contractor shall also co-ordinate the architectural aspects of the Plant with Owner's architect (if any) to ensure architectural harmony with adjoining facilities to be supplied by Owner to the extent reasonably possible within the limitations of Contractor's scope of Work and other obligations hereunder.

3.2.2 **Design / Construction Documents**

(a) The Contractor shall prepare documents in conformity with Section C10 of Specification in sufficient detail to satisfy and comply with, all Applicable Permits including regulatory Approvals, to provide suppliers and construction personnel sufficient instruction to execute the Works, and to describe the operation and maintenance of the completed Works. The Owner / Owner's Representative shall have the right to review and inspect the preparation of design and construction documents.

(b) Each of the design and construction documents shall, when considered ready for use, be submitted to the Owner / Owner's Representative for pre-construction review. In this sub-clause 3.2.2, "review period" means the period required by the Owner's Representative, which shall not exceed 30 days, calculated from the date on which the Owner/Owner's Representative receives a design / construction document and the Contractor's notice that it is considered ready, both for a pre-construction review in accordance with this sub-clause 3.2.2, and for use thereof. If the Owner / Owner's representative, within such review period, notifies the Contractor that such design / construction document fails (to the extent stated) to comply with the Owner's requirements, it shall be rectified, resubmitted and again reviewed in accordance with this sub-clause, at the Contractor's cost. Any such notification by the Owner / Owner's Representative or their failure to so notify shall not,

however, relieve or absolve the Contractor in any manner whatsoever of its obligations, performance guarantees and warranties under the Contract.

(c) For each part of the Plant and except to the extent that the prior consent of the Owner/ Owner's Representative shall have been obtained:

(i) Construction and erection shall not commence prior to the expiry of the review periods for the design/ construction documents, which are relevant to the design and construction of such part;

(ii) Construction shall be in accordance with such construction documents and

(iii) If the Contractor wishes to modify any design or document which has previously been submitted for such preconstruction review, the Contractor shall immediately notify the Owner/ Owner's Representative, and shall subsequently submit revised documents to the Owner / Owner's Representative for pre-construction review.

(d) If the Owner / Owner's Representative instructs that further design/ construction documents are necessary for carrying out either pre-construction review or the Works, the Contractor shall upon receiving the Owner/ Owner's Representative's instructions prepare such design/ construction documents at no extra cost.

(e) Errors, omissions, ambiguities, inconsistencies, inadequacies and other defects shall be rectified by the Contractor at his cost.

(f) Manuals:

Contractor shall submit to Owner, as they become available from time to time during their preparation, all Contractor specifications and Documents including data sheets, plans and drawings, and other information and documents required for the Plant including those listed in Section C11 hereto (collectively, the 'Design Documents") as per specification. In addition, Contractor shall provide the following:

(i) Operating Manual:

Owner and Contractor shall work together to agree at the earliest practicable date on a preliminary outline of the form and content of, after the Notice to Proceed is issued, Owner and Contractor shall agree on the final form and content of, complete equipment and system instructions for the start-up, operation and maintenance of the Plant (the 'Operating Manual"). Contractor shall prepare Operating Manual in English language in individually numbered bound volumes and deliver to Owner as per the Distribution schedule. Contractor shall consult with Owner in the preparation of the Operating Manual and OWNER will be permitted to make recommendations as to the final form and substance of the Operating Manual. Subsequent to such delivery, Contractor shall update and revise the Operating Manual, as

required, in order to reflect changes in Contractor or Sub-Contractor recommended operating or maintenance procedures, improvements in the original Operating Manual, or revisions requested by Owner, until one year of the date of Project Completion. Contractor shall obtain all instruction manuals and special directions required for preparation of the Operating Manual from equipment manufacturers or vendors or shall itself provide any such written instructions when they are not available from such manufacturers or vendors. The Operating Manual shall be based on generally accepted standard of professional care, skill, diligence and competence applicable to engineering and operating practices, shall be consistent with Prudent Utility Practices, and shall be prepared so that operation of the Facility in accordance with the Operating Manual shall, under anticipated operating conditions, result in operation of the Project at the capacity, efficiency, reliability, safety and maintainability levels contemplated by the Contract and shall in no way impair any warranty or guarantee on equipment, materials or services relating to the Project including those being furnished by Contractor under the Contract; provided, however, that nothing contained in this sentence shall be construed as an additional warranty by Contractor as to the availability or performance of the Facility.

(ii) Quality Control Manual:
Contractor shall, within 60 days after receipt of the LOA, deliver to Owner a manual prepared by Contractor conforming to the quality assurance program based on Section C3 and included in Appendix to the Contract Agreement, which Contractor shall adhere to, in order to ensure that the manufacturing and engineering methods and standards to be employed by Contractor under the Contract are achieved (the "Quality Control Manual").

3.2.3 **Contractor's Undertaking**

The Contractor undertakes that subject to Applicable Law and Project Schedule, the design, the construction documents, the execution and the completed works will be in accordance with the following, in order of priority:

(a) The Indian law and
(b) The documents forming part of the Contract, as altered or modified by "Change Order".

3.2.4 **Technical Standards and Regulations**

The design, engineering, the construction documents, the execution and the completion of Work including the Plant shall comply with the Indian National

Standards, AWWA, NSF/ANSI-61, HIS ; technical, building, construction and environmental regulations; regulations applicable to the electrical energy being generated at the Facility, as also to the Facility and the standards specified in the Owner's specification / the Contract; applicable to the Contractor's proposal and schedules; or defined by law. References in the Contract to such specifications and other matters shall be understood to be references to the edition applicable on the Effective Date of Contract, unless stated otherwise. In case of any conflict between provisions of codes and the design criteria /specification the provisions that are more stringent shall be complied with. If substantially changed or new applicable national specifications, technical standards or regulations come into force after the Effective Date of Contract, the Contractor shall submit proposals for compliance to the Owner's Representative. In the event that the Owner's Representative determines that such proposals constitute a Change Order, he shall then initiate a Change Order in accordance with clause no. 14. Metric units shall be used in all data/ documentation / drawings covered under this Contract.

Contractor shall comply with and shall cause the Work and all components thereof (including, without limitation, the design and engineering of the Plant) to comply with all Applicable Laws and Applicable Permits as they may be in effect at the time of Contractor's performance under the Contract. Without limiting the foregoing, the effect of any change in Applicable Laws (excluding therefrom any change in Applicable Permits resulting directly or indirectly from the acts or omissions of Contractor or any Sub-Contractor) enacted after the date of execution of the Contract shall be determined under clause no 14.

Each Party shall ensure that all actions on its behalf in connection with the Project shall be in compliance with Applicable Laws of India and the highest ethical standards. Specifically, each Party shall ensure that nothing of value is offered to any of its officials or government official to influence or reward action or inaction respecting the Project. Each Party agrees to take all reasonable steps to ensure that Persons appointed by it in connection with the Project shall comply with the Applicable Laws and obligations set forth in this clause no. 3.2.4.

3.2.5 **Error by Contractor**

If errors are found in the Work including design / construction documents or any equipment or materials or Works, then the same shall be corrected by the Contractor at its cost and risk.

3.3 **Construction and Construction Management**

Contractor shall develop a Plant construction plan and shall carry out, oversee, co-ordinate and ensure the expeditious design, engineering, procurement, fabrication, construction, commissioning, start-up and testing of the Plant in accordance with Specification and other provisions of the Contract consistent with the Guaranteed

Time Schedule.

Contractor shall supply all equipment and construction equipment required in the performance of the Work. All components of the Plant shall be new equipment other than Contractor's special tools used in the construction of the Plant.

Contractor shall perform and cause its Sub-Contractors to perform all design, engineering, procurement, fabrication, construction, commissioning, start-up, testing, operation and maintenance up to Take-over in accordance with Good Engineering Practices so that the Plant shall operate in accordance therewith and Prudent Utility Practices, all Applicable Laws and all Applicable Permits and in a manner as not to void or diminish any manufacturer's warranty or any insurance coverage with respect to the Project. Contractor shall inspect or cause to be inspected all equipment and shall reject those items not in compliant with the Specification, or approved Quality Assurance Plans. Contractor also shall carry out and oversee (a) the manner of incorporation of the equipment into the Plant and the workmanship with which such equipment is incorporated and (b) the performance of the Work.

Contractor shall establish and track project management controls systems and provide design, engineering, procurement, fabrication, commissioning, start-up, testing and construction management services in accordance with the Standards of Performance set forth in the Specification and the Contract.

3.4 **Procurement:**

3.4.1 **Sourcing:**

As part of the Work, Contractor shall procure and pay for, in Contractor's name as an independent Contractor and not as agent for Owner, all Contractor and sub-Contractors labour, materials, equipment, supplies, soil, gravel and similar materials and manufacturing, fabrication and related services (whether on or off the Site) for construction of and incorporation in the Facility or which are otherwise required for completion of the Work in accordance with the Specification and the Contract and are not explicitly specified to be furnished by Owner pursuant to the terms and provisions of the Contract including Specification. This would also include provision of

(a) An inventory of spare parts (including maximum usage of standards as spare parts) that is required for efficient and cost effective operation of the PLANT. For start-up and commissioning up to take-over of Plant (start-up and commissioning spares)

(b) Prior to Owner acceptance of Plant, all materials including lubricants, chemicals and other consumables, reasonably necessary or appropriate for operation of such unit / Plant. Upon Owner Take-over of Plant, Owner has a first right of refusal to purchase any unused materials relating to such Plant at Contractor's procurement cost. If any of the Owner's spare parts or materials are utilized during any Guarantee Period to fulfil Contractor's obligations

hereunder, Contractor shall replace such materials and spare parts at its own cost.

(c) In connection with its procurement work, Contractor shall be responsible for the shipping, transportation and delivery of all items fabricated, manufactured, constructed or procured as set forth in the Specification and the Contract. All such items and equipment, materials and supplies to be provided by the Contractor pursuant to the Contract shall be new and of utility-grade quality, free from improper workmanship or defects and properly warranted or guaranteed in accordance with the Contract. Any apparent omission or error in the equipment specifications will be corrected by the Contractor to the extent required by the Contract including Specification.

(d) Contractor shall ensure that all construction equipment shall be of the most suitable grade of their respective kinds for the purposes and uses intended and construction equipment other than rented construction equipment shall be maintained in a good state of repair and working condition.

(e) When required by the Contract including Specification or where equipment / systems is referred to as "equal" any particular standard, Contractor shall furnish Owner for approval as to compliance with the technical specifications full information concerning the equipment / systems which it contemplates incorporating in or using in connection with the Plant. Equipment purchased without obtaining any required approvals from Owner may subsequently be rejected and the cost thereof shall be for the account of Contractor and not reimbursable. Should any such equipment required to be so submitted for approval under this paragraph be installed or used by Contractor or a Sub-Contractor without approval by Owner, they may subsequently be rejected, and the cost thereof, including the cost of all services and labour relating thereto, shall be for the account of Contractor and not reimbursable.

3.4.2 **Co-ordination with Owner:**

(a) Contractor shall, upon delivery to the Site and for imported items of the Plant be fully responsible for transportation and shipping to the relevant Indian port of entry, arrange for importation (including customs clearance) into India, receiving, marshalling, complete transportation, handling and storage of all materials, spare parts, equipment and construction equipment (including transportation of all thereof to the Plant Site) and other items necessary or desirable for the Project or the performance of the Work (whether imported or procured within India), including expediting, transportation, unloading, receiving, inspection and documentation.

(b) Contractor shall be responsible for obtaining all Indian customs and import clearances and completing all clearance formalities in respect of all imported equipment, standard spare parts, and construction equipment used in

connection with the performance of the Work, although Owner will be named importer of the spare parts and equipment to be incorporated in the Plant. Contractor shall pay (without reimbursement thereof) all import and customs clearance fees and charges with respect to the foregoing. He shall also be required to pay import duties as per sub-clause 3.18 of this Section.

(c) Contractor shall arrange and ensure the security of all the foregoing items while in transport or storage, and the safe delivery of the same to the Plant Site and the incorporation of the same into the Plant. In the event any such materials, equipment, supplies or other items are damaged, lost, stolen, destroyed or otherwise impaired, Contractor shall at its own cost and expense restore or replace such items.

(d) Since the Contractor shall co-ordinate and follow up with Owner, except as may be expressly excused in the Contract including Specification, no delay or failure to perform on the part of Owner (or its vendors material, men, Contractors and / or sub-suppliers) shall excuse Contractor from the timely performance of its obligations under the Contract.

3.5 **Labour and Personnel:**

3.5.1 The Contractor shall make his own arrangements for the engagement of all staff and labour, local or otherwise, and for their payment, housing, feeding and transport. Contractor shall provide all labour and personnel required in connection with Work, **Including:**

(a) Professional Engineers licensed in accordance with any applicable licensing requirements in India or by any other governmental instrumentality to perform engineering services pursuant to the Contract.

(b) Project team of necessary engineers from various disciplines including, construction manager, project engineer and lead engineers for structural, mechanical, electrical, instrumentation and control, civil, cost, scheduling, procurement, construction, start-up and training supervisors, all of whom shall have had extensive Thermal Power Plant experience in facilities of similar technology and magnitude and shall be proficient in the English language and have knowledge of prudent utility practices, applicable laws and applicable permits.

(c) A project manager or other Representative, who shall be fully acquainted with the Project, shall be proficient in the English language and shall have the authority to administer this Agreement on behalf of Contractor**.** He shall give his whole time to directing the preparation of all documents required for the construction, erection and execution of the Works. Except as otherwise stated in the Contract, the Contractor's Representative shall receive (on behalf of the Contractor) all notices, instructions, consents, approvals, certificates, determinations and other communications under the Contract. Whenever the Contractor's Representative is to be absent from the site, a suitable replacement person shall be appointed, and the Owner / Owner's

Representative shall be notified accordingly.

(d) Shall employ (or cause to be employed) only persons who are careful and appropriately qualified, skilled and experienced in their respective trades or occupations.

(e) Quality assurance personnel, all of whom shall report directly to Contractor's home office managers and not to the Project personnel located at the Site.

(f) A qualified warranty engineer at the Site during all warranty periods prescribed under the Contract.

Upon Owner's request, Contractor shall provide Owner with the resume and arrange for the interview by Owner of any or all personnel described in clauses (a), (b), (c), (e) and (f) above. In addition, Owner will have the right to approve those individuals who will hold the positions described in clauses (a), (b), (c), (e) and (f) above and any other key Project personnel employed by Contractor, and Owner will be offered the opportunity to choose among candidates for the positions of Project Manager, Project Engineer and Construction Manager. Contractor shall not remove any Project personnel described in clauses (a), (b), (c), (e) and (f) above or any other individual in a supervisory or lead position without the prior consent of Owner, which consent shall not be unreasonably withheld.

3.5.2 **Removal of Staff and Labour**

The Owner / Owner's Representative may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's representative, who in the opinion of the Owner / Owner's Representative:

a. Persists in any misconduct,

b. Is incompetent or negligent in the performance of his duties,

c. Fails to conform with any provisions of the Contract;

d. Persists in any conduct which is prejudicial to safety, health, or the protection of the environment.

or

e. Other good and sufficient reasons.

Owner's reasonable determination of what constitutes "good and sufficient reasons" for removing any of such persons shall be conclusive. "Good and sufficient reasons" shall also include any violation of applicable laws or applicable permits, any default in the performance of any obligations hereunder, and any failure to adhere to prudent utility practice. If appropriate or required by the Owner, the Contractor shall then appoint (or cause to be appointed) a suitable replacement person acceptable to Owner.

3.5.3 **Rates of Wages and Conditions of Labour**

The Contractor shall ensure that he pays all his personnel and shall ensure and

procure that his sub-Contractors pay to their personnel regularly their wages, overtime and other compensations. The attendance register and the wage register shall be submitted to the Owner for verification at regular intervals. The Contractor shall also furnish the Owner at regular intervals as governed by Applicable Laws including local statutes but not less than monthly intervals, certificates that he has paid and caused his sub-Contractors to pay all the dues to his/ his sub-Contractors workmen. In case such payment is not made regularly by the Contractor or his sub-Contractors, the Owner will be in his right to make such payments and deduct the same from the Contractor's progress payments.

In case the Owner becomes liable to pay any wages or dues to the labour or to any Government agency under any of the provisions of the Minimum Wages Act, Workmen's Compensation Act or any other Applicable Law due to act or omission of the Contractor, the Owner may make such payments and shall recover the same from the Contractor's bills.

3.5.4 **Persons in the Service of Others**

The Contractor shall not recruit, or attempt to recruit, his staff and labour from amongst persons in the service of the Owner or the Owner's Representative or persons retired from the Owner’s establishment in the past two years.

3.5.5 **Labour Laws**

The Contractor shall comply with and shall ensure and procure that his Sub-Contractors comply with all the relevant labour laws applicable to his/ his Sub-Contractors employees, and shall duly pay and afford and cause his Sub-Contractors to pay and afford to them all their legal rights. The Contractor shall require all such employees to obey all applicable laws and regulations concerning safety at work.

Contractor shall be responsible for all labour relations matters relating to the Work and shall at all times use its best efforts to maintain harmony among the personnel employed in connection with the Work and shall enter into all necessary labour agreements with such personnel. Contractor shall at all times comply with all applicable permits and applicable laws relating to employment and labour welfare and use its best efforts and judgement as an experienced Contractor to adopt and implement policies and practices to avoid work stoppages, slowdowns, disputes, strikes, lockouts and other labour strife and disagreement.

3.5.6 **Working Hours**

No work shall be carried out on the Site outside the normal working hours or on the locally recognized days of rest or local festivals *I* holidays, unless:

(a) Contract so provides,

(b) Work is unavoidable, or necessary for the saving of life or property or for the

safety of the Works, in which case the Contractor shall immediately advise the Owner/ Owner's Representative or

(c) Owner/ Owner's Representative gives his consent.

3.5.7 Facilities for Staff and Labour

The Contractor shall provide and maintain all necessary accommodation and welfare facilities for his (and his Sub-Contractor's) staff and labour. The Contractor shall also provide the facilities specified in the Contract including Specification, for the Owner's and Owner's Representative's personnel. The Contractor shall not permit any of his or his Sub-Contractors employees to maintain any temporary or permanent living quarters within the structures forming part of the Works. Contractor shall make his own arrangements to procure and construct adequate labour housing outside the Plant and colony battery limits. No areas inside the Plant and colony shall be used as labour colony.

3.5.8 Health and Safety

Precautions shall be taken by the Contractor to ensure the health and safety of his and his Sub-Contractors staff and labour. The Contractor shall, in collaboration with and according to the requirements of the local health authorities, ensure that medical staff, first aid facilities, sick bay and ambulance service are available at the accommodation and on the Site at all times, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Owner's Representative may reasonably require. Contractor shall be responsible for the medical treatment/hospitalization of his and his Sub-Contractor's staff / labour.

The Contractor shall appoint a member of his staff at the Site to be responsible for maintaining the safety, and protection against accidents, of personnel on the Site. This person shall be qualified for his work and shall have the authority to issue instructions and take protective measures to prevent accidents. The Contractor shall send, to the Owner's Representative, details of any accident as soon as possible after its occurrence.

3.5.9 Contractor's Superintendence

The Contractor shall provide all necessary superintendence during the design**,** engineering, construction, erection and execution of the Works, and as long thereafter as the Owner's Representative may consider necessary for the proper fulfilling of the Contractor's obligations under the Contract. Such superintendence shall be given by the sufficient persons having adequate knowledge of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents) for the satisfactory and safe execution of the Works.

3.6 Permits

3.6.1 Contractor shall obtain and maintain in effect all Applicable Contractor Permits including other permits as per sub clause 2.2 of this Section required in connection with Contractor's performance of its obligations hereunder, including performance of the Work including (a) licenses to permit Contractor to do business in the jurisdictions where the Work is to be performed, (b) design, engineering, procurement, fabrication; construction; erection, testing and commissioning; start-up testing; tests before Taking-over; (c) export; import (which permits shall be in the name of Owner), other applicable permits necessary to move, transport and deliver construction equipment (including parts of the Plant and the Project) to and from the Site and into and out of India, and (d) all building permits and construction permits required to be obtained with respect to the performance of the Work. Contractor shall also obtain in the name of Owner at the appropriate stage of construction those applicable permits listed in Table at the end of this section.

3.6.2 **Contractor and Construction Permits**

Contractor shall obtain all necessary Contractor and Construction permits. If Contractor at any time becomes aware, whether as a result of notice from Owner or otherwise, of any applicable permit not obtained by him, Contractor shall promptly give notice thereof to Owner and Contractor shall be responsible for obtaining such applicable Permit.

The Contractor shall indemnify and hold harmless to the Owner and all Owner indemnified parties from and against any damages arising from and out of the securing of, or failure to secure, such permits.

3.6.3 **Owner's Permit Support**

With respect to Owner permits, Contractor shall provide permitting support to Owner in obtaining all Owner Permits. Such Contractor support shall include:

(a) Overall co-ordination of permitting requirements;
(b) Attendance at meetings with Owner and third parties designated by Owner;
(c) Preparation of permit applications or, as applicable, application to transfer permits to the Owner;
(d) Assistance in preparation of responses to inquiries by governmental instrumentalities/ agencies;
(e) Assistance in presentations at hearing of governmental instrumentalities I agencies;
(f) Provision of all available information and documents required by Owner in connection with obtaining any Owner Permits; and
(g) Such other services as Owner may request from time to time required for Owner permits.

3.7 Co-ordination of the Works

3.7.1 The Contractor shall be responsible for the co-ordination and proper execution of the Works, including co-ordination of other Contractors to the extent specified in the Contract. The Contractor shall co-ordinate his work with that of other Contractors employed by the Owner. Such co-ordination should be carried out through the Owner/ Owner's Representative. The Contractor shall, as specified in the Specification, afford all reasonable opportunities for carrying out their work to:

(a) Any other Contractors employed by the Owner and their workmen,
(b) The workmen of the Owner, and
(c) The workmen of any legally constituted public authorities who may be employed in the execution on or near the site of any work not included in the Contract, which the Owner may require.

3.7.2 Contractor shall permit other Contractors and sub-Contractors of Owner, if any employed by or on behalf of Owner at the Plant site or the project site, to introduce and store materials in those areas of the Plant site and the project site under Owner's direct control and perform their respective services without hindrance or disruption. Contractor shall have responsibility for co-ordination with Owner and all other Contractors and vendors of Owner, and Owner shall co-operate with Contractor to co-ordinate the performance of the Work with the work and services of Owner's other Contractors and Sub-Contractors. Notwithstanding the foregoing Contractor shall not be deemed to have any greater obligation in respect of the security of materials owned by Owner's Contractors and Sub Contractors than it has in relation to materials owned by it or within its control.

3.8 Inspection and Expediting.

3.8.1 Contractor shall perform all inspection, expediting and quality surveillance as may be required for performance of the Work.

3.8.2 Contractor's responsibilities under this sub-clause shall include without limitation inspecting all supplies, materials and equipment that comprise or will comprise the Plant or that are to be used in performance of the Work. During currency of the Contract in case the Owner establishes that the Contractor is not carrying out all inspection and quality control aspects as per approved Quality Assurance Plan, the Owner has the right to appoint at Contractor cost Third Party Inspection Agencies to ensure adherence of QA plans at Contractors' works.

3.8.3 Contractor / Contractor's Third Party inspection agency shall perform such detailed inspection of all work in progress at intervals appropriate to the stage of design, engineering, procurement, fabrication, construction, erection, testing, commissioning, start-up or tests before Take-over as is necessary to ensure that such work is proceeding in accordance with the Contract including Specification, the

design documents, Applicable Laws, Applicable Permits, Good Engineering Practices and Prudent Utility Practice and to protect Owner against defects and deficiencies in such work (including any which would diminish or void the ability of Owner or Contractor to realize upon any manufacturer's or supplier's warranty or under any applicable insurance coverage). On the basis of such inspections, Contractor shall keep Owner continuously informed of the progress and quality of all work (including performance of the work), whether performed by Contractor, any Sub-Contractor or any other person, and shall provide Owner with written reports which shall contain notwithstanding anything to the contrary contained herein defects and deficiencies revealed through such inspections and of measures proposed by Contractor to remedy such defects and deficiencies. Owner or Owner's Representative shall have the option, at Owner's expense, of being present at all such inspections; provided that Contractor's obligations to give notice of any such inspection shall be limited to those agreed obligations contained in the approved quality assurance plan.

3.8.4 In the event that the progress and quality of the Work including Works is not proceeding in accordance with the Contract including Specification and the design / construction documents, Owner or Owner’s Representative shall be entitled to make recommendations to Contractor or any Sub-Contractor for the purpose of remedying such failure and any such defects and deficiencies or variances. No inspection performed or not performed by Owner hereunder shall be a waiver of any of Contractor's obligations under the Contract or be construed as an approval or acceptance of any of the Work hereunder or absolve the Contractor in any manner of its liabilities, responsibilities and obligations under the Contract. In addition, Contractor shall secure for Owner and its designees (including the Owner's Representative) the inspection rights set forth in this section and those set forth in Section C3 of Specification.

3.8.5 The Owner and the Owner's Representative shall be entitled, during design, engineering, manufacture, fabrication and preparation at any places where Work is being carried out, to inspect, examine and test the materials and workmanship, and to check the progress of manufacture, of all Plant, equipment and materials to be supplied under the Contract. The Contractor shall give them full opportunity to inspect, examine, measure and test any work on Site or wherever carried out. All inspection and tests shall be in line with approved quality assurance plan and the Contract including requirements of Specification and Owner / Owner's Representative shall carry out necessary inspection as per the Contract including Section C3 of Specification.

3.8.6 The Contractor shall give due notice to the Owner / Owner's Representative whenever such work is ready, before packaging, covering up or putting out of view. The Owner's Representative shall then either carry out the inspection, examination,

measurement or testing without unreasonable delay, or notify the Contractor that it is considered unnecessary. If the Contractor fails to give such notice, he shall, when required by the Owner / Owner's Representative, uncover such work and thereafter reinstate and make good at his own cost.

3.9 Transporting (Shipping), Forwarding, Storage and Related Matters

3.9.1 Promptly after issuance of the Letter of Award, Contractor shall submit to Owner for approval the detailed list of equipment and materials to be shipped, and a reasonable time after the Letter of Award overall shipping and forwarding plan for all equipment and other items in connection with the performance of the Work. Contractor agrees that any material variation therefrom shall require the written consent of Owner.

3.9.2 All demurrage, wharf age and other expenses incurred due to delayed clearance of the material or any other reason shall be to the account of the Contractor.

3.9.3 All equipment / systems, maintenance tools and tackles and spares which is stored at a location other than on the Plant site shall be

(a) Stored or other appropriate location approved in advance by Owner (to the extent reasonably possible), and

(b) Properly tagged and identified for the Plant and segregated from other goods (to the extent reasonably possible).

3.9.4 All equipment shall be labelled with permanently affixed durable nameplates which will include the manufacturer's name equipment model number, equipment serial number and all appropriate design parameters.

3.9.5 Contractor shall arrange and be responsible for security of all items and equipment to be incorporated in or forming part of the Plant or are required to be delivered to the Owner under the Contract, while in transport or storage prior to deliver / Take Over by the Owner. In the event any equipment or item is damaged, lost, stolen, destroyed or otherwise impaired while in storage or transit, Contractor shall at its own expense and cost restore or replace such affected equipment or item.

3.10 Erection, Pre-operational Testing, Initial Operation and Unit Characteristic Tests:

Work shall include the erection, commissioning of components / systems, calibration of controls and equipment, tuning, start-up, all functional and verification tests, and all other commissioning, testing and Initial Operations. The requirements are further detailed in the Contract including the Section C8 of Specifications. At all times during the performance of the Work, Contractor shall avoid wasteful consumption (consistent with Prudent Utility, Good Engineering Practices and the terms of the Contract) of fuels, utilities, supplies, materials, equipment, consumables, waste

disposal services, electricity, water and chemicals.

3.11 **Performance Guarantee Testing:**

Contractor shall perform, and re-perform if required, the Performance Tests in accordance with the Contract including provisions of Section C8 of Specification, in order to demonstrate achievement of the Performance Guarantees for the Plant as set-forth in the Contract as per Section C5 of Specification and guaranteed by Contractor in Section F3. If the Plant does not meet the Performance Guarantees, **the Contractor shall at no extra cost to Owner redesign, modify, remedy, repair or replace the Plant or any part or section thereof including any component, equipment or system with one which meets the requirements** and again demonstrate achievement of the Performance Guarantees for the Plant as set-forth in the Contract including Section C5 of specification.

3.12 Construction Facilities, Construction Power, Construction Water Facilities, Sanitary Facilities, Telecommunication Facilities, Start-up & commissioning spares and consumables.

3.12.1 Plant start-up / Construction power, will be arranged by Owner. Contractor shall arrange and pay for lubricants and other consumables in sufficient quantities, and the disposal of sewage and other Contractor generated and Sub-Contractor generated wastes, as necessary, to enable Contractor and each Sub-Contractor to perform the Work.

3.12.2 **Construction Power Supplies**

Temporary power supplies of a total of 06 KVA required for the performance of the Work and other obligations of the Contractor under the Contract (the "Construction Power") shall, to the extent otherwise expressly provided in the Contract, will be arranged by the Owner at one point in YCCPP premises on Free of Cost Basis. The Construction Power system by its design and nature shall be a temporary system and not part of the permanent power supply. The Contractor acknowledges that electricity sourced from KPTCL / BESCOM may be unreliable in quality and availability and its interruption or non-availability or variations in supply voltage or frequency for any reason shall not constitute a condition for claim of extra time or costs on part of Contractor. Further, Contractor shall be responsible for making necessary arrangements to ensure that uninterrupted Construction Power supply (DG sets) is available. Without limiting the generality of the foregoing, such temporary supplies of Construction Power shall include:

(a) Power for all construction offices or trailers, temporary warehouses and storage areas, and other temporary buildings used during the performance of the Work, and facilities used in connection with the performance of the Work;

(b) Power for temporary equipment put in place until such time as permanent Plant power supply systems are installed. Such temporary equipment shall include temporary construction lighting on buildings, chimneys and stacks, navigational lighting, and power to cranes and hoists;

(c) Power utilized by Contractor and Sub-Contractor on the Site for the purposes of performance of the Work, such activities to include curing, welding, forming, stress relieving and provision of power for all electrical construction equipment.

(d) Other requirements of construction power as set-forth in the Bid Documents.

3.12.3 **Construction Water Facilities**

Construction water will be made available by the Owner at one location within the Plant site at free of cost. However it is the responsibility of the Contractor to lay network of pipe lines at his cost to various work spots requiring construction water. In case of any shortage of water, at any time during the contract period, the Contractor shall make alternate arrangements for supply of water at his cost. Subsoil water cannot be used for construction of civil works.

3.12.4 **Sanitary Facilities**

Adequate sanitary facilities inside the Plant boundary for the use of persons employed at the construction Site shall be provided and maintained by the Contractor to the extent and in such manner and at such places as shall be acceptable to the Owner. Separate Toilet facilities for both gents and ladies shall be provided. Contractor shall make all temporary arrangements for the treatment and discharge of sewage and drainage from or in connection with the construction and Work Site and shall maintain the same to the satisfaction of the Owner as long as they may be required. All sanitary waste shall be treated in accordance with the Applicable law including applicable local regulations.

In this regard, Contractor shall prohibit the committing of nuisance on the site or upon the land of the Owner or of adjacent land Owners and any employee found violating this provision shall be liable to immediate dismissal.

3.12.5 **Telecommunication Facilities**

Contractor shall install and maintain for the duration of the Project a reliable telephone system for voice and data communications at the Site and also for other project Offices of the Contractor. The Contractor shall also establish adequate e-mail connections at their site office and e-mail facility shall be extended to Owner's use.

3.12.6 **Start-up Spares**

Contractor shall be solely responsible for the cost of all start-up spare parts and consumables used by Contractor or any Sub-Contractor prior to Performance Acceptance/ Take-Over of Plant, and Contractor shall replace them. Contractor shall

deliver Plant at Performance Acceptance / Take-over with a full "topping-up" of all required lubricants, chemical and other consumables including those as stipulated elsewhere in the Contract including Specification.

3.13 **Manuals:**

Contractor shall provide appropriate manuals and other written materials, all of which materials shall be in English language**.** Manuals shall also be in the form of Compact Discs as per distribution schedule which will be furnished to the successful bidder.

3.14 **Plant Access:**

Contractor shall provide Owner and its designees (including the Owner / Owner's Representative) with reasonable access without any reservations to Contractor's offices at the Site and at all design, engineering, fabrication, manufacturing and construction premises of Contractor and its Sub-Contractors at all times upon reasonable prior notice, including access to design, engineering, fabrication and construction drawings, sufficient to permit Owner (or its designees) to inspect work being performed and to monitor compliance by Contractor and the Sub-Contractors with the terms of the Contract.

3.15 **Clean-Up and Waste Disposal**

Contractor shall, and shall cause all Sub-Contractors, at all times to keep the Site reasonably clean and otherwise free from accumulation of waste materials, rubbish and other debris resulting from performance of the Work and perform daily clean-up of the Site and shall provide for the disposal of all soil, gravel and similar materials required for performance of the Work. Contractor's labour camp and housing colony shall be maintained to the highest standards of hygiene and shall be kept reasonably free of debris, litter and mal-odour. On or before Acceptance of Plant or the earlier termination of the Contract or, if earlier, upon Owner taking custody and control of the Plant, Contractor shall use its reasonable efforts to remove, but in any event prior to Final Performance Acceptance, from the Site all petroleum, waste materials, rubbish, other debris and hazardous materials, as well as all construction equipment and other surplus material and substances to which Owner does not hold title, and shall leave the Site in a neat, clean and usable condition. Contractor shall remove, transport and dispose of any hazardous material transported onto the Site by Contractor or any Sub Contractors, or created, used or handled as part of Contractor's or any Sub-Contractors construction activities at the Site. Contractor shall notify Owner immediately upon the discovery of presence of any hazardous material on, or the release of hazardous material on or from, the Site. All clean up and disposal activities of Contractor (including the transportation and disposal of any hazardous materials taken from the Site) shall be conducted in accordance with all Applicable Laws and applicable Permits.

3.16 **Reporting Requirements**

3.16.1 Prior to commencement date, Contractor shall deliver to Owner a computer-based network schedule in accordance with the Contract.

3.16.2 Progress scheduling report shall be provided by the Contractor to the Owner in accordance with the Contract including but not limited to requirements indicated in the Specification. Contractor shall be responsible for ensuring that performance of the Work proceeds in accordance with the network schedule, the Project Schedule and Guaranteed Time Schedule and for coordinating the activities of all Sub-Contractors.

3.16.3 In the event of a disruption (other than Force Majeure which excuses performance by Contractor under the Contract or suspension by Owner) that is unusual in nature and far reaching in impact and is such that Contractor could not reasonably have foreseen the impact of such disruption,

(a) Contractor may request, and Owner in its reasonable discretion may grant, an appropriate reasonable extension in the time to submit written reports and computer-based network schedule and

(b) Contractor may augment previously submitted materials with quantified, objective data.

3.16.4 **Progress Reports**

Monthly progress reports shall be prepared by the Contractor and distributed as per Specification. The first report shall cover the period up to the end of the calendar month after that in which the commencement date occurred; reports shall be submitted regularly every month. Each progress report shall include:

a. Photographs and detailed descriptions of progress including each stage of design, procurement, manufacture, delivery at Site, construction, erection; testing and commissioning;

b. A detailed description of the milestones achieved and the Work/ Services performed prior to the date of the Monthly Progress Report and the extent to which Scheduled Payments therefore have been received. Appropriate weightage system for percentage progress shall be developed by Contractor and submitted to Owner for its approval no later than 30 days of Commencement Date and upon approval with or without modification by the Owner, the same shall be binding on and be followed by the Contractor and shall not be modified save and except with the prior consent of the Owner.

c. A description of the current status (the name of manufacturer, manufacture location, percentage progress, and the actual or expected dates of commencement of manufacture,

Contractor's inspections, tests and delivery) of supplies and Equipment and of Contractor's and all Major Sub Contractors (Sub-Contractors having in respect of their respective Sub-Contracts) activities and engineering, manufacturing and construction progress as compared with the Project Schedule (and, at the request of Owner, an updated schedule),

d. Copies of quality assurance reports including test results (i) from the manufacturing and fabrication facilities of all Sub Contractors and (ii) with respect to all construction activity at the Facility Site.

e. Safety statistics required under Applicable Laws, including details of any hazardous incidents and activities relating to environmental aspects and public relations.

f. Comparisons of actual and planned progress, with details of any aspects which may jeopardize the completion in accordance with the Contract, including Project Schedule and the measures / catch-up plan being (or to be) adopted to overcome such aspects. It shall include a clear identification and evaluation of problems and deficiencies in the Services (including but not limited to an evaluation of any factors which are anticipated to have a material effect on the Project Schedule),

g. Any other information as considered necessary by Owner / Owner's Representative.

3.17 Project Schedules

3.17.1 Without prejudice and in addition to the foregoing the Contractor shall prepare and furnish to Owner updated monthly schedules of the Work to be performed, including a critical path schedule.

3.17.2 Contractor shall be responsible for ensuring and shall perform the work in conformity with the Project Schedule as updated from time to time. The Project Schedule shall be updated on a monthly basis as the Work progresses and shall include delay and acceleration analyses where appropriate together with steps being taken as per sub clause 9.5 of this section.

3.18 GST, Cess, Duties, etc.,

Taxes means GST, cess, duties, and any other taxes not mentioned here prevailing as on the last date of submission of bid shall be to the account of bidder.

3.18.1 Contractor shall be entirely responsible for all duties, taxes, stamp duties, license fees and other such levies imposed including any variations in the rates, on performance of Work under Contract, outside Owner's country. Contractor shall also be

responsible for payment of GST, (including Indian Income Tax and surcharge), duties, cess, etc., including interest / penalty levied by tax authorities, etc.,

3.18.2 Please refer clause no. 13.1.2 (b) regarding customs duty.

3.18.3 Any statutory variation in percentage of applicable taxes, duties, Cess, etc., as set-forth in Schedule of Prices of volume-III and Delivery after the Commencement Date shall be reimbursed by Owner to Contractor or by the Contractor to the Owner, as the case may be, against submission of documentary evidence in support thereof .Any variations in/new taxes & duties by the Govt. of India and Govt. of Karnataka, subsequent to last date of submission of bid and during the contract period is to the Owner's account.

Any variations in duties and taxes upward /downward by the Governments of India and Karnataka, subsequent to last date of submission of bid and during the contract period shall be paid or recovered for the purpose of determining the GST, duties, cess, etc. of Govt. of India and Govt. of Karnataka, Contractor shall consider prevailing rates as on last date of submission of bid.

However, in case of delay, from the scheduled date of delivery or in Take-over**,** as may be relevant for the computation thereof, as set-forth in the Project Schedule due to reasons not attributable to the Owner, any increase in percentage of such applicable taxes / duties, levies, etc. over and above those specified under clause no. 3.18 and volume-III Section F-1 of Schedule of Prices and Delivery during the delayed period shall be to the Contractor's account and the Owner shall not be liable for the same in any manner whatsoever.

3.18.4 The Contractor shall also bear the local taxes, if any, on or in respect of transactions between the Owner and the Contractor under this Contract including taxes, if any, imposed on the Plant, equipment, and tools and tackles specified in volume-III, Schedule of Prices and Delivery hereto and which are to be incorporated in the Facility. For this purpose, the Ex-works price if stated in foreign currency and so incorporated in the Contract, shall be converted to Indian Rupees as per the exchange rates prevailing on the date of actual dispatch ex-Contractor's works (if applicable).

3.18.5 Owner will issue in accordance with relevant statutes, the requisite GSTIN declaration form(s) to the Contractor in order to get the benefit of any concession in the rate of GST.

3.18.6 The contractor shall submit a comprehensive list of all the goods to be imported into India under the Contract to enable the Owner to issue the project essentiality certificate with endorsement of project imports for availing concessional rate of

Indian customs and import duties. Any additional liabilities for such custom and import duties or penalties thereon, due to any discrepancies in the list of goods furnished by the Contractor or any other lapse of the Contractor in this regard, shall be to the Contractor's account.

3.18.7 Necessary information for any change in project essentiality certificate will be provided by Contractor to the Owner well in time so that required formalities can be completed in time. The consequences arising out of delay in furnishing of such information by the Contractor will be to Contractor's account. Owner shall arrange for amendment of project essentiality certificate expeditiously subject to applicable laws and regulations.

3.18.8 For the purpose of the Contract, it is agreed that the Contract price specified at volume-III, Schedule of Prices and Delivery, is based on the GST, duties, Cess and charges prevailing in Karnataka/India on the last date of submission of bid. If any rates of Tax are increased or decreased, a new Tax is introduced, an existing Tax is abolished, or any change in interpretation or application of any Tax occurs in the course of the performance of Contract, which was or will be assessed on the Contractor in connection with performance of the Contract, an equitable adjustment of the Contract Price shall be made to fully take into account any such change by an amendment to the Contract. If any tax exemptions, reduction, allowances or privileges may be available to the Contractor in India or the State where the Site is located, the Owner shall, subject to applicable laws and regulations, use its best endeavour to enable the Contractor to get benefit from any such tax savings**.** In case Contractor has not included any applicable taxes, duties, at all and/or at rates prevailing in India on the last date of submission of bid and the Contractor has to pay such taxes/duties, Owner shall not be liable to pay / reimburse such taxes/duties/levies, etc., to Contractor.

3.18.9 In the event of issue of any Change Order pursuant clause no. 14 of the Conditions of Contract, the Contract Price shall be adjusted appropriately in accordance therewith read with this clause. Such adjustments shall be limited to direct transactions between the Owner and the Contractor and no amount shall be payable on procurement of raw materials, intermediary components etc. by the Contractor.

3.18.10 Any variation in taxes and duties on transaction between the Contractor and its Sub-vendors / Sub-Contractors/ Suppliers will be to Contractor's account except for directly des-patchable items to Site complete in all respect and be liable in the same shape.

3.18.11 Notwithstanding anything to the contrary contained in these conditions of Contract, any Custom Duties or levies including the stamp duty and Import License fee levied

by the Government of India or any State Government in India on the equipment and materials to be provided by the Contractor in pursuance of any Guarantees/ Warranties under the Contract including any replacements and/ or repairs to be carried out under such guarantee / warranty, which the Contractor is required to supply free of cost to the Owner, shall be to the Contractor's account irrespective of whether the Project Essentiality Certificate, custom clearance permit, etc., for such items is provided by the Owner or arranged by the Contractor itself.

3.18.12 Further, all import and custom duties and other levies payable in India including any State thereof in respect of Contractor's Equipment i.e. erection tools and tackles, testing instruments, etc. which may be imported by the Contractor for performing any portion of the Work to be done in India and which are not envisaged to become the property of the Owner as per terms of the Contract, shall be to the Contractor's account and the Owner shall not be liable for the same in any manner whatsoever. Please refer clause no. 13.1.2 regarding custom duty benefits.

3.18.13 **Benefit of credit for tax**

If, as a result of any agreement, whether existing or modified or signed in future on avoidance of double taxation between the Government of India and the Government of the Contractor's country or under any law, any tax benefit shall accrue to the Contractor in country of the Contractor by way of deduction as expenses or as tax credit or refund or otherwise against its tax liability, on account of taxes, which are paid in India by the Owner pursuant to this Contract, the benefit of such credit, deduction as expense or refund along with details shall be passed on to the Owner within 15 days of the receipt of such credit / refund deduction as expense of the same by the Contractor/expatriate. The Contractor/its expatriates shall take immediate and appropriate action for obtaining the admissible credit or refund from such country's authorities and payment of the same to the Owner. The Contractor shall keep the Owner informed about the same at all times. The Contractor shall furnish on an annual basis, a certificate from an independent Chartered Accountant confirming:

(a) The amount of credit or refund or deduction as expense that may be due, if any, to it on account of tax paid by the Owner in India in respect of payments under the Contract to the Contractor; and

(b) Amount of credit or refund that may be obtained or deduction as expense that may be permissible, if any, during the relevant period. No such annual certificate is required with regard to expatriates' tax credit or refund. However, the Contractor will inform the Owner of all such credits or refunds obtained by its expatriates as aforesaid.

3.18.14 The Contractor shall be responsible for payment of all Indian Taxes, duties, Cess, etc, assessed against the persons employed by the Contractor, in order to its obligations and performance of Work under the Contract.

3.18.15 If direct payment of taxes, duties etc. which are the liability of and are to be borne by the Contractor as above, is not permitted by Indian Law or regulations and / or if any deduction or withholding in respect of such taxes, duties etc. shall be required to be made, the Owner shall pay the sums due to the Contractor after making such deductions or withholding as may be required by the relevant law / regulations and the Contractor shall receive only the net sum available after such deduction / withholding. The sums so deducted / withheld shall be deposited by the Owner with the relevant authorities on behalf of the Contractor, as per Applicable Law / regulation. Immediately thereafter, Owner shall inform the Contractor of the detailed calculations of such deductions and shall provide the Contractor with the corresponding receipt from the Tax authority.

3.18.16 The Contractor and all its expatriate personnel shall be responsible for timely and prompt filing of all returns, documents, estimates, accounts, information and details complete and accurate in all respects as may be required under the applicable laws / regulations in India with the appropriate authorities in India. In case the Contractor or any of its expatriate personnel do not comply with the above requirements, which results in any penalty, interest or other liability, the same shall be borne by the Contractor and he shall indemnify and keep harmless the Owner against the same at all times.

3.18.17 All direct taxes (e.g., income tax, etc.,) arising out of the Contract and payable as per Indian laws shall be borne by the Contractor. As regards the Indian income-tax, surcharges on income tax, the Owner shall not bear any tax liability, whatsoever, irrespective of the mode of contracting. The Contractor shall be liable and responsible for payment of all such taxes including Indian income tax on the fees payable to the Contractor for services for its expatriate personnel deputed in India for execution of work, and all taxes attracted under the provision of the law. The Owner, if required by applicable laws will withhold the taxes and pay the same to the Government and will provide the necessary tax deduction certificate to the Contractor.

3.18.18 Notwithstanding anything to the contrary contained herein the Owner shall further not be liable for any taxes, duties, fees or levy of any kind whatsoever in India or elsewhere, of the Sub-Contractor(s) of the Contractor or the Sub-Contractor's personnel, including taxes on the income of such Sub-Contractor(s) or their personnel.

3.18.19 Each party hereto hereby agrees to indemnify and keep indemnified and saved harmless at all times the other party against any loss, cost, expense or damage suffered or incurred by it by reason of its failure to pay taxes, duties etc. which it is obliged to pay pursuant to the provisions of this clause and / or arising out of its failure to comply with its obligations under this clause.

3.19 **Employee Identification, Plant Site Security and Protection of Plant Site.**

3.19.1 Contractor shall provide a method which shall be subject to the reasonable approval of Owner, of checking the employees of Contractor, the Sub Contractors, Owner and Owner's other suppliers and Contractors in and out of the areas in which the Work is to be performed under the Contract.

3.19.2 Contractor shall be responsible for the security of the Plant and the Site at all times while the Work is being performed up to the earliest of:

(a) Take-over of System
(b) The transfer of care, custody and control of the Plant as a whole to Owner with the concurrence of the Owner, or
(c) Termination of the Contract; provided that Contractor shall co-ordinate such security with Owner's obligations.

3.19.3 Contractor shall do all things necessary or expedient to protect any and all parallel, converging and intersecting electric lines and poles, highways, access or other roads, bridges, waterways, railroads, sewer lines, natural gas pipelines, drainage ditches, culverts, fences, walls, and water lines, and any and all physical property of others, from damage resulting directly or indirectly from performance of the Work. Without limiting the generality of the foregoing, Contractor shall maintain the access roads to the Site and all access roads within the Site including colony area, in good repair and passable at all times as well as proper drainage of the area required by Contractor. In the event that any such physical property is damaged or destroyed in the course of the performance of the Work Contractor at his cost shall rebuild, restore or replace such damaged or destroyed physical property.

3.19.4 Contractor shall provide, and shall ensure that its Sub-Contractors provide, proper and ample protection from damage or loss to the Plant, the Site, equipment and construction equipment during its performance of the Work.

3.19.5 In the event that any of the equipment /structure are damaged or destroyed prior to acceptance of such equipment /structure, Contractor shall rebuild, restore or replace the equipment /structure or such items, subject to and in accordance with the Contract including Specification. All costs irrespective of reimbursement of claims from insurance shall be to Contractor’s account.

3.20 Royalties and License Fees

3.20.1 Contractor shall pay all required royalties and license fees with respect to proprietary rights, intellectual property licenses and agreements, and shall procure, as required, the appropriate proprietary rights, intellectual property licenses and agreements, for materials, methods, processes, systems and services incorporated into the Plant or the Project or otherwise relating to the performance of the Work. These shall be in favour of the Owner and the draft agreements shall be approved by Owner.

3.20.2 In performing the Work, Contractor shall not incorporate into the Plant, or use in connection with the Plant or the performance of the Work, any materials, methods, processes, systems or service that involve the use of any confidential information, intellectual property or proprietary rights that Owner does not have the right to use or incorporate or which may result in claims or suits against Owner, Contractor or any sub-Contractor arising out of claims of infringement of any third party domestic or foreign patent rights, copyrights, other proprietary rights, or intellectual property rights, licenses or agreements, or applications for any thereof, or rights of use of confidential information. In case of violation the claims if any will be to the Contractors account.

3.21 Releases and Waivers

3.21.1 Prior to final acceptance / Take-over, Contractor shall provide to Owner final releases and waivers in the appropriate form acceptable to the Owner of all liens, charges and encumbrances of whatever nature, legal and equitable, against Owner, the Plant, the Project, the Site and all other project property and equipment arising out of or in connection with the Work performed under the Contract.

3.21.2 Notwithstanding anything to the contrary contained herein above, if Contractor fails to deliver any required release or waiver whether of the Contractor or a Sub Contractor, Contractor may provide to Owner, in lieu thereof, a bond or stand by letter of credit in form and content acceptable to Owner, to fully indemnify Owner against any loss resulting from claims, liens or other interests of the Contractor or such Sub-Contractor, and Owner shall draw on such bond or stand by letter of credit as the case may be to satisfy the Contractor's or such Sub-Contractor's claim, lien or other interest prior to exercising Owner's set-off rights under the Contract.

3.22 Standard of Performance

3.22.1 Without limiting any other provision of Contract including Specification,

(a) Contractor shall perform the Work hereunder in accordance with Good Engineering Practices and standards of professional care, skill, diligence and competence generally accepted in the independent power industry applicable to engineering and construction and project management practices for power

stations of similar size and type as the Plant that are intended to have a thirty year useful life (when operated in accordance with the operating manuals) all Applicable Laws, all Applicable Permits, Prudent Utility Practices, all manufacturer's and vendor's guarantees and warranties, all applicable insurance policies, the safety precautions set forth in this section and the provisions of Contract including Specification.

(b) The Plant including all equipment comprised in the Plant shall be designed, engineered, procured, manufactured, fabricated, constructed, erected, started-up and commissioned, operated, maintained and repaired upto Taking-Over, tested, restored, if required in (i) a good workman like manner, (ii) in accordance with Good Engineering Practices and Prudent Utility Practices, all manufacturer's and vendor's guarantees and warranties, all applicable insurance policies, all applicable laws, all applicable permits, the power purchase agreement, the fuel supply agreement and the safety standards set forth in clause no. 3.24 and in accordance with the Contract.

3.22.2 Contractor shall arrange and ensure all design, engineering; fabrication, manufacture, construction, commissioning, start-up and testing work requiring certification from any Government Instrumentality shall be properly certified.

3.23 Compliance with Applicable Laws

Contractor shall comply with and shall cause the Plant and the Project and all components thereof (including the design, engineering, procurement, manufacture, fabrication, erection, construction, commissioning, start-up, testing, operation, maintenance and repair of the Plant and the Project) and the performance of the Work to comply, or be capable of complying, including after Final Acceptance, with all Applicable Laws and Applicable Permits as they may be in effect from time to time during Contractor's performance of Work under the Contract up to date of Final Acceptance, assuming Owner has met his obligations, and thereafter if and so long as Contractor shall have obligations under the Contract including in respect of the Works.

3.24 Safety Precautions

Contractor shall, and shall cause all sub-Contractors to, implement and administer a safety program for the Plant and the Project, subject to the approval of Owner (which shall not be unreasonably withheld), which shall include:

a. Development of a project safety manual (the “Safety Manual”) establishing Contractor, Sub-Contractor safety guidelines and requirements (including a fall prevention program), copies of this manual shall be provided to Owner and Owner's Representative immediately upon its development and Contractor shall incorporate into such safety manual any and all reasonable

comments of Owner;

b. Conducting of weekly project safety meetings with the employees and agents of Owner, Contractor, Sub-Contractor and Owner's other Contractors and their Sub-Contractors;

c. Development, implementation and enforcement of procedures for advising employees and agents of Owner, Contractor, Sub-Contractors and Owner's other Contractors and their Sub-Contractors of, and correction of, safety violations and deficiencies;

d. Taking of all other actions necessary to provide a safe work environment in accordance with Applicable Laws and Applicable Permits. Contractor shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to avoid damage, injury or loss to:

i. All persons employed by Owner, Contractor and its sub-Contractors and Owner's other Contractors and their sub-Contractors in connection with the Work or Owner and its Contractors and sub-Contractors (whether in the performance of their obligations under the Contract or otherwise) and all other persons who may be affected by the performance of the Work or any of such persons.

ii. All supplies used in connection with the Plant and all equipment to be incorporated into the Plant, whether in storage on or off the Site under the care, custody or control of Owner, Contractor, any Sub-Contractor or Owner's other Contractors and their Sub-Contractors.

iii. At all times (including during commissioning, start-up, testing and initial operation reliability operation and Tests before Take Over including Performance Tests of the Plant) Contractor shall require all Sub-Contractor's working on or supplying equipment or construction equipment to the Site to comply with all safety requirements in effect at all such times and all applicable laws and applicable permits. Contractor shall, and shall cause the Sub-Contractor's to, comply with all Applicable Laws and Applicable Permits.

3.25 Contractor's Equipment

The Contractor shall provide all Contractors' equipment necessary to perform the Work and complete the Works. All Contractor's equipment shall, when brought on to the Site, shall be deemed to be exclusively intended for the execution of the Works and performance of Services. The Contractor shall not remove from the Site any such Contractor's equipment without the consent of the Owner / Owner's Representative.

3.26 Access Route

The Contractor shall be deemed to have satisfied himself as to the suitability and availability of the access routes he chooses to use. The Contractor shall (as between

the Parties) be responsible for the maintenance of access routes. The Contractor shall provide any signs or directions, which he may consider necessary for the guidance of his staff, labour and others. The Contractor shall obtain any permission that may be required from the relevant authorities for the use of such routes, signs and directions.

The Owner will not be responsible for any claims which may arise from the use or otherwise of any access route. The Owner does not guarantee the suitability or availability of any particular access route, and will not entertain any claim and shall not be liable for any non-suitability or non-availability for continuous use during construction of any such route.

3.27 Rights of Way and Facilities

3.27.1 The Contractor shall bear all costs and charges for special or temporary rights-of-way required by him for access to the Site. The Contractor shall also provide, at his own cost, any additional facilities outside the Site required by him for the purposes of the Works or Services. Contractor shall carry out a detailed route survey for assessment of transportation of heavy and large equipment to Site.

3.27.2 The Contractor shall, whenever required by the Owner / Owner's Representative, provide in writing, for information, a detailed description of the arrangements and methods, which the Contractor proposes to adopt for the execution of the Works and performance of Services. No significant alteration to the program, or to such arrangements and methods, shall be made by the Contractor without informing the Owner / Owner's Representative. If the progress of the work does not conform to the program, the Owner's Representative may instruct the Contractor to revise the program, showing the modifications necessary to achieve completion within the time for completion.

3.28 Matters Affecting Execution of the Works

The Contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Contract Price. Unless otherwise expressly agreed or provided in the Contract, the Contract Price shall cover performance of all of the Contractor's obligations and Work under the Contract (including those under provisional sums, if any) and all things necessary or required for correct engineering the proper design, execution and completion of the Works in all respects and the remedying of defects and deficiencies, if any in accordance with Good Engineering Practices and Prudent Utility Practices.

The Contractor shall work under the guidance of the manufacturer's erection supervisors to ensure that erection procedures adopted by the Contractor as well as completed erection of equipment is such as not to interfere with or prevent

equipment from functioning as intended, as well as to the entire satisfaction of the manufacturer's supervisor / Owner / Owner Representative. Adherence to instructions of the manufacturer's supervisory engineers is compulsory. The Contractor shall also permit and provide all facilities for the manufacturer's erection supervisors to carry out all checks that they may wish to, and approve any erection procedure and / or final setting and alignment of components, in order to satisfy themselves that erection has been carried out as intended by them. This shall, however, in no way or manner relieve or absolve the Contractor of his responsibility for providing adequate and competent supervision and quality workmanship and for its Work, performance guarantees, warranties, liability and obligation under or arising out of the Contract. In case of any dispute, the decision of the Owner / Owner's Representative / manufacturer's erection supervisor shall be final.

3.29 **Insurance**

Contractor shall obtain and maintain all insurance required to be obtained by Contractor as per the Contract including clause no. 6.0 hereof.

3.30 **Schedule of Work**

3.30.1 **Milestones**

Time is of the essence and those obligations of Contractor referred to as "Milestones" herein shall be accomplished on or before the dates fixed there off in the milestone / Project Schedule or in the event only a month is specified therefor, on or before the last day of such month. If any major milestone is not completed on or before the respective date or last day of the respective month indicated, as the case may be, then, and in addition to any other rights which Owner may have under this Contract, Owner shall be excused from making any further payments to Contractor of the Contract Price until such time as all milestones which have not been completed on the date required have been properly completed. If Contractor believes that any milestone may not be or has not been completed by the date required it shall forthwith give written notice thereof to Owner specifying the reason therefore and what remedial action Contractor proposes to take.

The Contractor guarantees to the Owner that the Contractor shall perform the Work and complete the Works in a timely manner so that all Units and the Plant as an integrated whole achieve Provisional Performance Acceptance on or before Guaranteed Completion Dates under the Contract.

3.30.2 **Priority of Work**

The designation herein of certain obligations of Contractor as milestones shall not reduce or in any way or manner dilute the responsibility of Contractor to complete the Work in the shortest practicable time. To this end Contractor shall give the Work the highest priority; that is, no other job of Contractor shall take precedence over the

Work nor shall Contractor make any allocation of its resources, which would have the effect of delaying the timely performance of the Work.

3.30.3 **Maintenance of Project Network Schedule and Milestone Schedule**

If Contractor is not performing the Work at a rate which will maintain the Project Schedule or the milestone schedule, Contractor shall at his expense cause Contractor's personnel, to work such overtime and furnish such additional personnel, to work such overtime, and provide such additional construction equipment as may be required to comply with the Project Schedule or the milestone schedule (as the case may be).

4.0 SUB-CONTRACTORS

4.1 Subcontractors and Suppliers

4.1.1 All vendors, suppliers, and sub-Contractors providing equipment, materials, construction equipment, or services to Contractor under a Subcontract purchase order or similar purchase form or arrangement with Contractor for the performance of the Work under this Contract are herein referred as "Sub-Contractors", and any such subcontracts, purchase orders and similar purchase forms and arrangement entered into by or on behalf of Contractor with Sub-Contractors are herein referred to as "Subcontracts" provided that none of Owner's other Contractors or their Subcontractors shall be deemed to be Subcontractors under the Contract of the Contractor. The Contractor shall be obligated to select Subcontractors it retains in connection with the performance by Contractor of the Work from a Subcontractors list which would be finalized and approved by the Owner. Owner and Contractor may by mutual agreement add to or delete from such list from time to time and approve any successor or replacement of any person listed on such list or any other vendor, supplier, material-man, consultant or Subcontractor.

4.1.2 Contractor shall provide to Owner such information concerning the Subcontractors as Owner may from time to time reasonably request and shall ensure that each Subcontract contains provisions in all material respects not less stringent than the provisions of the Contract and shall include terms and provisions required to be included pursuant to the Contract. In the event of termination of the Contract under clause no. 15.2 or clause no. 16.2, Contractor shall forthwith deliver to Owner a copy of each Subcontract.

4.1.3 Contractor shall supervise and direct the work of all Subcontractors and shall be responsible for all design; engineering; procurement; manufacturing; transportation; delivery; fabrication; construction; erection; commissioning; start-up, Initial Operation, and Tests before Taking over including Performance Tests; maintenance, repair; methods; techniques; sequences and procedures of and for coordinating the work of Subcontractors.

4.1.4 If Contractor fails to correct, or commence to correct and prosecute the correction with due diligence of deficient or defective work performed by any Sub Contractor within seven days, after receipt by Contractor of a notice from Owner with respect thereto or delivery thereof by the Contractor, Owner may (but shall not be obligated to), after seven days following receipt by Contractor of an additional notice, and without prejudice to any other right or remedy take all reasonable steps to remedy such defective or deficient work at risk and cost of Contractor.

4.1.5 Contractor shall require all Subcontractors to perform the Subcontracts in accordance with the relevant requirements of the Contract including Specification, all Applicable Laws**,** Applicable–Permits, Prudent Utility Practice, Good Engineering Practices, and all Warranties of Vendors and Manufacturers and all insurance policies relating to the Plant or the Work.

4.1.6 Contractor shall be solely responsible for paying each Subcontractor and any other person to whom any amount is due from Contractor for services, equipment, construction equipment, materials or supplies otherwise related to or in connection with the Plant or the Work. Contractor shall take all reasonable steps and actions to ensure those services, equipment, construction equipment, materials and supplies and the like have been or will be received, inspected and approved by the authority and that such services have been or will be properly performed.

4.1.7 In performing the duties incidental to its responsibilities hereunder, Contractor shall issue to the Subcontractors such directives and impose such restrictions as may be required to obtain such compliance herewith and with the terms of the subcontracts.

4.2 **Sub-Contractors and Manufacturer Guarantees**

4.2.1 Contractor shall, for the protection of Owner, obtain from all Subcontractors, including all vendors, material, men and manufacturers of equipment, all available Guarantees and Warranties on all equipment and other items used in connection with the performance of the Work or incorporated in or forming part of the Plant or the Project (other than minor items), and such Guarantees and Warranties shall not be amended, modified or otherwise discharged without the prior written consent of Owner. Guarantees shall be in the joint names of Owner and Contractor.

4.2.2 Contractor shall obtain from each of approved Subcontractor and each Subcontractor that is a party to, a Subcontract pursuant to which engineered equipment is to be provided, Guarantees and warranties, Contractor shall obtain additional guarantees if required by the Contract including Specification.

4.2.3 Contractor shall obtain from each Subcontractor who is party to a Subcontract pursuant to which off-the shelf equipment is to be supplied or purchased (whether

or not such equipment is engineered equipment), the best guarantee or warranty commercially available.

4.2.4 Owner shall be entitled to receive all benefits and proceeds (including damages and rebates) paid by or on behalf of any Subcontractor pursuant to any Guarantee or Warranty. Neither Contractor nor its Subcontractors, nor any person under the control of either. Thereof, shall take any action which could release, void, impair or waive any Guarantee or Warranty on equipment, materials, items, goods or services relating to the Project or the Work.

4.2.5 Nothing in this clause shall derogate from the obligations of Contractor to provide the Guarantees and Warranties described in, and to comply with the provisions of clause no. 11.0 and 12.0 of these Conditions of Contract.

4.2.6 Contractor shall, based on its part professional judgment enforce all Guarantees and Warranties provided by the Subcontractors to the fullest extent thereof till such time they are transferred to the Owner pursuant to sub-clause 4.2.7 below.

4.2.7 Upon the expiration or termination of any of the Guarantees or Warranties provided by Contractor pursuant to the Contract or termination of the Contract for any reason whatsoever, the Contractor shall assign, and hereby assigns, effective as of such date, or otherwise make available, to Owner all of Contractor's rights under all such Subcontractor guarantees and warranties (except to the extent Contractor has therefor provided warranty services to Owner and is enforcing Contractor's rights with respect to such services under the applicable Subcontractor guarantee or warranty) and shall deliver to Owner copies of all Contracts providing for such guarantees and warranties.

4.2.8 Contractor, in accordance with the Contract, shall require all Subcontractors to be covered by the insurance specified in the Contract, during the time in which they are engaged in performing Services.

4.2.9 Contractor shall require all Subcontractors to release and waive any and all rights of recovery against Owner, and each of their promoters (including the directors, officers and shareholders of each such promoter), affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters, and against Contractor and all other Sub Contractors which the releasing Sub Contractor may otherwise have or acquire, in or from or in any way connected with any loss covered by policies of insurance maintained or required to be maintained pursuant to this the Contract (other than third party liability insurance policies) or because of deductible clauses in or inadequacy of limits of any such policies of insurance. Contractor shall further require all Sub Contractors to include in all policies of insurance maintained by the

Sub Contractors clauses providing that each underwriter shall release and waive all of its rights of recovery, under subrogation or otherwise, against Owner, the KPCL, and each of their promoters, affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters, and against Contractor and all other Sub Contractors.

4.2.10 Owner shall not be deemed by virtue of the Contract to have any contractual obligation to or relationship with any Sub Contractor.

4.3 **Review and Approval Note Release of Contractor's Liability: No Privity between Owner and Sub-Contractors**

The review by and approval and consent of, Owner as to the approved Sub Contractors list or as to Contractor entering into any subcontract with any approved Sub Contractor or as to any work done or supply made or services provided by any such approved Sub Contractor shall not relieve Contractor of any of his duties, liabilities or obligations under this Contract, and Contractor shall be liable hereunder to the same extent as if any such sub-contract had not been entered into. Any inspection review or approval by Owner of any work or of any work in progress by Contractor or Sub-Contractors or participation by Owner in any test conducted by or under the direction or supervision of the Contractor or any Sub-Contractor shall not relieve Contractor of any of its Work, duties, liabilities or obligations under the Contract. Owner shall not be deemed by virtue of the Contract to have any contractual obligation or liability to, or relationship with, any Sub-Contractor.

5.0 INSPECTION AND TESTING

5.1 Requirements

5.1.1 The Contractor shall provide all documents and other information and assistance, labour, materials, stores apparatus and instruments as are necessary for inspection and testing as are required or necessary under the Contract or in accordance with Good Engineering Practices or Prudent Utility Practices or are normally undertaken in respect of any similar work, equipment, materials, items, things and Plant and for carrying out such tests efficiently.

5.1.2 The Contractor shall agree, with the Owner / Owner's Representative, the time and place for the testing of any equipment / materials and other parts of the works as specified in the Contract. The Owner / Owner's Representative shall give the Contractor not less than 24 hours' notice of his intention to attend the tests. The Contractor shall provide sufficient suitably qualified and experienced staff to carry out the tests specified in the Contract.

5.1.3 If the Owner's Representative does not attend at the time and place agreed, or if the Contractor and the Owner's Representative agree that the Owner's Representative

shall not attend, the Contractor may proceed with the tests, unless the Owner's Representative instructs the Contractor otherwise. Participation by Owner or Owner's Representative in or their absence from or failure to participate in any tests shall not relieve or absolve the Contractor from any Guarantee or Warranty or obligations or Work under or in pursuance of the Contract.

5.1.4 The Contractor shall promptly forward to the Owner / Owner's Representative duly certified reports of the tests. If and when the tests have been successfully held, the Owner / Owner's Representative shall endorse the Contractor's test certificate, or issue a certificate to him, to that effect.

5.1.5 Further requirements in respect of quality assurance, inspection and testing are set-forth elsewhere in the Section C3 and other relevant sections of the Specification.

5.1.6 If the Owner / Owner's Representative requires such equipment, materials, design or workmanship to be retested, the tests shall be repeated under the same terms and conditions. Contractor shall undertake additional testing of any material equipment or the Work, if the Owner / Owner's Representative believes the results of earlier tests are not accurate or do not establish the true condition or specification or guarantee of equipment, material or work being tested. If such retesting or additional tests demonstrate that the work**,** equipment or material being so tested conforms to the requirements of Contract and the retesting or additional testing requested by Owner / Owner's Representative also confirms that conclusion, or if the retesting is necessitated by Owner / Owner's representatives fault or negligence, and in each case there is material adverse effect on Contractor's ability to meet guaranteed completion date, then Owner shall bear the cost of such additional test and amend the time schedule accordingly and the cost of any required uncovering and covering the work shall be the subject of a Change Order. If however such retesting confirms Owner's conclusion and cause the Owner to incur additional costs, such costs shall be recoverable from the Contractor by the Owner and may be deducted by the Owner from any monies due, or to become due, to the Contractor. Neither the failure by Owner / Owner's Representative to discover defects, nor any payment to Contractor in respect thereof, shall prejudice the rights of Owner thereafter to require and obtain from Contractor the performance of the Work in accordance with the Contract therewith Owner shall not be deemed to have accepted any work as a result of any additional testing.

5.1.7 Notwithstanding anything to the contrary contained herein the attendance or requirement by or participation by the Owner/ Owner's Representative in any test, additional test or retest undertaken or done by a Sub Contractor (the "Sub Contractor test") or their failure to participate in or acceptance of or failure to accept the results of any Sub Contractor Tests or of any supplies or services provided or

work done by any Sub Contractor shall not relieve or absolve the Contractor in any way or manner of its obligations, work, responsibilities and liabilities including any Guarantee or Warranty under the Contract in any manner whatsoever.

5.2 **Rejection**

If, as a result of inspection, examination or testing, the Owner / Owner's Representative decides that the Plant or any equipment / system, materials, design or workmanship has failed the initial test, Tests before Take-over including Performance Guarantee Test, additional tests or retest or is defective or otherwise not in accordance with the Contract, the Owner's Representative may reject such Plant, portion of the Plant, equipment / system, materials, design or workmanship and shall notify the Contractor promptly, stating his reasons. The Contractor shall then promptly correct or replace, or cause its sub-Contractors to correct or replace such item or portion so as to pass additional testing or retesting and otherwise meet and conform to such requirements. No changes to Project Schedule or Milestone schedule or increase in the Contract Price shall be granted with respect to such additional testing. Contractor shall solely bear any cost resulting there from (including the cost of any water, fuel, consumables, materials, etc.) and the cost of any required uncovering and recovering of work.

6.0 INSURANCE

6.1 **Insurance of Plant**

Contractor shall, at their sole cost, in the joint names of Owner, Contractor, and the sub-Contractors, take insurance cover for full replacement value for the following:

6.1.1 "Material Damage Insurance" (Storage-cum-Erection Insurance) on an “All Risk" basis (including terrorists act, SRCC) of loss or of damage arising during period of Insurance coverage to any part of the Contract works, material and supplies including any transit and off-site storage, and anywhere in India for ex-works Indian factory and foreign supplies, materials, etc.,

6.1.2 "Marine Insurance" on an "All Risk" basis (including terrorist acts, war and mine, SRCC) on all supplies for use on or in Corporation within the project for **CIF+10%** value from Ex-works Manufacturer's premises anywhere in the world up to the site, whether by air, sea, road or rail.

6.1.3 Contractor shall bear the risk of loss pursuant to clause 6.7 hereof and hence all deductibles and also for the difference of the amount of claims settled and loss suffered shall be the responsibility of the Contractor.

6.1.4 Such insurance shall be administered and managed by the Contractor and shall be effected from the Commencement date of Contract and thereafter shall operate from the time the relevant property leaves the premises of the manufacturers in the

country of origin, and shall continue during the ordinary course of transit and during storage on or off the Plant site, if any, and during erection and commissioning until the date on which Owner takes over the care, custody and control of the Plant, to the exclusion of Contractor.

6.2 **Rented Equipment**

6.2.1 All construction equipment shall be brought to and kept at the Site at the sole cost, risk and expense of Contractor. Owner shall not be liable for any loss or damage thereto. Contractor, at his sole discretion, may maintain adequate, appropriate and prudent insurance with respect to such construction equipment.
Contractor shall obtain adequate insurance to cover all construction equipment rented or leased from third parties and also for the construction equipment of sub-Contractor.

6.2.2 Any insurance policy carried by Contractor, any Subcontractor or any third party on or in respect of any construction equipment shall provide for waiver of the underwriter's right to subrogation against Owner, their assignees, subsidiaries, parent companies, affiliates, employees, insurers and underwriters.

6.3 **Statutory Insurance Benefits**

Contractor shall maintain with respect to the Work to be done under the Contract, in each applicable jurisdiction, all statutory benefits and other insurance required by law including without limitation unemployment insurance.

6.3.1 **Third Party Insurance**

(a) Contractor shall, in the joint names of Owner, Contractor and the Subcontractors prior to the commencement of any work on the Site pursuant to this Agreement, insure thereof against any liability for damage or death or personal injury occurring on the Site, obstruction, loss of amenity, trespass, nuisance or advertising liability pursuant to the Contract. Such insurance shall be endorsed or amended as to be considered primary, and any other insurance maintained by Owner shall be in addition and not contributory to this insurance.

(b) Indemnity amount indicated under 6.3.1 (a) above shall be the minimum coverage that the Contractors take under the policy. Notwithstanding the above coverage, the Contractor at their discretion will take policy for an appropriate coverage not less than the indemnification amount prescribed as above, so as to meet all the liabilities that may arise on account of third party risks from the commencement of contract till the Owner takes over the care, custody and control of the Plant, to the exclusion of Contractor.

6.3.2 **Insurance against Accident, etc. to Workmen; Other Insurance**

Contractor shall, at its sole expense, insure and shall maintain insurance as required by Indian and all other applicable laws for all actions, suits, claims, demands, costs, charges and expenses arising in connection with the death of or injury to any person employed by Contractor or its Sub Contractors for the purpose of the performance of the Work.

In addition, Contractor shall obtain and maintain all the insurance required to be obtained and maintained by it.

6.4 **General Insurance Requirements:**

6.4.1 All insurance obtained by Contractor shall be maintained with an insurer approved and licensed by the IRDA and insurers approved by Owner.

6.4.2 On or prior to the Commencement date of Contract**,** Contractor shall furnish certificate of insurance to the Owner (Owner or Contractor so directs, copies of the actual insurance policies signed by an authorized Representative of the insurer) from each insurance carrier showing that the above required insurance is in force, the amount of the carrier's liability there under, and further providing that the insurance will not be cancelled, changed or not renewed until the expiration of at least 90 days (to the extent obtainable under commercially reasonable terms) (or 10 days in the case of cancellation due to non-payment of premiums) after written notice of such cancellation, change or non-renewal has been received by Owner and the Contractor. All policies and certificates of insurance effected in accordance with this clause shall be in form and content mutually acceptable to Owner and Contractor.

Insurance Company concerned shall not cancel the policy without the written consent of the Owner

6.5 **Remedy on Failure to Insure**

If Contractor fail to effect and keep in force the insurance for which it is responsible under the Contract including clause no. 6.0 hereof, Owner may effect and keep in force any such insurance, and pay such premiums as may be necessary for that purpose, and from time to time, after receipt of a reimbursement request therefor accompanied by relevant supporting documentation, deduct the amount so paid by Owner from any amounts due or which may become due to the Contractor under the Contract or otherwise from the Owner.

6.6 **Descriptions not Limitations**

The insurance coverage referred to in this clause no. 6.0 shall be set forth in full in the respective policy forms, and the foregoing descriptions of such policies are not intended to be complete, nor to alter or amend any provision of the actual policies and in matters, if any, in which the said description may be conflicting with such instruments, the provisions of the policies of the insurance mutually agreed by the

Parties shall govern; provided, however, that neither the content of any insurance policy or certificate nor Owner's approval thereof shall relieve the Contractor of any of its obligations under the Contract.

6.7 **Risk of Loss of Damage**

(a) Between the date hereof and the earlier of (i) Performance Acceptance and (ii) the Date of Termination of this Agreement and provided the Owner has taken over the Plant (in each case, the "Risk Transfer Date"), Contractor shall bear the complete risk of loss, destruction or damage (including deterioration in quality) of or to the Plant, and all equipment and components thereof (including all temporary equipment, materials and other items and including equipment, construction equipment and other items that are purchased for permanent installation in or for use during construction of the Plant regardless of whether Owner has title thereto or otherwise in connection with the performance of the Work), arising from any cause whatsoever; provided, however, that Contractor shall bear such risk of loss, destruction or damage with respect to the Unit or part thereof, any common component of the Plant for any period during which such Unit or part thereof, any common component or the Plant, as the case may be, is shut down or control thereof is delivered to Contractor because of the testing, commissioning or start-up of the Unit, any common component or the Plant as a whole during the operation of the Plant by the Owner under the supervision of the Contractor.

(b) At all times after the Risk Transfer Date Owner shall bear the complete risk of loss, destruction or damage (including deterioration in quality) of or to the Plant, and all components thereof, arising from any cause whatsoever save and except where covered by any Guarantee and Warranty.

(c) In the event of loss, destruction or damage (including deterioration in quality) of or to the Plant, or any component thereof (including all equipment, construction equipment and other items including temporary materials and other items that are purchased for permanent installation in or for use during construction of the Plant, regardless of whether Owner has title thereto or otherwise in connection with the performance of the Work), prior to the relevant Risk Transfer Date, Contractor will be obliged to repair or replace the work or material which has suffered loss, damage or destruction or which has deteriorated.

(d) Notwithstanding anything to the contrary contained in the Contract, the costs and expenses any loss, destruction or damage of or to the Plant or any equipment or component forming part thereof will be borne by Owner to the extent Owner bears the risk of loss pursuant to the preceding sub-clause (b) and such costs and expenses will be borne by Contractor to the extent that Contractor bears the risk of loss pursuant to the sub-clauses (a) and (c) above.

Contractor shall bear the complete risk of loss, destruction or damage to the Plant till the date of Take-over and in respect of all equipment, construction equipment, materials, and other items provided ex-works at the relevant factory until the relevant Risk Transfer Date.

6.8 **Waiver of Subrogation**

All insurance policies supplied by Contractor shall include a waiver of any right of subrogation of the insurers there under against Owner and their respective assign, subsidiaries, affiliates, parent companies, employees, insurers and underwriters, and of any right of such insurers under such Contractor policies to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under any such policy.

6.9 **Contractor's Waiver**

Contractor further releases, assigns and waives any and all rights or recovery against Owner and their respective assigns, subsidiaries, affiliates, parent companies, employees, insurers and underwriters, and against other Contractors of Owner and their Sub Contractors which Contractor may otherwise have or acquire in or from or in any way connected with any loss covered by the policies of insurance maintained or required to be maintained by Contractor pursuant to this Contract (other than third party liability insurance policies) or because of deductible clauses in, or inadequacy of limits of, any such policies of insurance.

6.10 **Additional Insurance**

Except to the extent prohibited by law and except for insurance coverage described above, all insurance converges referred to in this clause no. 6.0 shall name Owner and their respective assignees, subsidiaries, affiliates and parent companies as additional named insured and loss payees, as their respective interests may appear.

6.11 **No Limitation of Liability**

The required coverage referred to and set forth in this clause no. 6.0 shall in no way affect or limit Contractor's liability with respect to performance of the Work or any obligation under the Contract.

6.12 **Claims for losses/damages**

6.12.1 Contractor/Sub-Contractor shall make all claims with the underwriter/s and undertake all formalities/step required for settlement of claims and receive claims as per the loss payee clause.

6.12.2 Contractor-Sub-Contractor shall hold harmless the Owner for non-settlement/short settlement/part settlement or repudiation of claims by the underwriter/s.

6.12.3 Contractor shall be obliged to replace / repair the Equipment/ components/ parts/spares etc., without waiting for loss settlement by the underwriter/s.

7.0 TITLE

7.1 Title to material or equipment forming part of Work shall pass to Owner at the time such material is

(a) in case being imported into India either
   i) loaded onto ocean cargo vessels at the port of shipment,
   ii) loaded into an air carrier at the port of departure or

(b) With respect of material manufactured or purchased from a supplier within India, when the material is shipped from the factory / premises of the supplier thereof.

7.2 Title to drawings shall pass to Owner at the time such drawings are received by Owner.

7.3 Title to work in progress shall pass to Owner upon the earlier of

(a) Payment for such work or

(b) Incorporation of such work into the Plant.

7.4 It is expressly understood and agreed, however, that the passage of title shall not release or relieve in any manner whatsoever the Contractor from Contractor's responsibility to perform fully its obligations hereunder and risk of loss or damage to any such equipment material or Work shall be of the Contractor till the date of Take-over by the Owner.

8.0 FOSSILS

8.1 All fossils, coins, articles of value or antiquity, and structures and other remains or things of geological or archaeological interest discovered on the Site shall (as between the parties) be the property of the Owner. The Contractor shall take reasonable precautions to prevent his staff & labour, his sub-Contractor's staff and labour or other persons from removing or damaging any such article or thing. The Contractor shall, immediately upon discovery of such article or thing, advice the Owner or Owner's Representative, who may issue instructions for dealing with it.

8.2 If the Contractor suffers delay and / or incurs cost in following these instructions of the Owner/ Owner's Representative, and if such delay and / or cost was not (by the Effective Date) foreseeable by an experienced Contractor, the Contractor shall give notice to the Owner's Representative, with a copy to the Owner. After receipt of such

notice, the Owner/ Owner's Representative shall proceed in accordance with sub-clause no. 9.4.2 to agree or determine:

(a) Any extension of time to which the Contractor is entitled under sub-clause 9.4
(b) The amount of such cost, which shall be added to the Contract Price, and shall notify the Contractor accordingly.

9.0 COMMENCEMENT, DELAYS AND SUSPENSION

9.1 Conditions Precedent:

The obligations of Owner under this Contract are contingent upon the occurrence of the following conditions, in each case in form and substance reasonably satisfactory to Owner:

(a) Execution of the Contract
(b) Owner shall have obtained all necessary Government approvals
(c) Owner shall have received the Performance Security specified as per Contract from the Contractor
(d) Contractor shall have acquired all applicable insurance policies required pursuant to clause no. 6 of these Conditions of Contract.

9.2 Commencement of the Work

Contractor will commence the Work as indicated in the LOA.

9.3 Contractual Time for Completion

The Plant/System shall be completed and shall have successfully passed the Tests before Take Over within the time for Project Completion as set-forth in the Contract which is **Twelve months (12)** for entire scope of mentioned elsewhere from **the Zero Date (LOA Date),** failing which the Contractor shall pay to the Owner as part of the consideration and late completion payment for such delay in Plant Completion (the "Delay Liquidated Damages"). Payment of any Delay Liquidated Damages shall not affect or prejudice in any way or manner Owner's right to terminate the Contract nor shall any termination of Contract prejudicially affect the Owner's right to recover any accrued Delay Liquidated Damages or release the Contractor from any obligation for payment thereof.

9.4 Extension of Time for Completion

9.4.1 The Contractor may apply for an extension of the time for completion if he is or will be delayed either before or after the time for Plant Completion by any of the following causes:

(a) A Change Order (unless an adjustment to the time for completion is agreed under clause no. 14 of these Conditions of Contract);
(b) A force majeure event (as defined in sub-clause 20.1 of these Conditions of

Contract)

(c) A cause of delay giving an entitlement to extension of time under a sub-clause of this clause unless the Contractor has not complied with such sub-clause; or

(d) Any delay, impediment or prevention solely by the Owner for reasons solely attributable to the Owner.

9.4.2 As per the requirement of sub-clause 3.16.2 (or such other period as may be agreed by the Owner / Owner's Representative), the Contractor shall submit an application with full supporting details together with any other notice required by the Contract and relevant to such cause. Except that, if the Contractor cannot submit all relevant details within such period because the cause of delay continued for a period exceeding 7 days, the Contractor shall submit interim details at intervals of not more than 14 days (from the first day of such delay) and full and final supporting details in support of his application within 14 days of the date of ceasure of such delay.

The Owner / Owner's Representative shall proceed to agree or determine either prospectively or retrospectively such extension of the time for completion as may be due. The Owner / Owner's Representative shall notify the Contractor accordingly. When determining each extension of time, the Owner / Owner's Representative shall review his previous determinations and may revise the total extension of time.

9.5 **Rate of Progress**

9.5.1 If, at any time, the Contractor's actual progress falls behind the Project Schedule or it becomes apparent that it will so fall behind, the Contractor shall submit to the Owner / Owner's Representative a revised program taking into account the prevailing circumstances. The Contractor shall, at the same time, notify the Owner / Owner's Representative of the steps being taken to expedite progress, so as to achieve completion within the time for completion stipulated under the Contract, including in particular the Project Schedule and the Guaranteed Completion Dates.

9.5.2 If any steps taken by the Contractor in meeting his obligations under this sub clause no. 9.5 cause the Owner to incur any additional costs, such costs shall be recoverable from the Contractor by the Owner, and may be deducted by the Owner from any monies due, or that may become due, to the Contractor under the Contract or otherwise.

9.6 **Suspension of Work**

9.6.1 The Owner may at any time instruct the Contractor to suspend progress of part or all of the Work. During suspension, the Contractor shall protect, store and secure such part or all of the Work including the Works against any deterioration, loss or damage.

9.6.2 If the Contractor suffers delay and / or incurs cost in following the Owner / Owner's Representative's instructions under this clause hereto and in resumption of the Work, and if such delay and / or cost was not (by the Effective date of Contract) foreseeable by an experienced Contractor, the Contractor shall give notice to the Owner's Representative, with a copy to the Owner. After receipt of such notice the Owner / Owner's Representative shall proceed to agree or determine:

(a) Any extension of time to which the Contractor is entitled under the Contract including clause no. 9.4 of these Conditions of Contract; and

(b) The amount of such cost, which shall be added to the Contract Price, and shall notify the Contractor accordingly. Provided, however, notwithstanding anything to the Contrary contained in these Conditions of Contract the Contractor shall not be entitled to such extension and payment of cost if the suspension is due to a cause attributable to the Contractor.

9.6.3 The Contractor shall not be entitled to extension of time for, or payment of the costs incurred in, making good any deterioration, defect or loss caused by faulty design, workmanship or materials, or by the Contractor's failure to take the measures specified in clause no. 9.6.1 of these Conditions of Contract.

9.6.4 **Prolonged Suspension**

If suspension under clause no. 9.6.1 of these Conditions of Contract, continues for more than 180 days in case of a single event and 270 days in case cumulative events, and the suspension is not due to a cause attributable to the Contractor, the Contractor may by notice to the Owner / Owner's Representative require permission to proceed within 30 days. If permission is not granted within the said 30 days period by the Owner, the Contractor may treat the suspension as an omission of the affected part of the Work under clause no. 14.0 of these Conditions of Contract. If such suspension affects the whole of the Work, the Contractor may terminate his employment, under clause no. 16.2 of these Conditions of Contract subject to clause no. 16.3 of this section.

9.6.5 **Resumption of Work**

After receipt of permission or of an instruction to proceed, the Contractor shall, after notice to the Owner, and together with the Owner's Representative, examine the Works and the Plant and materials affected by the suspension. The Contractor shall make good any deterioration or defect in or loss of the Works or Plant or materials, which has occurred during the suspension.

10.0 TESTS BEFORE TAKE OVER

The Tests before Take Over shall be conducted at Site after the Plant as on integrated whole and each equipment individually has attained stable operation at the end of

startup tests as per Section C8 of the Specification. The Tests before Take Over are the tests to prove the Performance Guarantees as per Section C5 and Section F3 of the Contract.

10.1 **Performance Guarantee Tests**

10.1.1 **Requirements:**

Contractor shall undertake, perform and conduct in the presence of the Owner and Owner's Representative, the Performance Guarantee & Characteristic Tests and other required tests of Plant in accordance with the procedures and protocol set forth in the Contract including Sections C5 and C8, the Applicable Laws, the Applicable Permits at no additional cost or expense except as otherwise expressly provided in the Contract and in accordance with performance test codes as set-forth in the Schedule of Performance Guarantee Section – F3 hereto to prove and establish to the satisfaction of the Owner the Performance Guarantees including noise guarantees as set-forth in the Contract. Owner shall supply electricity (Electricity on Free of cost basis) as reasonably necessary to carry out the applicable tests (but shall be under no obligation to do so for any re-run of such tests due to Contractor).

10.1.2 Contractor shall give at least 30 days' prior notice to the Owner of the anticipated schedule for undertaking of the Performance Tests, so that they may designate and make available representatives to observe the preparations for and conduct thereof including to monitor the taking of measurements so as to confirm compliance to the Owner of achievement of the Performance Guarantees and compliance with the Contract. Such Schedule for the Performance Tests shall be subject to approval of Owner *I* Owner's Representative.

10.1.3 Contractor shall not perform or undertake any Performance Test:

(a) All conditions and requirements that must be fulfilled under the Contract hereunder prior to commencement of such performance test, have not been duly fulfilled or

(b) Owner gives advance notice to Contractor that Work necessary for the safe performance of such Performance Test has not been performed or is incomplete or defective.

As soon as practicable after completion of each test, Contractor shall deliver a copy of all test log sheets and other records to Owner / Owner's Representative.

10.1.4 No materials / equipment / system shall be operated during any Performance Test of any the Plant in excess of:

(a) The limits allowed by its manufacturer to maintain the Guarantee on such materials / equipment / system or

(b) The limits imposed by Prudent Utility Practices and Good Utility Engineering Practices taking into account the design life of such materials.

10.1.5 Unless Owner otherwise certifies in writing, during the Performance Test, Contractor shall demonstrate that the system meets net output at the rated capacity and the noise guarantees as set-forth in the Contract.

10.1.6 If the system fails at the conditions set-forth in the Contract in the "Guarantee Conditions" to Meet the Performance Guarantees, to achieve the Power consumption as set-forth in the Contract in Section F4 at guarantee conditions the Contractor shall at no extra cost to Owner redesign, modify, or replace the system which achieves the Performance Guarantees within a period not exceeding 60 days. Further, if Performance Guarantees are within the limits but the combined (total) liquidated damages payable for deficiency in system Performance Guarantees as per Contract including clause no. 19.2.2 of these Conditions of Contract exceeds the value in sub-clause 19.2.2.(a), the Contractor shall at no extra cost to Owner redesign, modify or replace the system which achieves the Performance Guarantees and combined (total) liquidated damages payable for deficiency in system Performance Guarantees as per Contract does not exceed value in sub-clause 19.2.2.(a).or the system Performance Guarantees.

10.2 Owner Acceptance and Take-over Certificate

In order to achieve Owner acceptance, Contractor must certify to the satisfaction of Owner / Owner's Representative that:

(a) All punch list items have been completed in accordance with this Contract;

(b) All the Contractor's and Sub-Contractor's personnel, supplies, unused materials, waste, rubbish and temporary facilities located at or near such Plant have been removed from such location,

(c) All other provisions of and all items required by this Contract have been performed or delivered, as the case may be, in accordance with this Contract and in a manner satisfactory to Owner.

Upon certification by Contractor of satisfactory completion of sub-clauses 10.2 (a) through 10.2(c), Owner shall issue a Takeover Certificate certifying such matters within 120 days.

10.3 **Use of the System Prior to Owner Acceptance**

Owner reserves the right to take possession of and use for any intended purpose, any portion or all of any delivered but as yet unaccepted system. The taking of possession at any time or use of any of such portion of system shall not be deemed to be an acknowledgement of Owner acceptance of Unit or the system, and shall not be exclusive with respect to Contractor until Owner acceptance of the system, has occurred. Owner shall provide Contractor with reasonable and timely access to complete its obligations hereunder. It is the expectation of the parties that any such modifications or repairs will be accomplished by Contractor with minimal interference with operation of the system, and that reduction in and shutdowns of Plant operations will be required only when necessary.

11.0 LIQUIDATED DAMAGES

11.1 Liquidated Damages for Delay

11.1.1 If Performance Acceptance does not occur on or before the Completion Date of Plant (12 months), Contractor shall pay liquidated damages to Owner for such delay for each and every day which elapses after the guaranteed completion date for Plant until the earlier of Performance Acceptance or the day on which Contractor has paid to the Owner the maximum amount of liquidated damages for delay pursuant to the Contract including in particular set forth in clause No. 19.2.2.

11.1.2 The Liquidated damages payable by the Contractor to the Owner for delay in Supply and "Erection including achieving Performance acceptance after the Completion Date of the Plant (12 months) shall be at the rate of **Half (0.5) percent of total contract value per week** or part thereof of delay.

11.1.3 Notwithstanding the foregoing, no Delay Liquidated Damages shall be payable for period of delay in achieving performance Acceptance Guaranteed Completion Date of Plant to the extent such delay is solely on account of Force Majeure Event and Contractor has been granted an extension of time pursuant to clause no. 20.0 of these Conditions of Contract with respect to such period.

11.2 The Liquidated Damages for Failure to meet Performance Guarantees (Subject to provisions of clause No. 6.0 of Section –C8 of these Conditions of Contract):

11.2.1 On or before the Guaranteed Completion Date of Plant, Owner shall be required to accept the Plant only if the Plant satisfies the Performance Guarantees. After the Guaranteed Completion Date of Plant, and provided the Contractor has complied with clause no. 11.1 above and Owner has determined that Performance Acceptance has occurred pursuant to clause mentioned else- where of these Conditions of

Contract, the Owner shall be required to accept the Plant if and only if (i) the Performance Guarantees are met, or (ii) the Performance Guarantees are within the Guaranteed Performance limits and aggregate sum total of liquidated damages payable for deficiency in Plant meeting the Performance Guarantees does not exceed the limits set-forth in clause no. 19.2.2 (a) and Contractor has paid to the Owner, as agreed genuine pre-determined loss and damage, the sums determined in accordance with clause no. 11.2.2 below (the "Performance Liquidated Damages") within 60 days. Nothing herein contained shall be deemed to liquidate, limit or reduce Contractor's liability for any failure to complete the Work, to perform corrective work or otherwise to perform the Contractor Guarantees and Warranties.

11.2.2 The Performance Liquidated Damages payable by the Contractor to the Owner in case the Plant/Equipment does not meet the Performance Guarantees as per Section C5, section F3-Schedule of guaranteed parameters and section F4 Schedule of Power Consumption at the rates set-forth in the following Schedule:

For increase in power consumption of the plant:

An amount of **Rs**. **7,93,439/-** lakhs (Rupees Seven lakhs Ninety Three thousand Four hundred and Thirty Nine only) per every KW increase in measured power consumption over and above the guaranteed power consumption indicated by the bidder against Schedule of Guaranteed Power Consumption – F4 (maximum amount of liquidated damages for increase power consumption please refer clause no. 19.2.2)

11.2.3 In addition to and not in derogation any payment obligation pursuant to this clause (and without limitation of any remedies otherwise available to Owner in Contract or law), Contractor shall continue to expeditiously perform, rectify/repair, replace and modify the Plant and undertake Work until such time the Performance Acceptance occurs.

11.3 **Liquidated Damages Responsible**

i. The Parties acknowledge that actual damages for

(a) Contractor's failure to meet any Guaranteed Completion Date and

(b) Contractor's failure to achieve the Performance Guarantee, are difficult to determine and that the liquidated damages set forth in the Contract including clause no. 11.0 of these Conditions of Contract are genuine pre-estimated reasonable and appropriate measures of the damages for such delays or such failures and are neither penalty nor consequential damages including loss of profits sustained by Owner as a result of such delays and / or failures. Payment of all liquidated damages pursuant to this clause no. 11.0 shall be

subject to the limitation on liability in respect thereof set forth in clause no. 19.2.2 of these Conditions of Contract.

(c) Contractor waives any defence to non-performance of its obligation to pay liquidated damages pursuant to the Contract including this clause no. 11.0 on the ground of alleged invalidity or unenforceability of provisions relating to payment of liquidated damages based on any theory or law or otherwise including without limitation that liquidated damages are excessive or constitute a penalty or consequential damages.

12.0 Guarantee

12.1 Contractor Guarantees

Contractor Guarantees to Owner that:

a) Contractor shall perform the Work in full compliance with the Work scope including Guarantees and Warranties and in accordance with the terms and conditions of the Contract;

b) The Plant/equipment can be designed, engineered, manufactured, delivered, constructed, erected, commissioned and tested in strict accordance with the Contract for the Contract Price and shall have the performance as guaranteed under the Contract;

c) The Plant/equipment shall be designed, engineered, manufactured, delivered, constructed, erected, commissioned and tested and all Work shall be performed, in a good and workman like manner and in strict accordance with the Contract all Applicable Approvals, all Applicable Laws, Prudent Utility Practices and Good Engineering Practices;

d) All material and equipment installed as part of the Plant:

(i) shall be of first-class quality, free from any charge, encumbrance, lien or other security interest and shall conform to the specifications and descriptions set forth in this Contract, and

(ii) Shall be new, free from defects of any kind and shall meet the requirements of the Work Scope;

e) The Plant/equipment shall be free from all defects and shall be designed, engineered, manufactured, delivered, constructed, completed, commissioned and tested in compliance with the Contract and shall meet the Performance

Guarantees as set-forth in the Contract including Section F3;

f) The Plant/equipment will be designed, engineered, manufactured, delivered, constructed, completed, commissioned and tested in such manner as to provide reasonable certainty that the minimum working life of the Plant will be 25 years (this reasonable certainty is based on good engineering practices, manufacturer's specifications and guidelines and normal operation and maintenance);

g) All Subcontractors shall perform their portion of the Work or supply or install materials in accordance with the applicable provisions and terms of the Contract;

h) Adherence to the Operations Manual shall allow operation and maintenance of the Plant in accordance with manufacturer's guidelines with performance at a level at least as favourable to Owner as the Performance Guarantees and such operation will not impair any warranty in respect of Work including equipment and materials;

i) The Plant/equipment shall satisfy the Noise Guarantees during its normal operation over the Plant life.

j) Provided that the Owner provides prompt written notice upon discovery thereof and establishes the existence of any latent defect, Contractor guarantees each equipment, material and Works including each component of each unit and of the Plant/equipment as a whole including start-up and commissioning spare parts included in the Contract, to be free from latent defects for a period of three (3) years from the date of Take-over of the Plant (Latent Defect Period). Any such latent defects during Latent Defect Period shall be corrected and made good by the Contractor at his sole cost.

12.2 Guarantee Period or Latent Defect Period Notices

12.2.1 The Contractor Guarantees shall survive for the term of the Guarantee Period which is twelve (12) months from date of Take-over of Plant/equipment. Any Work having defects which is guaranteed and corrected by Contractor shall be further guaranteed by Contractor for a period ending twelve (12) months after the date such correction is effected and accepted by Owner / Owner's Representative, and to the extent such period extends beyond the Guarantee Period, the Guarantee period (and the corresponding rights and obligation of the parties under this clause no. 12.0) shall be extended for with respect to such corrected portion of the Work. Owner shall give notice of observed defects promptly following such observation.

12.2.2 In order to be effective hereunder, such notice must be given at the latest within 30 days after the end of the Guarantee Period or, if applicable, within 30 days after the end of any extension of the Guarantee Period or within 30 days after the end of the Latent Defect Period not with-standing the foregoing,

(a) if Owner fails to observe any defect within 30 days after the end of the Guarantee Period or latent defect within 30 day after the end of the Latent Defect Period;

(b) Such defect would not have been revealed to Owner during the Guarantee Period or Latent Defect Period as applicable despite Owner following of Prudent Utility Practices; and

(c) The Owner / Owner's Representative certifies within 180 days of the expiry of the Guarantee Period that it existed during the Warranty Period.
Then the Guarantee Period or Latent Defect Period (and the corresponding rights and obligations of the Parties under this clause shall be extended to effect repair of such defect. If Contractor fails to repair any defect promptly following receipt of a notice from Owner, Owner may cause such repairs to be affected at Contractor's expense.

12.2.3 Contractors obligation to effect repairs based on Contractors Guarantees shall not extend to failure caused by
(a) Fair wear and tear;
(b) Failure to adhere to the Operations Manuals; or
(c) Modifications to the Plant which have been made without the Contractor’s approval or consent.

12.2.4 In no event shall any Guarantee period or latent defect period for any item under the Contract extend beyond 48 months from the date of Take-over of the Plant.

12.3 **Sub-Contractor Guarantees**

All Sub-Contractor Guarantees shall be in joint name of Owner and Contractor. No Guarantee obtained from any Sub-Contractor shall be deemed to reduce or limit Contractors Guarantees set forth in this clause or Contractors obligation to perform corrective work. Contractor shall furnish to the Owner a copy of back to back Guarantees obtained for Sub-Contracts for verification by Owner.

12.4 **Manufacturer Guarantees**

12.4.1 All Manufacturers Guarantees shall be in joint name of Owner and Contractor. No guarantee obtained from any manufacturer shall be deemed to reduce or limit

Contractor's Guarantee under the Contract including those set forth in this clause or Contractor's obligation to perform corrective work. Contractor shall furnish to the Owner a copy of back to back Guarantee obtained from manufacturers for verification by Owner. Contractor shall use its reasonable efforts to obtain Guarantee which extend for at least the Guarantee period and latent defect period and obligate the respective manufacturers to rebuild, remove and replace work or material which has defects**,** in the manner and on terms and conditions substantially similar to those contained in the Contract for the Work. At the request of Owner,

Contractor shall seek to obtain from the manufacturers of the Materials and equipment extended Guarantee coverage. The Guarantee Period for any Materials or part thereof or of any equipment which has been replaced due to a defect shall be extended for a fresh Guarantee period equal to the original Guarantee Period. In respect of extended Guarantee, Contractor shall use reasonable efforts when requested by Owner to assist in enforcing such warranties and guarantees.

12.4.2 The installation or incorporation of any and all Materials and equipment in the Plant shall be in strict accordance with the manufacturers' requirements**.** In the event Owner seeks to enforce a claim based upon a manufacturers Guarantee, and if such manufacturer fails to honour its Guarantee based in whole or in part, on a claim of defective installation or incorporation, Owner shall be entitled to enforce said Guarantee against Contractor in accordance with the terms of such Guarantee, and the, Contractor hereby agrees to defend, indemnify and hold owner harmless from and against any liability in respect of such defect. Contractor acknowledges accepts and confirms that any claim of defective installation or incorporation made by the Owner shall not be a defence of Contractor to any Guarantee claim by Owner on any account.

12.5 **Survival of Guarantees**

All covenants, guarantees and warranties (including Subcontractor Guarantee and manufacturers Guarantee) under the Contract including in this clause shall survive any termination of the Contract in respect of any part of the Work for which Owner has paid Contractor.

12.6 **Guarantees and Remedies Exclusive Limitation and Disclaimers**

12.6.1 Owner's right to enforce the Contractor Guarantees and remedies is subject to Owner complying with procedures specified in this clause and Owner operating and maintaining the Plant in accordance with the operations manual to the extent feasible having regard to the nature of defect or deficiency.

12.6.2 The provisions of, and, in particular, the technical and numerical provisions relating to quantities and material capacities, including those which appear in the documents,

are descriptive only and are not Guarantees, nor are they Guaranteed unless expressly stated to be so in the Contract including in this clause, specifications and Performance Guarantees.

12.7 **Emergency Repairs**

In the event of an emergency where Contractor's personnel is not available on Site or cannot be on Site within an acceptable period of time and if in the judgement of Owner the delay from giving formal notice would cause serious loss or damage which could be prevented by immediate action, defects may be corrected by Owner or a third party designated by Owner without giving prior notice to Contractor. In the event such action is taken by Owner, Contractor will be notified promptly and shall assist wherever possible in undertaking the necessary corrections.

12.8 **Removal of the Defective Work**

If the defect or damage either prior to taking-over or during Guarantee Period is such that it cannot be remedied expeditiously on the Site, the Contractor may, with the consent of Owner/ Owner's Representative, remove from the Site for the purposes of repair any part of the Works which is defective or damaged. If the value of part or material removed from the Site is substantial (value to be finalized at appropriate stage) as determined by the Owner / Owner's Representative, the Contractor shall provide security in the form of bank guarantee for a value as determined by the Owner / Owner's Representative.

12.9 **Further Tests**

If the remedying of any defect or damage is such that it may affect the performance of the Plant, the Owner may require that Tests before Take Over to be repeated to the extent necessary. The requirement shall be made by notice within 30 days after the defect or damage is remedied. Such Tests shall be carried out in accordance with procedures set-forth in clause no. 10.0 of the Conditions of Contract.

12.10 **Right of Access**

Until the Performance Certificate has been issued by the Owner, the Contractor shall have the right of access to all parts of the Plant and to records of the working and performance of the Plant, except as may be inconsistent with any reasonable security restrictions imposed by the Owner for the protection and security of the Plant or with Prudent Utility Practices or Good Engineering Practices.

12.11 **Contractor to Search**

The Contractor shall, if required by the Owner, search for the cause of any defect, under the direction of the Owner / Owner's Representative. Unless the defect is one for which the Contractor**,** his Sub-Contractor including his manufacturer is liable, the cost of such search, shall be added to the Contract Price.

12.12 **Performance Certificate**

12.12.1 The Contractor shall not be considered to have completed the Work and discharged its obligations under the Contract until the Performance Certificate has been signed by the Owner and delivered to the Contractor. The Performance Certificate to be issued pursuant to this clause shall be substantially in form and content as set-forth in the Contract hereto and shall state the date on which the Contractor has completed the Work and his obligations under the Contract to the Owner's satisfaction ("Performance Certificate").

12.12.2 The Performance Certificate shall be issued by the Owner to the Contractor:

(a) 120 days after the expiry of the Contract Period, or

(b) Within 10 (ten) days of fulfilment of all of the following as soon after such date as

(i) the Contractor has provided to the Owner all the final design, engineering, construction documents pertaining to the Plant including as built drawings, O&M Manuals, and other documents required to be delivered or furnished to the Owner by the Contractor pursuant to the Contract

(ii) has completed and tested the Plant, and the Performance Acceptance has occurred, and

(iii) The Contractor has remedied all defects and deficiencies in the Plant /equipment during the Guarantee Period all the Works including remedying any defects.

12.12.3 Only the Performance Certificate shall be deemed to constitute approval of the Plant and completion of Work by the Contractor in accordance with the Contract.

13.0 CONTRACT PRICE AND PAYMENT

13.1 The Contract Price

13.1.1 The Contract Price shall remain firm during the bidder's performance of the contract and not subject to any variation on any account. Contract price includes cost of all work, materials, equipment, systems, software, manpower, supply, storage, transportation, customs clearance, wharf age, services or any costs related to intellectual property rights to be used or furnished in performance of the work, or incorporated in the Plant including erection, testing, commissioning, and satisfactory completion of the Tests before Take Over and includes all Taxes and Duties payable in respect thereof subject to clause no. 3.18 above. Allocation of Contract Price to different portions of the Work shall be as per volume-III, Schedule

of Prices. Contract describes Contractor's obligation in respect of design, engineering, manufacture, supply, construction, erection, testing and commissioning and tests before Take-over of the Plant, but shall not relieve or derogate from Contractor's obligation to take all measures necessary to deliver the Plant /equipment to Owner in accordance with the Performance Guarantees and to do and perform all such other and further work and supplies as are necessary for completion of Plant/equipment in all respects or incidental thereto and for the Plant /equipment to meet the Performance Guarantees.

13.1.2 The Contract Price shall not be adjusted for changes in the cost of labour, materials, equipment, systems, software or other matters;

a) Bidder's fixed price shall include all applicable duties, import cost, customs duties and GST, fees of obtaining permits, plan check cost, insurance and business license required to be paid by the bidder associated with and required for the purpose of carrying on its business in the performance of the contract.

b) Any Indian custom duties or levies including stamp duties and import license fee if any levied by the Govt. of India or any State Govt. in India on equipment, materials and spare parts covered in the work under the contract to be imported to India rest with the successful bidder only.

The successful bidder has to arrange for importing all goods that are required for the project (Comprehensive list to be submitted) work duly observing all statutory provisions read with foreign trade laws and other issues that are applicable for getting import of materials for smooth functioning construction activities on behalf of the Owner (KPCL).

c) The taxes payable in respect of foreign/Indian personnel should also be included in the bidders fixed price.

d) **For the purpose of determining the GST, duties, etc., of Govt. of India and Govt. of Karnataka, bidder shall consider prevailing rates as on last date of submission of BID.**

e) Any variations in/new duties & taxes by the Government of India and Karnataka, subsequent last date of submission of BID and during the contract period are to the Owner's account.

f) In case bidder wishes to claim the increase in duties and taxes levied by Govt. of India and Govt. of Karnataka, necessary document should be produced as requested by the Owner. It is therefore necessary, within one month of the placement of order the Contractor shall furnish to the Owner the break-up of equipment procured within India and outside India.

g) As regards Indian Income tax, surcharge on Income tax and any other corporate tax, the Owner shall not bear any tax liability whatsoever,

irrespective of mode of contracting. The bidder shall be liable and responsible for payment of all such tax if attracted under the provisions of the law.

13.2 Performance Security or Performance Bank Guarantee

13.2.1 Contractor shall furnish to Owner a bank guarantee (the "Performance Security") as a performance security for due and faithful performance of its obligations under Contract, in format at Annexure – 2 of Section A2 of specification, issued and confirmed by any of the Indian Nationalized /Scheduled Banks **for an amount equivalent to 10% of the Contract value**.

The validity of the above Performance Security Bank Guarantees shall be up to the end of guaranteed period plus claim period of six months.

13.2.2 In case Contractor fail to fulfil its obligations under Contract, the proceeds of Performance Security may be appropriated by Owner as part compensation for any loss resulting from Contractor's failure to perform and fulfil the Work and its obligations under Contract without prejudice to any of the rights or remedies Owner to which may be entitled to under the Contract or otherwise in law.

13.2.3 Contractor shall extend the validity of the Performance Security suitably, if required, due to delay in Acceptance of Plant for reasons attributable to Contractor, at its own cost well in time and in any extent at least 30 (thirty) days before the expiry of the period of validity thereof.

13.2.4 The Performance Security Bank Guarantees shall also be extended suitably at least thirty days before the expiry of the period of validity thereof in the event of repair / replacement of any equipment or any part thereof during Guarantee Period to take care of extended Period of repaired / replaced equipment or its part.

13.2.5 The Performance Security Bank Guarantees shall be discharged by Owner after completion of all of Contractual obligations including Guarantee Period obligations under the Contract are completed.

13.3 Payment schedule:

The terms of payment shall be as follows:

13.3.1 For Supplies from Contractor / Sub-vendor

i. **10%** of total contract price for supply (excluding GST & Duties/levies/cesses) with interest of SBI -1 year MCLR + 6.15% per year as initial advance (if required by the bidder) along with Letter of Award (LOA) against the Bank Guarantee of the same value and Performance Bank Guarantee of 10% of contract value. The bank guarantee furnished towards advance will be released only after complete advance and interest are adjusted / recovered.

ii. **55%** (65% if advance not taken) of contract price for supply (including GST & Duties/levies/cesses) on pro-rata basis progressively against joint inspection report at site. The interest will be recovered at SBI 1 year MCLR + 6.15% per year on 10% of invoice value (advance paid) from each bill till complete advance is adjusted.

iii. **25%** of contract price (including GST & Duties/levies/cesses) for supply will be released after completion of each mile stone activity.

iv. **10%** of contract price (including GST & Duties/levies/cesses) for supply on completion of PG test of the plant and supply of all essential spares as listed elsewhere.

13.3.2 Erection & Commissioning:

i. **10%** of total contract price for Erection & Commissioning (including GST & Duties/levies/cesses) with interest of SBI 1 year MCLR + 6.15% per year per year as initial advance (if required by the bidder) along with Letter of Award (LOA) against the Bank Guarantee of the same value and Performance Bank Guarantee of 10% of contract value. The bank guarantee furnished towards advance will be released only after complete advance and interest are adjusted / recovered.

ii. **55%** (65% if advance not taken) of contract price for Erection & Commissioning (including GST & Duties/levies/cesses) on pro-rata basis progressively against joint inspection report at site. The interest will be recovered @ SBI 1 year MCLR + 6.15% per year on 10% of invoice value (advance paid) from each bill till complete advance is adjusted.

iii. **25 %** of contract price for Erection & Commissioning (including GST & Duties/levies/cesses) will be released after completion of each mile stone activity.

iv. **10%** of contract price for Erection & Commissioning (including GST & Duties/levies/cesses) on completion of PG test of the plant.

13.3.3 Freight:

i. **10%** of total contract price for Freight portion (including GST & Duties/levies/cesses) with interest of SBI 1year MCLR + 6.15% (or prevailing rate of KPCL) per year as initial advance (if required by the bidder) along with Letter of Award (LOA) against the Bank Guarantee for an equivalent amount and Performance Bank Guarantee of 10% of contract value. The bank guarantee furnished towards

advance will be released only after complete advance and interest are adjusted / recovered.

ii. **55%** (65% if advance not taken) of contract price for Freight portion (including GST & Duties/levies/cesses) on pro-rata basis progressively against joint inspection report at site. The interest will be recovered @ SBI 1year MCLR + 6.15% (or prevailing rate of KPCL) per year on 10% of invoice value (advance paid) from each bill till complete advance is adjusted.

iii. **25%** of contract price (including GST & Duties/levies/cesses) for supply will be released after completion of each mile stone activity.

iv. **10%** of contract price for Freight portion (including GST & Duties/levies/cesses) on completion of PG test of the plant and supply of all essential spares as listed elsewhere.

13.3.4 Civil Works:

i. **10%** of total contract price for civil works (including GST & Duties/levies/cesses) with interest of SBI 1 year MCLR + 6.15% per year as initial advance (if required by the bidder) along with Letter of Award (LOA) against the Bank Guarantee of the same value and Performance Bank Guarantee of 10% of contract value. The bank guarantee furnished towards advance will be released only after complete advance and interest are adjusted / recovered.

ii. **55%** (65% if advance not taken) of contract price for civil works (including GST & Duties/levies/cesses) on pro-rata basis progressively against joint inspection report at site. The interest will be recovered @ SBI 1 year MCLR + 6.15% per year on 10% of invoice value (advance paid) from each bill till complete advance is adjusted.

iii. **25%** of contract price for civil works (including GST & Duties/levies/cesses) will be released after completion of each mile stone activity.

iv. **10%** of contract price for civil works (including GST & Duties/levies/cesses) on completion of PG test of the plant.

13.3.5 Payment of Essential Spares

i. No advance will be paid.

ii. 100% payment (including GST & Duties/levies/cesses) will be made after receipt of spares at site against Joint Inspection Reports.

13.3.6 Payment for Start-up & commissioning spares

iii. No separate payment will be made for Start-up & commissioning spares.

13.4 Mode of Payment

13.4.1 All payments shall be released to Contractor directly through cheques / electronic transfer within 30 days of submission of invoices/ bills along with requisite documents.

13.4.2 Contractor shall be responsible for all permits, licenses and the like from respective authorities necessary for import of equipment from the respective countries to the Owner.

13.4.3 Payments by Owner to Contractor shall be made in INR by wire transfer or cheque to an account or accounts designated by Contractor and maintained by Contractor or by such other person or entity at a bank or banker in Bangalore, Karnataka, India in writing. Extra Work shall be paid in accordance with the applicable Change Order and shall be invoiced and documented under clause no. 14.0 of these Conditions of Contract as part of the Work. Once all acts necessary to initiate the relevant wire transfer have been completed within the time specified for such payments, any delays within the international or domestic banking system in the transfer of such payments to Contractor's account or accounts as aforesaid shall not give rise to a claim that Owner has breached its payment obligations hereunder.

13.4.4 The Owner shall pay the Invoice amount within 30 days from the date on which the Owner / Owner's Representative received the Contractor's statement and supporting documents and the Owner shall pay the amount certified in the Final Payment certificate within 120 days from the date of issue of the Take-over certificate.

13.5 Payments Withheld

13.5.1 Owner shall have the right to withhold from any payment due to Contractor, including the final payment, such amounts as Owner reasonably deems necessary or appropriate to protect it because of any one or more of the following reasons:

(a) Defects in any work which might affect Owner's ability to operate system as contemplated herein, whether or not payment has been made thereof.

(b) The filing of any vendor / tradesman’s lien or similar encumbrance in respect of the Work or the Plant (or any portion thereof).

(c) A dispute as to the accuracy or completeness of any request for payment received by Owner pursuant to this clause no. 13.0 within 90 Days of receipt

thereof or payment made there under.

(d) Contractor's failure to deliver any Performance Securities as per clause 13.2.

(e) Any requirement in accordance with Applicable Laws to withhold any Taxes payable by Contractor in respect of the Work or any part thereof.

(f) Contractor's failure to make payments to Sub Contractors or workers for Work, including amounts withheld by Contractor because of disputes between Contractor and such Persons.

13.5.2 In addition to the provisions of this clause no. 13.0 which relates to the recovery by the Owner of any amounts that the Owner may have paid, for which the Contractor is liable under the Contract, the Owner shall also be entitled to recover all the dues in terms of the Contract including liquidated damages for delay, liquidated damages for the shortfall in the guaranteed performance parameters, etc., by way of deductions from the payments due to the Contractor or that may become due to the Contractor in future or from any securities / guarantees under the Contract and / or otherwise.

13.5.3 Notwithstanding any dispute that Contractor may have, and regardless of the basis thereof or grounds therefor, Contractor agrees that it will, for so long as the Contract has not been terminated diligently prosecute the Work up to Final Performance Acceptance and Take-over of Plant, all in accordance with the terms of the Contract.

13.6 Performance Acceptance and Contractor's Request for Final Payment

13.6.1 On Performance Acceptance of Plant, Contractor shall submit to Owner / Owner's Representative, a final Request for Payment. Contractor shall, prior to or concurrently with that request,

(a) Provide certification to Owner / Owner's Representative that every liability to Sub-Contractors, workers and other persons incurred by or for Contractor on account of the performance of the Work of such Plant has been duly paid, discharged or waived, together with releases and waivers of liens effective under applicable law and in form and substance satisfactory to Owner from all the foregoing (to the extent such releases and waivers have not already been delivered to Owner);

(b) Furnish to Owner / Owner's Representative a sworn statement setting forth in reasonable detail each liability to Sub Contractors and other persons which are disputed by Contractor and which Contractor knows or has reason to believe may thereafter be disputed on account of the performance of the Work of such Plant;

(c) Furnish to Owner the records required by Sub-clause 3.2.2

(d) Prepare with Owner / Owner's Representative a list of all punch list of items

which remain to be finished, corrected or otherwise performed. Promptly after preparation of the Punch List Items, Owner *I* Owner's Representative shall mutually agree on the amount of the punch list reserve to be withheld from the payment due to Contractor and date of completion shall be as per clause no. 10.2 above. The Punch List reserve shall in no event exceed 150% of the aggregate value of Punch List Items, as reasonably determined by Owner / Owner's Representative. Any final request for payment which does not satisfy all of the conditions set forth above does not constitute a valid and proper final request for payment and Owner shall not have any obligation to make any payment there under.

13.6.2 After the Performance Acceptance of Plant (after Take-over) and Owner's receipt of a valid final request for Payment, Owner shall pay to Contractor the Contract Price then unpaid plus all other net amounts then owed by Owner to Contractor hereunder in connection with such Plant, less

(a) The punch list reserve,

(a) Such amount as Owner deems reasonably necessary to pay each liability then outstanding against Contractor on account of the Performance of Work of such Plant, together with any amounts withheld from the Final Payment pursuant to clause no. 13.5 above (collectively, the "Claims reserve") and

(c) The amount of any liquidated damages payable and paid determined in accordance with clause 11.0 above. The Claims Reserve shall be held by until Contractor provides Owner with:

(i) Satisfactory evidence that each of the foregoing underlying liabilities has been duly paid, discharged or waived or

(ii) A letter of credit satisfactory in amount, form and substance to Owner to indemnify Owner against the same or otherwise guarantee payment thereof in a format acceptable to Owner from a bank.

13.7 **Punch List Items**

Contractor shall perform all work required or appropriate for all Punch List Items within a schedule to be mutually determined by Contractor and Owner after submission of the Final Request for Payment in accordance with clause no. 13.6 above. Such schedule shall provide for completion of all Punch List Items as soon as practicable following determination of the completion schedule, but no later than the date set forth in clause no. 10.2 above. Upon completion of the Punch List Items, Contractor may submit to Owner and the Owner's Representative a request for release of the Punch List Reserve and shall furnish with such a request a certificate that all Punch List Items have been completed. Unless Owner disputes a charge or statement in such request or certificate, Owner shall release the Punch List Reserve

to Contractor within 30 days after receipt of Contractor's request therefore given in accordance with the foregoing sentence of this clause.

13.8 **Effect of Payment**

13.8.1 No payment and no partial or entire use or occupancy of Plant by Owner shall:

(a) Be deemed a representation that Owner has inspected the Plant;

(b) Constitute or be deemed an acceptance, in whole or in part, of any portion of the Work or the Plant; or

(c) Operate to release Contractor from any obligations or Liabilities under the Contractor.

13.8.2 The Final Payment shall be deemed to release Contractor from all obligations hereunder except those in respect of Owner acceptance of such Plant, Contractor's Guarantees and Warranties regarding the Plant, the indemnification and any other obligations under the Contract which by their terms can be deemed to survive beyond the Final Payment.

13.9 **Release**

The acceptance by Contractor of payment pursuant to clause no. 13.6 above shall, to the fullest extent permitted by law, operate as a release by Contractor to Owner of all liability of Contractor and any Subcontractor or any other person who performed Work or cause Work to be performed, directly or indirectly, on behalf of Contractor, for any further payment for all things done or furnished in connection with the Work, except for and to the extent of

(i) Amounts withheld under clause no. 13.6.2 above

(ii) Any unresolved payment disputes between Contractor and Owner which have not been resolved prior to receipt of the Final Payment.

14.0 CHANGE ORDERS OR SCOPE CHANGE ORDER

14.1 Work shall be subject to further detailing from time to time and Contractor shall receive no additional compensation for such detailing to the extent that such detailing does not constitute a Change Order.

14.2 **Right to Change Order or Scope Change Order**

14.2.1 Change Orders may be initiated by the Owner / Owner's Representative at any time during the Contract Period, either by instruction or by a request for the Contractor to submit a proposal. If the Owner / Owner's Representative requests the Contractor to submit a proposal and subsequently elects not to proceed with the change, the Contractor shall not be reimbursed for the cost incurred for proposal.

14.2.2 The Contractor shall not make any alteration and / or modification of the Works, unless and until the Owner / Owner's Representative instructs or approves a Change Order in writing. If the Construction Documents or Works are not in accordance with the Contract, the rectification shall not constitute a Change Order.

14.3 **Value Engineering**

The Contractor may, at any time, submit to the Owner / Owner's Representative a written proposal which in the Contractor's opinion will reduce the cost of constructing, maintaining or operating the Works, or improve the efficiency or value to the Owner of the completed Works, or otherwise be of benefit to the Owner or as required by a Change in Law. Any such proposal, shall be prepared at the cost of the Contractor.

14.4 **Change Order or Scope Change Order Procedure**

14.4.1 If the Owner / Owner's Representative requests a proposal, prior to instructing a Change Order, the Contractor shall submit the same within fifteen days or as mutually agreed:

(a) A description of the proposed design and / or work to be performed and a programme for its execution together with supporting calculations.

(i) Show the quantities of manpower, usage and services to be added and / or by size, type and / or amount provided

(ii) Make references to International Standards, industry guide books or practices used to determine prices, man hours per unit of installed materials, rental rates and other similar cost standards and

(iii) Contain a break down for manpower, material and overhead. Cost of overheads shall not exceed a 10% mark-up.

(b) The Contractor's proposal for any necessary modifications to the programme including the scheduled effects related to

(i) The implementation of stated changes and

(ii) Cumulative impact of effects resulting from the stated changes on all prior work and changes in work to be performed as scheduled.

(c) the Contractor's proposal for adjustment to the Contract Price, Guaranteed Completion Dates, Network Schedule and / or modifications to the Contract.

14.4.2 The Owner / Owner's Representative shall, as soon as practicable after receipt of

such proposals, respond with approval, rejection or comments.

14.4.3 If the Owner / Owner's Representative instructs or approves a Change Order, he shall proceed to agree or determine adjustments to the Contract Price, draw down schedule and / or Time for Completion.

14.4.4 Contractor shall not suspend performance of this Contract during review and negotiation of any Change Order, except as may be directed by Owner.

14.5 **Payment in Applicable Currencies**

Payment will be made in INR only.

15.0 DEFAULT OF CONTRACTOR

15.1 **Notice to Correct**

If the Contractor fails to carry out any of his obligations, or if the Contractor does not execute the Works in accordance with the Contract, the Owner / Owner's Representative may give notice to the Contractor requiring him to make good such failure and remedy the same within a specified time.

15.2 **Termination**

15.2.1 If the Contractor:

(a) Fails to comply with a notice under sub-clause 15.1,
(b) Abandons or repudiates the Contract,
(c) Without reasonable excuse fails:
  (i) to commence the Works in accordance with clause no. 9.2
  (ii) to proceed with the Works in accordance with clause no. 9.0 or
  (iii) to demonstrate that sufficient design and engineering, manufacturing, erection, testing and commissioning capability is employed in the execution of the Works to achieve completion within the Time for Completion.
(d) Becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under any applicable law) has a similar effect to any of these acts or events,
(e) Fails to comply with a notice issued under clause no. 5.2 above within 30 days after having received it,
(f) Assigns the Contract or Sub-Contract the Works without the required consent of Owner;
(g) Fails to make prompt payments to Sub Contractors or for labour, materials or equipment,

(h) Fails to comply with Applicable Laws and/or Applicable Permits, or

(i) Is in material breach of the Contract, then the Owner may, without prejudice to any other right or remedy Owner may have under the Contract or at law or in equity after having given 15 days' notice to the Contractor, terminate the Contractor's employment under the Contract and expel him from the Site. The Contractor shall simultaneously deliver all Construction and other Documents relating to the Project prepared by the Contractor or procured from other sources to the Owner / Owner's Representative and the Owner shall automatically without the necessity of any further action by the Contractor stand subrogated to the interests of Contractor in or under any Sub-Contracts. The Contractor shall not be released from any of his obligations or liabilities under the Contract. If requested by Owner, Contractor shall withdraw from the Site, and to Owner shall succeed Contractor's sub-Contractors, purchase orders and vendor contracts provided always, the Owner shall compensate such Sub-Contractors only compensation becoming due and payable under their agreements with the Contractor from and after the date Owner deeds to succeed to the interests of the Contractor. Upon termination the Contractor shall remove as directed by Owner such materials used and any debris or waste materials (including any hazardous substances) generated by Contractor in performance of the Work, and Owner may take possession of any and all materials, documents, purchase orders, correspondence and schedules that Owner deems necessary to complete the Plant. The rights and authorities conferred on the Owner and the Owner's Representative by the Contract shall not be affected.

15.2.2 The Owner may upon such termination complete the Plant itself and / or by employing any other Contractor. The Owner or such other Contractor may use for such completion such of the Construction Documents, other design documents made by or on behalf of the Contractor, Contractor's equipment, temporary works, Plant and materials as he or they may think proper. Upon completion of the Works, or at such earlier date as the Owner / Owner's Representative thinks appropriate, the Owner / Owner's Representative shall give notice that the Contractor's equipment and temporary works will be released to the Contractor at or near the site. The Contractor shall remove or arrange removal of the same from such place without delay and at his cost. The Contractor shall pay to the Owner within 15 days of notice in this regard any additional costs incurred by the Owner in completing the Plant itself or by any other Contractor pursuant to this clause no. 15.

15.3 **Payment after Termination**

15.3.1 After termination under clause no. 15.2 above, the Contractor shall not be entitled to any further payment under the Contract, except that, if Owner completes the Plant and the costs of completion are less than the Contract Price, the Owner shall pay

Contractor an amount properly allocable to Services fully performed by Contractor prior to termination for which payment was not made to Contractor or a Subcontractor, upon completion of the Plant by Owner.

15.3.2 The Owner shall be entitled to recover from the Contractor the extra costs, if any, of completing the Works. In addition, Owner shall be entitled to exercise any rights or remedies available to Owner hereunder or at law or in equity.

15.4 **Bribes**

If the Contractor, or any of his sub-Contractors, agents or servants gives or offers to give to any person any bribe, gift, gratuity or commission as an inducement or reward:

(a) For doing or forbearing to do any action in relation to the Contract or any other contract with the Owner, or

(b) For showing or forbearing to show favour or disfavour to any person in relation to the Contract or to any other contract with the Owner, then the Owner may, after having given 15 days' notice to the Contractor, terminate the Contractor's employment under the Contract and expel him from the Site. The provisions of this clause shall apply as if such termination and expulsion had been made under clause no. 15.2 above.

16.0 DEFAULT OF OWNER

16.1 **Contractor's Entitlement to Suspend Work**

16.1.1 If the Owner fails to pay the Contractor the amount due and fails to explain why the Contractor is not entitled to such amount, within 120 days after the expiry of the time stated in clause no. 13.4.3 above within which payment is to be made, except for any deduction that the Owner is entitled to make under the Contract, the Contractor may suspend work or reduce the rate of work after giving not less than 15 days' prior notice to the Owner at Contractor's cost and risk. Such action shall not prejudice the Contractor's entitlements to payment under clause no. 13.5 above and to terminate under clause no. 16.2 below.

16.1.2 If the Contractor suspends work or reduces the rate of work at Contractor's cost and risk, and the Owner subsequently pays the amount due, the Contractor's entitlement under clause no. 16.2 below shall lapse in respect of such delayed payment, unless notice of termination has already been given, and the Contractor shall resume work.

16.2 **Termination**

If the Owner:

(a) Fails to pay the Contractor the amount due within 180 days after the expiry of the time stated in clause no. 13.4.3 above within which payment is to be made

(except for any deduction that the Owner is entitled to make under the Contract or any disputed amount),

(d) Becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under any applicable law) has a similar effect to any of these acts or events, or, if a prolonged suspension affects the whole of the Works as described in clause no. 9.6 above, then the Contractor may terminate his employment under the Contract by giving notice in writing to the Owner, subject to clause no. 16.3 below.

16.3 **Notice Right to Cure**

Notwithstanding anything to the contrary in this Contract, Contractor shall not be entitled to terminate this Contract unless:

(a) Contractor gives written notice to Owner which specifies the default and
(b) Owner shall within 120 days after such notice fail to cure any such default.

16.4 **Cessation of Work and Removal of Contractor's Equipment**

16.4.1 After termination under clause no. 2.3 or clause no. 16.2 above, the Contractor shall:

(a) Cease all further work, except for such work as may be necessary and instructed by the Owner / Owner's Representative for the purpose of making safe or protecting those parts of the Works including Plant already executed, and any Work required to leave the Site in a clean and safe condition,
(b) Hand over all Design Documents, Construction Documents, Manuals, equipment, materials and spares for which the Contractor has received payment,
(e) Hand over those other parts of the Works executed by the Contractor upto the date of termination, and
(f) Remove all Contractors' equipment which is on the Site and repatriate all his staff and labour from the Site.

16.4.2 Any such termination shall be without prejudice to any other right of the Contractor under the Contract.

16.5 **Payment on Termination**

16.5.1 After termination under clause no. 16.2 above, the Owner shall return the Performance Security, and shall pay the Contractor an amount calculated and certified in accordance with clause no. 20.6.

16.5.2 **Survival of Obligations**

Notwithstanding anything to the contrary contained herein, any termination of this Contract shall not relieve:

a. Either party of its obligations with respect to confidentiality as set forth in this Contract,
b. Either party of any obligations hereunder which expressly or by implication survives termination hereof, and
c. Either party of its obligations or liabilities for loss or damage to the other party arising out of or caused by acts or omissions of such First party prior to the effectiveness of such termination or arising out of such terminations and shall not relieve Contractor of its obligations and liabilities for portions of the Work already performed prior to the date of termination.

17.0 INDEMNIFICATION

17.1 Requirements

17.1.1 Contractor shall fully indemnify, save harmless and defend Owner, Owner's shareholders, the Owner's Representative, the Financing Parties, each of their subsidiaries and affiliates and parent companies, and the directors, officers, agents and employees of each of them (the "Owner Indemnified Parties"), from and against any and all losses, costs damages, injuries, liabilities, claims and causes of action, penalties and interest, including reasonable attorney's fees (collectively, the "Damages"), directly or indirectly arising out of or resulting from or related to claims by third parties arising out of or related to this Contract or the Project,

including any damage to or destruction of property of, or death of or bodily injury to, any person (whether such person is another Owner Indemnified Party or Contractor Indemnified Party or Sub-Contractor or any other person unaffiliated with the Project, or employee of any thereof) to the extent resulting from Contractor's any Sub-Contractor's fault, negligence, strict liability, alleged fault or intentional act or omission or other act or omission in the performance of the Work, breach of this Contract or any Sub-Contract otherwise relating to the Plant, the Project, the Work, this Contract, any sub-contract, and including failure to comply with applicable laws or applicable permits, failure or mistake in paying taxes, or non-payment of amounts due in connection with work or equipment furnished to Contractor, or any sub-Contractor or any of their respective sub-Contractors or any other amounts payable by Contractor, or any Sub-Contractor.

17.1.2 Owner shall fully indemnify, save harmless and defend Contractor and its shareholders and subsidiaries, and the directors, officers, agents and employees of

each of them (the "Contractor Indemnified Parities"), from and against any and all Damages arising out of or resulting from claims by third parties arising out of or related to the performance of Owner's obligations pursuant to this Contract to the extent caused by Owner's omissions or negligence; provided that the foregoing obligation shall not apply to the extent the Contractor Indemnified Parties are contributory negligent or to the extent such damages are caused by the acts or omissions of the Contractor indemnified Parties.

17.2 **Specific Indemnification**

17.2.1 Contractor shall fully indemnify, save harmless Owner Indemnified Parties from and against any claim, demand, liability, action, proceedings, cost or expense in favour of any third party with respect to:

(a) Failure of Contractor, any Sub-Contractor or any of their respective sub-Contractors to comply with Applicable Laws and Applicable Permits.

(b) Failure of Contractor to make payments of taxes relating to Contractor's, any Sub-Contractor's income or other taxes required to be paid by Contractor pursuant to this Contract without reimbursement or compensation hereunder, and

(c) Any hazardous materials Contractor, any Sub Contractor, or any of their respective sub-Contractors has at any time brought on and caused the release thereof on or from the Site or for which any of them is responsible by law or in the Contract.

17.2.2 Owner shall fully indemnify, save harmless and Contractor Indemnified Parties from and against damages in favour of any third party with respect to:

(a) Failure of Owner or any of its other Contractors to comply with Applicable Laws and Applicable Permits.

(b) Any hazardous materials of Owner, or any of its other Contractors (other than Contractor and the sub-Contractors) has brought on and caused the release thereof from the Project Site.

17.3 **Patent and Copyright Indemnification**

17.3.1 Contractor shall fully indemnify and save harmless and defend the Owner Indemnified Parties from and against any and all damages that the Owner Indemnified Parties may suffer, incur or pay in connection with infringement (or assertions of infringement) of any patent rights, copyrights or other intellectual property, proprietary or confidentiality rights with respect to equipment, designs, techniques, processes and information designed or used by Contractor or any sub-Contractor in performing the Work hereunder or under the sub-contracts in any way incorporated in or related to the Project other than any such equipment, designs, techniques, processes and information provided by the Owner Indemnified Parties or

the Fuel Suppliers.

17.3.2 If, in any suit or claim relating to the foregoing, a temporary restraining order or preliminary injection is granted, Contractor shall make every effort to secure the suspension of the injunction or restraining order. If, in any such suit or claim, the project, or any part, combination or process thereof, is finally held to constitute an infringement and its use is permanently enjoined, Contractor shall promptly make every reasonable effort to secure for Owner a license, at no Cost to Owner, authorizing continued use of the infringing work If Contractor is unable to secure such license within a reasonable time, Contractor shall, at its own expense and without impairing performance requirements, either replace the affected Work, or part, combination or process thereof with non-infringing components or parts or modify the same as that they become non-infringing.

17.4 **Notice and Legal Defence**

17.4.1 Promptly after receipt by a party of any claim or notice of the commencement of any action, administrative or legal proceeding, or investigation as to which the indemnities provided may apply, such party shall notify the other party in writing of such fact provided that the failure of a party to give any such notice promptly shall not excuse the indemnifying party from its indemnification obligations hereunder except to the extent any such failure actually prejudices the indemnifying party in the defence of such matters.

17.4.2 The indemnifying party shall assume on behalf of the indemnified party and conduct with due diligence and in good faith the defence thereof with counsel reasonably satisfactory to the indemnified party; provided that the indemnified party shall have the right to be represented therein by advisory counsel of its own selection and at its own expense; and provided, further, that if the defendants in any such action include both the indemnifying party and the indemnified party and the indemnified party shall have reasonably concluded that there may be legal defences available to it which are different from or additional to, or inconsistent with, those available to the indemnifying party, the indemnified party shall have the right to select separate counsel to participate in the defence of such action on its own behalf at the indemnifying party's expense.

17.4.3 The indemnified party shall, at the request of the indemnifying party, provide all reasonably available assistance in the defence or settlement of any such claim, action, proceeding or investigation, and all reasonable costs and expenses incurred by the indemnified party in connection with the defence or settlement of any such claim, action, proceeding or investigation shall be reimbursed by the indemnifying party promptly upon demand therefore. Neither party shall settle or compromise any claim, action or proceeding without the prior written consent of the other party.

17.5 **Failure to Defend Action**

If any claim, action, proceeding or investigation arises as to which the indemnities provided may apply, and the indemnifying party fails to assume the defence of such claim, action, proceeding or investigation, then the indemnified party may at the indemnifying party's expense contest (or, with the prior written consent of the indemnifying party, settle) such claim.

17.6 **Survival: Expiration of Indemnity**

The provision of this clause no. 17.0 shall survive final acceptance and the termination of this Contract; provided that neither party shall have any indemnity obligations pursuant to this clause no. 17.0 for any claim arising out of or resulting from events or circumstances occurring after the termination of this contract.

18.0 CONTRACTOR'S CARE OF THE WORKS

18.1 The Contractor shall take full responsibility for the care of the works from the Notice to Proceed until the date of issue of the Certificate of Take Over when responsibility shall pass to the Owner. If the Owner's Representative issues a Certificate of Take Over for part of the Works, the Contractor shall cease to be responsible for the care of that part from the date of issue of such certificate of Take Over when responsibility shall pass to the Owner.

18.2 The Contractor shall take responsibility for the care of any outstanding Work which is required to be completed prior to the expiry of the Contract Period, until the Owner's Representative confirms in writing that such outstanding work has been completed.

18.3 If any loss or damage happens to the Plant, during the period for which the Contractor is responsible, the Contractor shall rectify such loss or damage, at his cost, so that the Works conform to the Contract. The Contractor shall also be liable for any loss or damage to the Works caused by operations carried out by the Contractor after the date of issue of the Certificate of Take Over until the expiry of the Contract Period in so far as such loss or damage is not covered under Insurance to be taken by the Owner for operation of Plant.

19.0 LIMITATION OF LIABILITY

19.1 The Contractor shall in no event be liable to the Owner, by way of indemnity or by reason of any breach of the Contract or in tort or otherwise, for loss of production, loss of profit or loss of any Contract or for any indirect, special or consequential loss or damage which may be suffered by the Owner in connection with the Contract.

19.2 **Limitation of liability**

19.2.1 Except for any damages which may be payable hereunder and except with respect to any claims for personal injury or physical damage to property of third Persons,

Contractor, its agents, workers, sub-Contractors, vendors and suppliers and the employees of each shall not be liable for any special, incidental, indirect, or consequential damages or any loss of business contracts, revenues or other financial loss of business contracts, revenues or other financial loss (or equivalents thereof no matter how claimed, computed or characterized) arising out of or in connection with the Performance of the Work whether or not any such liability is claimed in Contract, equity, tort or otherwise, unless caused by such Person's gross negligence or wilful misconduct. In addition, Owner shall have no liability or any special, incidental, indirect or consequential damages or any loss of business contracts, revenues or other financial loss arising out of this Contract.

19.2.2 **Limitation of Liability**

Under no circumstances that the Contractor's aggregate liability for:

(a) Cumulative liquidated damages for delay (calculated as per clause no. 11.1.2 above),

and/or

(b) Cumulative Liquidated Damages for failure to achieve the Performance Guarantees (calculated as per clause no. 11.2.2 above),

and/or

(c) Cumulative Penalty for Additional power consumption over the guaranteed power consumption (calculated as per clause no. 11.2.2 above),

shall not exceed **10%** of the Contract Price.

19.2.3 **No Limitation of Other liabilities**

Except for the express limitations of Contractor's liability with respect to:

(a) Special, incidental, indirect or consequential damages (as set forth in this clause no. 19.0), and

(b) Liquidated damages for delay and performance deficiencies (as set forth in clause no. 11.0)

Nothing in this Contract shall limit Contractor's obligations under this Contract (including its obligation to achieve Performance Acceptance of Plant in accordance with the terms and conditions of this Contract including Guaranteed Completion Dates).

19.2.4 Notwithstanding the foregoing limitations of liability, such limitations of liability shall not apply to

(a) Any of Contractor's obligations of indemnity under this Contract**,** and

(b) Any liability of Contractor stemming from the fraud or wilful misconduct of Contractor or Contractor's employees.

In addition, Contractor expressly acknowledges and agrees that any liability of Contractor provided for by the proceeds of the insurance maintained pursuant to the Contract including clause no. 6, or from Sub-Contractor's Warranties or Guarantees (which Contractor hereby covenants to diligently pursue and enforce), shall not be counted toward any of the foregoing limitations of liability.

19.2.5 Notwithstanding any other provisions of this Agreement, Contractor's and Sub-Contractor's aggregate liability to Owner under the provisions of this Agreement whether based on Contract, Tort (including negligence), strict liability, Guarantee or otherwise for Performance of the Work or breach of this Agreement, except as provided in sub clause 19.2.4 above shall not exceed the Contract Price.

20.0 FORCE MAJEURE

20.1 Definition of Force Majeure

In this clause, "force majeure" means an event beyond the control of the Owner and the Contractor, which makes it impossible or illegal for either party to perform whole or in part its obligations, including but not limited to:

(a) Act of God;

(b) An act of war, (whether declared or undeclared), invasion, armed conflict or an act of foreign enemies, blockage, embargo, revolution, riot, terrorist or military action, civil commotion or sabotage.

(c) Contamination by radio-activity from any nuclear fuel, or form any nuclear waste from the combustion of nuclear fuel, radioactive toxic explosive, or other hazardous properties of any explosive nuclear assembly or nuclear component of such assembly;

(d) Riot, civil commotion, terrorism or disorder, unless solely restricted to employees of the Contractor or of his Sub Contractors.

(c) Any failure by a Governmental Instrumentality to grant any Applicable Permit within a reasonable time after application therefor having been duly made and the conditions for the issuance thereof having been duly satisfied.

20.2 Excused Performance

If either Party is rendered wholly or partially unable to perform its obligations under this Contract because of a Force Majeure event, that party will be excused from whatever performance is affected by the Force Majeure event to the extent so affected provided that:

(a) The affected party gives the other Party written notice of the occurrence of

the Force Majeure Event as soon as practicable after the occurrence of the Force Majeure event as soon as practicable after the occurrence thereof, and also gives the other Party written notice describing in reasonable detail the particulars of such occurrence, including an estimation of its expected duration and probable impact on the performance of such Party's obligations hereunder, and thereafter continues to furnish thereto timely regular reports with respect Continuation of the Force Majeure event;

(b) The suspension of performance shall be of no greater scope and of no longer duration than is reasonably required by the Force Majeure.

(c) No liability of either party which arose before the occurrence of the Force Majeure event causing the suspension of performance shall be excused as a result of the occurrence, including liability for the timely payment of money otherwise due and earned by performance of tasks required under this Contract by any Party;

(d) The affected party shall exercise all reasonable efforts to mitigate or limit damages to the other party.

(e) The affected party shall use its best efforts to continue to perform its obligations hereunder and to correct or cure the event or condition excusing performance; and

(d) When the affected party is able to resume performance of its obligations under this Contract that party shall give the other party written notice to that effect and shall promptly resume performance hereunder.

20.3 **Limitations**

Anything in this Contract to the contrary notwithstanding.

(a) Any act, event, or occurrence listed above or asserted as a Force Majeure Event that results materially from the negligence or intentional acts of the affected party (or, in the case of Contractor or any Sub Contractor, or any Sub Contractor of any thereof) shall not constitute a Force Majeure event; and

(b) The affected party shall not be relieved from obligations under this Contract to the extent that the negligence or wilful misconduct of the affected party (or in the case of Contractor or any Sub-Contractor or any Sub Contractor of any thereof) contributes to or aggravates the Force Majeure event.

20.4 **Effect of Force Majeure Event**

Neither the Owner nor the Contractor shall be considered in default or in contractual breach to the extent that performance of obligations is prevented by a force majeure event which arises after the Effective Date. Except as otherwise provided in a Change Order, an extension of time shall be granted to Contractor only to the extent Contractor proves to Owner;

(a) The performance of the Work is actually and necessarily delayed by an event

of Force Majeure and

(b) the effect of such event of Force Majeure could not have been prevented or avoided or removed despite exercise of reasonable due diligence whether before, after or during the event of Force Majeure.

20.5 **Payment to Contractor**

If, in consequence of force majeure, the Plant or any part thereof shall suffer loss or damage, the Contractor shall be entitled to claim and receive payment for the cost of Work executed in accordance with the Contract, prior to the event of Force Majeure. If the Contractor incurs additional cost in complying with clause no. 20.3 above, such cost shall be determined by the Owner / Owner's Representative and shall be added to the Contract Price.

20.6 **Optional Termination, Payment and Release**

Irrespective of any extension of time, if a Force Majeure event occurs and its effect continues for a continuous period of 180 days or have been delayed for a cumulative period in excess of 270 days, either the Owner or the Contractor may give to the other a notice of termination, which shall take effect 30 days after the giving of the notice. If, at the end of the 30-day period, the effect of the Force Majeure continues, the Contract shall terminate. If the Contract is terminated under this clause no. 20.6 or clause no. 2.3 or clause no. 15.2, the Owner / Owner's Representative shall determine the value of the work done and:

(a) The amounts payable for any work carried out for which a Price is stated in the Contract;

(b) The cost of Plant and materials ordered for the Works which have been delivered to the Contractor, or of which the Contractor is liable to accept delivery, such Plant and materials shall become the property of (and be at the risk of) the Owner against payment therefore by the Owner, and the Contractor shall place the same at the Owner's disposal promptly upon receipt of request in respect thereof from the Owner;

and

(c) Any other cost or liability which in the circumstances was reasonably incurred by the Contractor in the expectation of completing the Works and effect any outstanding payment to the Contractor in accordance with the Contract prior to Force Majeure.

21.0 CLAIMS AND SETTELMENT OF DISPUTES

21.1 **Procedure for Claims**

21.1.1 If the Contractor intends to claim any additional payment under any clause of these conditions or otherwise, the Contractor shall give notice to the Owner's Representative as soon as possible and in any event within 30 days of the start of the event giving rise to the claim.

21.1.2 Within 30 days of such notice, or such other time as may be agreed by the Owner / Owner's Representative, the Contractor shall send to the Owner / Owner's Representative an account, giving detailed particulars of the amount and basis of the Claim along with all necessary supporting documentation. Where the event giving rise to the claim has a continuing effect, such account shall be considered as interim. The Contractor shall then, at such intervals as the Owner / Owner's Representative may reasonably require, send further interim accounts giving the accumulated amount of the claim and any further particulars. Where interim accounts are sent to the Owner / Owner's Representative, the Contractor shall send a final account within 15 days of the end of the effects resulting from the event.

21.1.3 If the Contractor fails to comply with this clause no. 21.1, he shall not be entitled to any additional claim and shall be deemed to have waived the same.

21.2 **Payment of Claims**

The Contractor shall be entitled to have included in any Claim for payment such amount for any claim as the Owner / Owner's Representative considers due. If the particulars supplied are insufficient to substantiate the whole of the claim, the Contractor shall be entitled to payment for such part of the claim as has been substantiated.

21.3 **Settlement of disputes**

21.3.1 The appellate authority shall be energy secretary Department of Energy, GOK

21.3.2 If any dispute of difference of any kind whatsoever is to arise between the Owner and the Contractor on the following matters viz.,

i) The meaning of the specification, designs, drawings and instructions.
ii) The quality of workmanship or materials used.
iii) Any other question, claim, right, matter , thing whatsoever in anyway arising out of or relating to the contract, estimates, orders or those conditions or failure to execute the same whether arising during the progress of the work or after the completion, termination or abandonment thereof, the dispute shall be referred to the concerned Chief Engineer.

The Chief Engineer shall within a period of 30 days from the date of being requested by the Contractor to do so, give written notice of his decision to the Contractor.

21.3.3 Subject to other form of settlement hereafter provided, the Chief Engineer's decision in respect of every dispute or difference so referred shall be final and binding upon the Contractor. The said decision shall forthwith be given effect to and Contractor shall proceed with the execution of the work with all due diligence.

21.3.4 In case the decision of the Chief Engineer is not acceptable to the Contractor, the Contractor will request to convene the meeting of MD KPCL, The owner and CEO of the Contractor for amicable settlement of the dispute.

21.3.5 **ARBITRATION**

Any disputes or difference of claim arising out of or in connection with, or relating to the present contract or the breach, termination or invalidity thereof shall be referred and settled under the Arbitrations Centre – Karnataka (Domestic and International) Rules 2012 by one or more Arbitrators appointed in accordance with its rule.

21.3.6 **Suit or Proceedings**

Any suit or proceedings arising out of this contract shall be initiated in appropriate law courts at Bangalore, Karnataka State.

22.0 The following details / information shall be furnished along with bid:

a) HSN code of goods or accounting code of services.
b) Description of goods or services.
c) Quantity in case of goods and unit or Unique quantity code there of
d) Total value of supply of goods or services or both
e) Taxable value of supply of goods or services or both taking into account, discount or abatement, if any
f) Rate of tax (Central tax, State tax, Integrated tax, Union territory tax or cess)
g) Amount of tax charged in respect of taxable goods or services (central tax, State tax, Integrated tax, Union territory tax or cess)
h) Place of supply along with the name of state, in case of a supply in the course of inter-state trade or commerce
i) Address of delivery where the same is different from the place of supply.

TABLE – 1

RESPONSIBILITY FOR PERMITS, CLEARANCES AND LICENSES

SL. NO.	CLEARANCES	2. AUTHORITY	RESPONSIBILITY
1.0	**STATUTORY CLEARANCES (whichever is applicable)**		
1.1	Cost estimate (Section 29 (1) of Electricity (Supply) Act, 1948 (ES Act, 1948)	Central Electricity Authority (CEA)	Owner
1.2	Concurrence under Section 31 of the Electricity (Supply) Act, 1948	CEA	Owner
1.3	Techno-economic clearance {Section 30 of Electricity [Supply] Act, 1948}	CEA	Owner
1.4	Investment Clearance from Government of India	PIB & Cabinet Committee on Economic Affairs of Government of India	Owner
1.5	Publication {Section 29(2), (3), (4) and (6) E[S]Act, 1948}	Government of Karnataka	Owner
1.6	River Water drawal	Government of Karnataka Irrigation Department	Owner
1.7	State Electricity Board Clearance [Sec 44, E[S], 1948]	Karnataka Power Transmission Corporation Limited (KPTCL)	Owner
1.8	Pollution clearance, water and air [Sec.25 of the Water (Prevention & Control of Pollution) Act, 1974 as amended in 1988, and Sec. 21 of the Air (Prevention & Control of Pollution) Act, 1981 as amended in 1987]	Karnataka State Pollution Control Board (KSPCB)	Owner
1.9	No Objection Certificate for setting up the facility	(KSPCB)	Owner
1.10	Consent for operation	KSPCB	Owner
1.11	Environmental clearance	Ministry of Environmental Forest, Government of India	Owner
1.12	No objection for tallest structure	Airport Authority of India, New Delhi.	Owner
1.13	Import licenses & formalities	Controller of Imports & Exports	Owner

1.14	Foreign investment approval	Reserve Bank of India (RBI) / FIPB	Owner
1.15	Final financial package	CEA	Owner
1.16	External borrowings	Reserve Bank of India, Ministry of Finance, Government of India, Income Tax Authorities.	Owner

SL. NO.	CLEARANCES	AUTHORITY	RESPONSIBILITY
2.0	**NON-STATUTORY CLEARANCES**		
2.1	Land availability	Government of Karnataka / Private Land	Owner
2.2	Fuel linkage and approval of fuel supply agreement	Ministry of Coal	Owner
2.3	Transportation of Fuel	Ministry of Railways, Shipping and Surface Transport	Owner
2. 4	Real Estate, Rights & right to access and use of Site, including Right of Way for all corridors to the Facility	Government of Karnataka / Concerned Authorities / Relevant Village Panchayat	Owner
3.0	**OTHER CLEARANCES/ APPROVALS (whichever is applicable)**		
3.1	Approval as per Explosives Act and Rules	Chief Controller of Explosives	Contractor
3.2	Approval as per Indian Boiler Regulation	Chief Inspectorate of Boilers	Contractor
3.3	Approval as per Indian Electricity Act and Rules for Electrical Installation	Electrical Inspectorate	Contractor
3.4	Approval as per Indian Petroleum Act and Petroleum Rules for storage and transport of Petroleum Products	Chief Controller of Explosives	Contractor
3.5	Approval as per gas cylinder rules and handling and transport of compressed gases	Chief Controller of Explosives	Contractor
3.6	Approval of weigh bridge and weigh scales	Inspector of Weights and Measure	Contractor

3.7	a) Collection, storage and disposal of waste	KSPCB	Contractor
	b) Site clearances, safe report and safety audit		
3.8	Approval of Fire Protection Scheme	(a) Fire Brigade (b) Tariff Advisory Committee	Contractor
3.9	Confirmation of Collector / Directorate of Town and Planning for the use of the site for the construction and operation of the Power Station and Fuel Facility	Directorate of Town and Planning of Government of Karnataka	Owner
3.10	Consent of relevant Panchayat for the development of Project Site and the Township site	Directorate of Town and Planning of Government of Karnataka	Owner
3.11	Approval of Chief Inspector of Factories of the proposed design and construction of power station and fuel facility	Chief Inspector of Factories of Government of Karnataka	Contractor
3.12	Allocation / approval of electric supply for construction power and Contractor's township in colony area	KPTCL	Contractor
3.13	Allocation of electric supply for Owner's township	KPTCL	Owner
3.14	Carriage entrance to property	Municipal Corporation : Assistant Engineer, Roads or concern authorities	Contractor
3.15	Approval of building proposals and layout	Municipal Corporation : Executive Engineer, Building Proposal or concerned authorities	Contractor
3.16	Approval of building layout with fire safety concerns and receipt of No Objection Certificate	Municipal Corporation : Chief Fire Officer or concerned authorities	Contractor
3.17	Approval of reinforced cement and concrete design calculation (RCC)	Municipal Corporation : Executive Engineer, Building Proposals or concerned authorities	Contractor
3.18	No objection Certificate regarding air emissions	Municipal Corporation : Project Air Pollution Officer, Inspector of Chimney	Contractor

3.19	No objection Certificate for Chimney	Inspector of Smoke Nuisance	Contractor
3.20	No Objection Certificate for sewage water treatment and associated plumbing	Municipal Corporation : Executive Engineer, Sewerage and Planning or concern authorities	Contractor
3.21	No Objection Certificate for Storm Water Drainage Design	Municipal Corporation : Executive Engineer, Storm Water Drainage or concern authorities	Contractor
3.22	To review the frequency used for Power Line Carrier Communication (PLCC) system to ensure no interference with other power line users		Owner
3.23	No objection certificate for plant layout with regard to electrical equipment, operational safety	Chief Electrical Inspectorate of Karnataka	Contractor
3.24	No Objection Certificate for storage of construction materials and chemicals, etc.	Municipal Corporation : Assistant Engineer, Factory Department	Contractor
3.25	No Objection Certificate for storage of construction fuel oils and chemicals, etc.	Commissioner of Police	Contractor
3.26	No Objection Certificate for storage of Fuel oils	CCE	Contractor
3.27	No Objection Certificate for road opening and asphalting work including traffic work.	Municipal Corporation : Assistant Engineer, Roads or concern authorities	Contractor
3.28	Local approval for operating a factory	Municipal Corporation : Ward Office or concern authorities	Owner
3.29	Local approval of Architectural plans for township	Municipal Corporation or concern authorities	Owner
3.30	Local approval of other Architectural plans	Municipal Corporation or concern authorities	Contractor
3.31	Commencement Certificate upto Plinth	Municipal Corporation or concern authorities	Contractor
3.32	Commencement Certificate upto	Municipal Corporation or	Contractor

	Full Height	concern authorities	
3.33	Consent of the Controller of Explosives to the possession and use of explosives for the purpose of blasting	Home Department of Government of Karnataka	Contractor
3.34	Consent under the Factories Act, 1948 relating to firefighting capacities	Inspectorate of Factories	Contractor
3.35	Clearance of Lifts	Inspector of Lifts	Contractor
3.36	Approvals / clearances for labour / man power like License from labour commissioner for Construction labour, Registration of workers or exemption to be claimed if group insurance taken for some etc.	Concerned Authorities	Contractor
3.37	Deemed Export Benefits	Ministry of Industries	Contractor
3.38	All other clearances	Appropriate Authorities	Contractor

Notes: 1. For the items which are Owner's responsibility, the Contractor shall furnish all technical / commercial inputs.

2. For the items which are Contractor's responsibilities, Owner shall furnish relevant certificates, as required. However, all costs including fees, miscellaneous expenses and coordination in securing the NOC / Permit / clearance are in the scope of Contractor.

KARNATAKA POWER CORPORATION LIMITED
YELAHANKA COMBINED CYCLE POWER PLANT (1X370MW)
ZERO LIQUID DISCHARGE PLANT (ZLD)

SECTION: A5 VOLUME-I
PART- I - GCC

Additional Format to be submitted by Bidders –"Pre Qualifying Criteria"

TYPE of Bid: STAND ALONE / CONSORTIUM

Sl. No	Type of Bidder	Name of the Bidder	QR Ref	Qualifying Experience	Work order Ref with page no in Offer for supporting documents	Completion certificate ref for the referred Work with page no in Offer for supporting documents	The relevant satisfactory performance certificates signed by CE/CEO of respective Thermal Power Station / other major industries / water supply board, on letter head with Corporate Identification Number, certifying the satisfactory performance / relevant Undertakings/ other relevant documents with page no in the offer.	Remarks
	Standalone Bid (As per 2.0 of QR)		2.0	The intending bidder should have Designed, Engineering, Manufactured/Supplied, Constructed, Erected and Commissioned. a) Waste water pre-treatment plant with RO system of capacity not less than 75 Cum/hr. and b) Crystallizer cum Evaporator system & Salt Centrifuge with Mechanical vapour Recompression system (Zero Liquid Discharge plant) of capacity not less than 3 Cum/hr.	ENCLOSED/ NOT ENCLOSED			

				The bidder shall have executed the above works in any Power Plant/ Industrial Projects/ Water supply Board/ Municipal Corporation (including Civil works) in preceding **Five years** reckoned from last date for submission of bids and the same shall be satisfactorily and demonstrably performed continuously for a minimum period of **One** year as on last date for submission of bids. As a proof of the above, the intending bidder shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board etc. certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.				
				Under takings to be furnished by the bidder. As per Annexure-4-Instruction to bidders	ENCLOSED/ NOT ENCLOSED			
				Scanned copy of BG towards EMD	ENCLOSED/ NOT ENCLOSED			
2	CONSORO-TIUM BID	**(The number of partners in consortium including the lead bidder shall not be more than two)**						
			2	The intending bidder should have Designed, Engineering, Manufactured/Supplied, Constructed, Erected and Commissioned.				
	Lead Bidder	M/s	2a	i) Waste water pre-treatment plant with RO system of capacity not less than 75 Cum/hr.				
	Consort-ium Bidder	M/s	2b	ii) Crystallizer cum Evaporator system & Salt Centrifuge with Mechanical vapour Recompression system (Zero Liquid Discharge plant) of capacity not less than 3 Cum/hr.				
				The bidder shall have executed the above works in any				

				Power Plant/ Industrial Projects/ Water supply Board/ Municipal Corporation (including Civil works) in preceding **Five years** reckoned from last date for submission of bids and the same shall be satisfactorily and demonstrably performed continuously for a minimum period of **One** year as on last date for submission of bids. As a proof of the above, the intending /Lead bidder and his consortium partner shall furnish the relevant satisfactory performance certificates, on letter head with Corporate Identification Number, signed by competent authority/CEO of respective Thermal Power Station / other major industries / water supply board etc. certifying the satisfactory performance of the equipment/ system supplied and installed by the bidder in respect of paras Sl.Nos.2 (a) and 2(b) above.				
			Undertaking to be furnished by lead/consortium bidder					
		M/s		Undertakings to be furnished by the lead/consortium bidder as per Annexure – 4 by each bidder	ENCLOSED/ NOT ENCLOSED			
				Scanned copy of BG towards EMD	ENCLOSED/ NOT ENCLOSED			
3	Financial Turnover:							
	Standalone Bidder	M/s		The bidder (as per para 2.1) in his name should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum financial turnover of **Rs. 140.00 Crore**. As a proof, the bidder shall furnish Copies of audited P&L Account and audited balance sheet duly certified by the Chartered Accountant to establish annual turnover requirement stipulated above.	ENCLOSED/ NOT ENCLOSED			

	Lead Bidder	M/s		In case of consortium bid, Lead bidder and consortium partner (as per para 2.2.1 & 2.2.2) in their names should have in the last five years period i.e. 2013-14 to 2017-18 achieved in at least two financial years a minimum financial turnover of **Rs.84.00 Crore** and **Rs. 56.00 Crore** respectively. As a proof, the bidders shall furnish Copies of audited P&L Account and audited balance sheet duly certified by the Chartered Accountant to establish annual turnover requirement stipulated above.	ENCLOSED/ NOT ENCLOSED		
	Consortium Bidder	M/s			ENCLOSED/ NOT ENCLOSED		
4	Consortium agreement			Consortium agreement (as per KPCL format) between Lead bidder and consortium bidder/bidders.	ENCLOSED/ NOT ENCLOSED		

Bidder/ Lead Bidder/ Consortium bidders

KARNATAKA POWER CORPORATION LIMITED
(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP)

(1x370 MW)

BID DOCUMENTS

FOR

"ZERO LIQUID DISCHARGE PLANT COMPRISING OF WASTE WATER PRE-TREATMENT PLANT WITH RO SYSTEM AND CRYSTALLIZER SYSTEM AND ACCESSORIES"
FOR YCCPP-1X370MW

VOLUME-I

PART II

Special Conditions of Contract

OFFICE OF THE CHIEF ENGINEER (THERMAL DESIGNS)
KARNATAKA POWER CORPORATION LIMITED
No. 22/23, SUDHARSHAN COMPLEX, 2nd FLOOR
SESHADRI ROAD, BANGALORE-560 009

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SPECIAL SCOPE OF ENQUIRY

1.0 The scope of this enquiry shall be as detailed in the bid specification document elsewhere

CODES AND STANDARDS

2.0 All Plant, equipment, systems and works covered under these specifications shall comply with the latest editions including amendments thereto of applicable codes, standards, statutes, regulations and safety rules as on the date of submission of bid. Particular care shall be exercised in observing compliance to the rules and regulations governing the locality where the Plant is to be installed. Contractor's obligations in this regard shall not be limited to only those codes and standards mentioned in these specifications. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

3.0 In the event of any conflict between the applicable codes and standards and the requirements of these specifications, the more stringent of the two shall govern.

4.0 Contractor shall make available one copy each to the Engineer and Owner, of all international codes, standards, rules and regulations that are published outside India and used by him in the design, engineering and execution of the power project. The copies furnished shall be certified English version in case the original of the standard or code is in any other language.

5.0 In the event Contractor deviates from any material standard specified herein or offered by it at the bid stage and accepted by the Engineer or Owner, it shall demonstrate the equivalence or superiority of the new material proposed to the one specified or offered and accepted, to the satisfaction and approval of the Engineer.

6.0 Contractor shall maintain copies of all international, national, state and local codes, standards, rules and regulations used by him in the execution of the project in his design offices and manufacturing shops. Copies of those codes and standards that are relevant to the performance of civil works, equipment erection, commissioning and testing shall also be available at Contractor's site office.

7.0 Operation & maintenance of plant and equipment for a period of one year round the clock 7 days a week. Refer SEC C13 schedule of Operation and maintenance.

BREIF DESCRIPTION OF THE PROJECT					
1.0	Owner			:	Karnataka Power Corporation Ltd Shakthi Bhavan No.82, Race Course Road Bangalore–560 001 Karnataka, India
2.0	Project Title				1x370 MW Yelahanka CCPP
3.0	Location			:	Doddaballapur Road, S N Halli post, Near Puttenehalli, Yelahanka, Bangalore.-560064 Bangalore Dist Karnataka state,
4.0	Latitude and Longitude			:	13^{o} 07' N Latitude India 77^{o} 35' E Longitude
5.0	Elevation above mean sea level			:	900 meters
6.0	Climatic Conditions				
	(a)	Temperature			
	i.	Monthly basis			
		Mean of daily maximum temperature		:	37^{o} C
		Mean of daily minimum temperature		:	11.5^{o} C
	ii	Highest temperature recorded		:	39^{0}C
	iii	Lowest temperature recorded		:	9.9^{0}C
	(b)	Relative Humidity		:	Varies between 60% and 90%
	(c)	Rainfall			
		Annual average rain		:	970 mm
	(d)	Wind Speed			
		i.	Annual mean wind speed	:	2.82 m/s
		ii.	Maximum mean wind speed	:	3.71 m/s in the month of June.
		iii	Design Wind Speed		33 M/sec (As per IS: 875)

		Design Temperature	:	28^0
7.0	Seismic data			
	Zone		:	Seismic Zone II As per IS 1893
8.0	Distance from the nearest town / city / major human settlement		:	18 kms. from Bangalore, 25 kms from Bangalore International Airport
9.0	Distance from water source		:	Tertiary sewage treatment plant situated in Jakkur/Yelahanka which is 5-6 kms. from site.
10.0	Design ambient for electrical equipment / System		:	50^0 C
11.0	Out Door Design Conditions- Dry Bulb, Wet Bulb, RH for A/C & Ventilation System		:	
11.1	Summer		:	35.6^0C 25.6^0C 45%
11.2	Monsoon		:	27.8^0C 25.6^0C 82%
11.3	Winter		:	14.4^0C 12.2^0C 78%
12.0	Design Wind speed		:	33 m / sec (as per IS: 875)
13.0	Auxiliary Power Supply		:	Auxiliary equipment to be supplied against this specification shall be suitable for operation on the following supply:
13.1	AC Motors rated 200 kW and above		:	6.6 kV, 3 ϕ, 3 wire, AC Supply (Medium resistance earthed)
13.2	AC Motors below 200 kW and other LT loads		:	415 V, 3 ϕ, 3 wire, AC Supply (Effectively earthed)
13.3	Plant lighting, utility power sockets, space heating of panels and space heating of motors > 30 kW		:	240 V, 1 ϕ, AC Supply (Effectively earthed)
14.4	Control Circuit of local panels (like compressor control, crane		:	110/230 V, 1 ϕ, AC Supply System (Derived from 415/110/230 V step down

	control etc.) and 415 V switchgear outgoing feeder modules controls.		transformer)
14.5	Utility power sockets required for hand lamps for inspection of internals of condensers, boilers, etc.	:	24 V, 1 ϕ, AC Supply
14.6	For control of switchgears, switchyard equipment, DC emergency drives, DC emergency lights, switchyard and generator protection panels, etc.	:	: 220V DC Supply
14.7	For Instrumentation & Control :	:	±24 V DC or 48V DC or 110 V AC or 230 V AC supply (These voltage levels shall be derived from 230 V AC UPS supply)
15.0	Tropicalisation :	:	(a) All equipment supplied against this specification shall be given tropical and fungicidal treatment (b) Tropical protection shall conform to BS: CP-104:1963 entitled “Protection of Electrical Power Equipment against Climatic Condition”.
16.0	Unless otherwise specified all electrical system shall be designed for the following voltage and frequency variations :		
16.1	A C System:	:	
a)	Voltage variations	:	± 10 %
b)	Frequency Variation	:	± 5 %
c)	Combined Voltage & Frequency Variation	:	10 %
16.2	DC System	:	
a)	Voltage variation (220V)	:	: +10% to -15%
b)	Voltage variation (24V or 48V) :	:	To suit equipment of I&C system
16.3	UPS	:	: ± 10 %

1.0 BROAD SCOPE

1.1 "Design, engineering, manufacture, Quality Surveillance, inspection & testing at supplier's works, packing & forwarding, transportation, supply, delivery F.O.R. YCCPP site, unloading, receipt & storage, handling at site, erection, trial operation, testing, commissioning, conducting performance guarantee tests including painting and handing over of ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories with all civil, structural, mechanical, electrical, control & instrumentation works, integrating ZLD scheme with main power plant and Essential Spares including insurance towards transit risk / storage / intra-site transportation and erection including O&M of Plant and Equipment for a period of one year for 1 x 370MW of Yelahanka Combined Cycle Power Plant of KPCL, Yelahanka, Bengaluru- 560064, in the State of Karnataka, India.

The Contractor shall perform all of the work specified necessary to complete the scope of work in accordance with this specification. Further, the Contractor's performance of the work under the Contract shall include everything requisite and in accordance with good engineering and construction practices, notwithstanding the fact that every item involved may not be specifically mentioned or the item mentioned may be inadequate for its intended purpose. Details and items which are not specifically mentioned herein shall also be adequately and properly performed by the Contractor at no extra cost if such details and / or items are reasonably necessary to complete the intent of this specification or otherwise to complete the scope of work. The intent of this specification is to relieve the Owner of the necessity of engaging or supplying any labour, service, equipment or material to complete the work as per the tender specification.

Contractor attention is drawn into the following important design requirements:

Auxiliary Equipment Performance with Fluctuation in Power Supply Condition

All auxiliary equipment and drive motors shall be capable of delivering satisfactorily their rated outputs continuously for a voltage variation and frequency as mentioned in the specification.

Design Requirements

For the entire power plant only those designs and systems shall be used which have been proven in continuous operation for a long periods. Innovations and prototypes are not acceptable.

The plant shall be new and have a minimum working life of thirty (30) years. The equipment/components of the plant shall be designed for reliable and trouble free operation over the entire life of the plant.
All component parts including spares and spare assemblies shall be completely interchangeable. All equipment/systems shall be designed to meet the requirements specified in respective sections.

1.1 REFER TECHNICAL SPECIFICATION FOR BROAD SCOPE OF WORK

1.2 **PROJECT MANAGEMENT / SERVICES**

1.2.1 The Contractor shall identify a separate and independent project management team headed by a Project Manager for the execution of this Project.

The Contractor shall provide effective management of the Contract, which shall be compatible with the Owner's requirements as set out in this Specification. The Contractor shall allow access to its works and those of his sub-contractors at all reasonable times to permit the Owner / Engineers participation, if the Owner / Engineer considers it necessary in monitoring the Contract. He shall also work with other Contractors who interface with his Contract in order to ensure the smooth development of the project completion. Such participation up to its completion shall not, in any way affect the Contractor's obligations to complete the works in accordance with the Contract.

1.2.2 **Management Organization**

The Contractor shall describe as to how his management organization will meet the requirements detailed herein. He shall include an organization chart illustrating as to how the management structure / lines of authority will function during the Contract.

The Contractor shall submit the name, qualifications and experience of the proposed managerial and senior supervisory staff to be employed on the Contract. The Contractor shall indicate the number of staff, rating and seniority to be employed to manage and supervise the Contract and list separately for 'head office' and 'site' based locations. In particular how staff are planned to be deployed with respect to the Contract period timescale shall be stated.

The Contractor shall notify any proposed changes in senior staffing numbers or arrangements to the Owner.
The Owner reserves the right to evaluate and audit the Contractor's management systems and controls in the areas set forth in this section.

1.2.3 Engineering Services

The Contractor shall render complete engineering services for the project including complete detailed engineering, design, submission and documentation as specified and as required for a good design and installation ensuring efficiency, operability, availability, maintainability and reliability of the Plant. Prior to commencement of the engineering work all aspects of design, viz., criteria for selection and sizing of all equipment and systems, design margins, analysis and design calculations etc. shall be stated by the Contractor in design basis reports. As part of design submissions, the design basis reports shall be submitted for approval by the Owner / Engineer. The approved design basis reports shall form the basis for the detailed engineering work.

At any stage during the performance of the works, the Owner may require up-gradation / improvements in the Contracted Plant and consequent modification in the equipment / system designs in view of additional information available at a later date(s) or feedback(s) received during execution / operation of similar units. If so desired by the Owner, the Contractor shall make the necessary design modifications and carry out the up gradation / improvements in the Plant. Commercial and time implications of such action shall be mutually agreed upon between the Owner and the Contractor.

During the course of review of detailed engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and Plants engineered by the Contractors. In case Owner so desires the Contractor shall submit such analogous data and information to the Owner.

The Contractor shall cooperate with the Owner's other Contractors and Engineer and freely exchange with them such technical information as are necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Contractors and Engineer in respect of such exchange of technical information.

The Contractor shall furnish a comprehensive and detailed schedule of drawings and design documents, which shall be submitted by him after award of Contract indicating submission dates against each document. The list shall be subject to the approval of the Owner / Engineer.

The documents shall be divided into two categories:

(a) For approval
(b) For information / reference only

Documents submitted during bid stage, shall be revalidated or revised as required and submitted as certified document for approval / information of the Owner.

(a) System scheme drawings, and instrumentation diagrams
(b) Design basis reports
(c) Specification for major bought-out items
(d) Equipment data sheets and general arrangement drawings
(e) Drive motor list for all system covered under the scope of this specification.
(f) Materials for Construction
(g) Layout drawings
(h) Operation logic diagrams
(i) Typical control circuits
(j) Protection schemes

1.2.4 **Operating Manuals and Maintenance Instructions**

The Contractor shall submit to the Owner / Engineer, instruction manuals for all equipment covered under the contract at least thirty (30) days before the first shipment of the equipment.

The operating manuals and maintenance instructions shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, re-assemble, adjust or replace all equipment and components during the lifetime of the Plant. The manuals shall be specifically prepared for the contracted Plant. Only a collection of manufacturer's standard leaflets shall not be acceptable as the manuals.

In addition, the Contractor shall provide a consolidated manual for the complete system detailing out instructions for operation and maintenance before commissioning and taking over of the equipment/system,

The operating manuals, maintenance instructions manual and spare parts catalogues shall be submitted as detailed in Section C11. The instruction manuals shall be subject to the approval of Owner.

If after the commissioning and the initial operation of the Plant, the instruction manuals require modifications / additions, the same shall be incorporated by the Contractor and the updated final version of the manuals shall be submitted.

1.2.5 Plant Handbook and As-Built Documentation

Plant Handbook

The Contractor shall submit to the Owner, a preliminary Plant handbook preferably in A-4 size sheets which shall contain all approved design basis and design calculations, the design and performance data of various Plant, equipment and systems covering the complete project including single line flow diagrams. The final Plant handbook complete in all respects shall be submitted by the Contractor before start-up and commissioning activities. The Plant handbook shall be submitted in form of one (1) reproducible original and ten (10) copies along with Three (3) copies in Compact Disks (CDs).

"As-built" Documentation

The Contractor shall provide and keep up to date "As built" drawings of all structures constructed and all equipment and accessories and miscellaneous metal works erected or installed. These drawings shall show all changes and revisions from the original drawings and specifications, including the exact "As-built" locations, sizes and kinds of equipment and accessories, miscellaneous metal works, embedded piping and electrical systems and other concealed items of work. These drawings shall be kept in Contractor's field office but shall be made available at all times for review of the Engineer. At the end of every work, all entries, changes or revisions made in the drawings by the Contractor shall be checked and approved by the site Engineer. Reproducible prints with requisite copies of all "As-Built" drawings shall be progressively handed over to the Owner for information and records after taking over of the Plant by the Owner. In addition, all the as-built drawings / documents shall be submitted to the Owner in CDs.

1.2.6 Sub-Contractors

The Contractor shall submit to the Owner all major items that he deems necessary to be sub-contracted. The Contractor shall not change major Sub-Contractors without prior approval of the Owner.

The Contractor's orders to the Sub-Contractors shall quote the Owner's contract reference and station name, and instruct the sub-contractors to quote that number and name and also the order number in all correspondences.

A copy of all purchase orders placed on sub-contractors, and of all orders placed by sub-contractors shall be supplied to the Owner.

The Contractor shall be responsible for maintaining an up-to-date list of all sub-orders and interworks order and shall make this available to the Owner as required.

The Owner's Contract Reference and Station name, shall be added to all interworks and sub-orders.

The Owner reserves the right to check that the Contractor is making timely payments to his sub-contractors.

The Contractor shall ensure that their sub-contractors follow the requirements of the specification and have adequate control over all aspects covered by the specification.

1.2.7 Progress Reports

During the design and manufacturing stages the Contractor shall submit to the Engineer reports and information on the progress and manufacture by himself and by the Sub-Contractors of all Plant and materials required for the execution of the works. The reports shall be based on the Plant manufacturing programs.

The detailed procedure and requirements for progress reporting will be agreed with the Owner during the early phase of the works, as part of regular contract / project status reporting.

The Contractor shall also submit to the Owner monthly progress reports and any other reports as required by Owner / Lenders / Statutory authorities.

1.2.8 Access for Progress Monitoring

The Owner or his nominated representative shall be entitled at all reasonable times to visit all premises where design and manufacturing of the Plant is being carried out in order to monitor and verify progress.

1.3 MISCELLANEOUS

- Design engineering
- Quality control, shop testing and inspection.
- Consents, licenses and approvals from relevant statutory authorities other than those obtained by the OWNER.
- Packing & forwarding, transportation (ocean and inland), custom/port clearance, reconciliation with custom authorities, receiving and unloading at site.
- Unloading of materials at Railway Siding inside project area / airport / sea port, transportation to site store, assessment of lost / damaged items in

transit and arranging insurance claims and replacement of lost / damaged items in transit.

- Proper storage within the site and taking custody of all the materials till the Plant is officially taken over by the Owner after complete erection and successful trial run & commissioning
- Transportation of materials to their respective places of erection and erection of the complete Plant & equipment as supplied under this specification
- Trial run and commissioning of individual equipment/ sub-systems and the Plant as a whole to the satisfaction of the Owner including supply of temporary equipment and services for chemical cleaning etc.
- Conducting Performance guarantees tests.
- Supply and application of the final paints on all the equipment to be erected under this specification
- Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch and ward, commissioning and other services to be rendered under this specification
- Deployment of all erection tools & tackles, construction machinery, transportation vehicles and all other implements in adequate number, capacity and size
- Supply of all consumables, e.g., welding electrodes, cleaning agents, diesel oil, lubricants etc. as well as materials required for temporary supports, scaffolding etc. as necessary
- Construction of all civil, structural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment and all other related activities as detailed elsewhere
- Supply of necessary calibrated instruments for carrying out performance tests of Plant and equipment.
- Taking approval of all statutory authorities e.g., Factory Inspector, Inspector of Explosives, Electrical Inspectorate etc. for respective portions of work under the jurisdiction of such statutes or laws
- Quality assurance of all work executed at site
- Co-ordination and Project Management.
- Complete construction (including supply of material and labour), fabrication, erection, chemical cleaning, steam blowing, trial run, commissioning and performance testing of entire Plant.
- Construction of site office, canteen, construction stores, residential accommodation of Contractor's staff/labour, etc. including arrangement of land for the same on lease basis from the concerned. Further, the facilities provided at the construction staff/labour colony shall meet all the local regulation requirements.

- Supply of lubricants/consumables during construction and for first filling during testing and commissioning and all temporary provisions till take over.
- Spare parts as specified.
- Start up and commissioning spares as required
- Special tools and tackles, as required for the Plant
- All necessary calibrated instruments necessary for performance testing of entire Plant.
- Furnishing all documents, engineering & construction drawings, design basis reports, optimization study reports, design calculations, equipment data sheets from manufacturers, quality assurance plans, testing procedures, operation and maintenance manuals, commissioning procedures, 'As built" drawings, etc.
- Training of the plant Owner's personnel on plant operation and maintenance.
- Diversion of roads (if any) as required
- All other facilities/services as described in the section on 'Site Services'.

NOTE:
The above list of work is not exhaustive. Any additional works, whether or not specifically described in this document and incidental to complete the system in all respects shall be deemed to be in the scope of work of the Contractor.

2.0 TERMINAL POINTS AND EXCLUSION

Refer Volume I, Part III- Technical specifications.

3.0 Integration with the main plant

a. Tapping Power supply from existing 6.6kV switch gear as per scope mentioned technical specification (Electrical).
b. Pumping waste water from existing CMB to ZLD pre-treatment Scheme as per scope mentioned technical specification (Mechanical).
c. Pumping Treated water from CW water Make up tank to existing CW Forebay as per scope mentioned technical specification (Mechanical).
d. Tapping Steam from Existing HRSG LP steam Line as per scope mentioned technical specification (Mechanical).
e. Tapping Instrument air from existing Instrument air network as per scope mentioned technical specification (Mechanical).
f. Tapping water for Fire Hydrant from existing Fire hydrant network as per scope mentioned technical specification (Mechanical).
g. Tapping Potable water from existing potable water network as per scope mentioned technical specification (Mechanical).
h. Connecting drainage/Sewerage/Sewage to existing network/STP as per scope mentioned technical specification (Mechanical).

i. Any online monitoring data required shall be hooked up to existing system of the main plant.
j. Connecting ZLD plant roads to existing main plant roads as per requirement.

1.0 CONTRACTOR shall furnish the Project Milestone Schedule as per of Section-F2 of Volume-III.

2.0 PLANNING AND MONITORING

2.1 Planning

The CONTRACTOR shall prepare a Master Network Schedule in the form of PERT network. The network shall be prepared on a Work Breakdown Structure.

The master network shall identify milestones of key events of each system/package in the areas of engineering, procurement, manufacture and dispatch, erection and commissioning. The master network shall represent the Level I plan and will form the basis for development of detailed second and third tier execution plans.

The master network shall be submitted along with the bid and shall be mutually discussed and finalized before the award of Contract. The master network shall identify a complete list of inputs to be furnished by the OWNER which may be required for proper interfacing and tie up. Scheduled dates for providing such inputs shall also be indicated and the same will be mutually discussed and finalized.

The CONTRACTOR shall not change the Master network without the prior approval of the OWNER in accordance with the Conditions of Contract. In the event that the OWNER approves a revision to the Master Network in accordance with the Conditions of Contract, the CONTRACTOR shall submit a revised Master Network within two weeks thereafter. This program shall fully comply with the requirements of the specification and where necessary, reflect changes to the sequence or progress of the Works as indicated by the OWNER, or as proposed by the CONTRACTOR and accepted by the OWNER. Such an agreed revised program shall become the Overall CONTRACTOR Program for the outstanding works.

2.2 The CONTRACTOR, within **15 days** after the date of the issue of the LOA shall submit to the OWNER the detailed program along with detailed BBU for supply and erection which shall be consistent with the Project Schedule given above.

2.3 The Milestone schedule shall show the sequence, timing and duration of the Work and the planned commencement and completion dates of all separable portions of the Work, including each Milestone, in form, content and level of detail satisfactory to OWNER. The CONTRACTOR shall fix the major milestones to check / review progress on the life cycle curves so that the time gap between 2 milestones should not be more than 10% of the total time duration. A legend will be used to describe the milestone.

2.4 The Milestone Schedule shall show CONTRACTOR's man power forecasts, procurement, delivery and installation plans for major Materials and other schedule information reasonably requested by OWNER.

2.5 The CONTRACTOR shall at all times perform the scope of supply in accordance with Project Schedule and the programme.

2.6 Alteration of the Program

No material alteration to the Programme shall be made without the approval of the ENGINEER. However, CONTRACTOR may make alterations to the Program without the approval of the ENGINEER being required where such alterations are consistent with the key milestone dates set out in the Project Schedule and do not affect the payment schedule.

2.7 The CONTRACTOR shall submit the coding procedure being adopted for computerization along with the logic and the Work Breakdown Schedule with their respective weightages used for generating the life cycle curves and shall submit the Work Intensity Chart based on weightages conforming to their overall schedule.

3.0 REVISION OF PROGRAMME

If the progress of the Scope of Supply or any other part of the Works does not conform to the Program, the OWNER may instruct the CONTRACTOR to revise the program.

If such modifications are required for reasons for which the CONTRACTOR is not responsible, the cost of preparing the revised program shall be certified by the OWNER and added to the contract price.

4.0 If for any reason which does not entitle the CONTRACTOR to an extension of time the rate of progress of the Scope of Supply or part thereof is at any time in the reasonable opinion of the Employer or the ENGINEER too slow to secure completion of the works within the Time for Completion or any extended date the Employer may so notify the CONTRACTOR in writing and the CONTRACTOR shall thereupon take such steps as are necessary and the Employer may approve an order to accelerate (whether by re-programming the order or sequence of work or by increasing the personnel or other resources of the CONTRACTOR or its SUB-CONTRACTORs employed on the Scope of Supply) the progress of the Scope of Supply or part thereof so as to achieve completion of each section by the Time for Completion as may be extended. The CONTRACTOR shall not be entitled to any additional payment or extension of time for taking such steps.

5.0 REPORTING AND COORIDNATION

5.1 During the performance of the Work, CONTRACTOR shall submit monthly updates comparing the Work completed against the milestone schedule or if CONTRACTOR's performance is not in compliance therewith, more frequently as requested by OWNER. If CONTRACTOR's performance of the work is not in compliance with the Milestone Schedule, without restricting any other rights or remedies of OWNER hereunder, CONTRACTOR shall (i) submit its plan for schedule recovery and (ii) specify in writing the steps to be taken to achieve ongoing compliance with such revised schedule. CONTRACTOR shall submit the overall life cycle curve for progress curve. The CONTRACTOR shall adopt a milestone approach and shall identify several milestones to be achieved so that they could be measured physically. Computation of progress of the CONTRACTOR shall use weighted value concept and submit detailed computerized linked bar chart. CONTRACTOR shall submit work breakdown structure in detail along with the weightage and the milestone to be achieved every week preferably in a graphical / tabular format.

5.2 CONTRACTOR shall comply with the Milestone Schedule and to attend and participate in progress, site co-ordination or special purpose meetings. Progress, site and co-ordination meeting will be held at CONTRACTOR's engineering office or the Site on a weekly basis, unless otherwise requested by OWNER. CONTRACTOR shall have in attendance at any such meeting the Project Manager and other management workers authorized to commit additional manpower to the Work and shall for any progress meeting bring a forecast showing the last period's progress versus the last period's scheduled work plan and the work plan for the next three weekly time periods. Unless otherwise stated in writing by OWNER the forecast shall describe the Work by task, by site location, by area or building and by bay for a one month period. The commencement and completion of each task to be performed shall be clearly designated. If requested by Employer, representatives of Vendors of major materials shall be at each such meeting. Employer may on reasonable notice to CONTRACTOR call a special purpose meeting whether at CONTRACTOR's engineering office or the site to review any portion of the Work, the performance of which is of substantial concern to Employer.

5.3 The CONTRACTOR shall use the latest version of a project management software preferably Primavera Project Planner to generate and submit the following to the OWNER to facilitate monitoring the project progress.

(a) Overall Schedule (Monthly basis) hard copy along with the electronic file in a floppy.

(b) Performance / Forecast look ahead schedule i.e., three weeks work ahead and previous week's performance.

(c) Milestone slippage report.

1.0 QUALITY ASSURANCE REQUIREMENTS:

1.1 Introduction:

The minimum Quality Assurance / Quality Control (QA/QC) requirements and the services the Contractor is expected to provide to assure 'Quality Assurance' are described in this section. `Quality Assurance' is defined as the entire program adopted by the Contractor during engineering, procurement and construction to assure conformity with the contract specifications. Quality Assurance/Quality Control procedures proposed by the BIDDER should address the QA/QC requirements under the following phases of the project:

(a) Engineering
(b) Procurement
(c) Construction including commissioning testing

Bidder shall prepare the quality assurance plans for equipment's to cover the overall quality assurance requirements. Bidder shall submit a quality assurance plan for all applicable equipment & systems.

1.2 Engineering

1.2.1 Prior to finalization of contract

Prior to finalization of the Contract, the Contractor shall prepare and submit a project Quality Assurance Plan that covers the engineering phase of the Works. The plan will be designed for this project and will address the specifics of how the CONTRACTOR will control, monitor and verify the requirements contained in this section. The Contractor will utilize all of his QA/QC resources, manuals and procedures when preparing the plan. Owner will review the plan prior to utilization and upon issue the plan will become the basis by which Owner will evaluate the Contractor's engineering QA/QC activities as they relate to this project.

1.2.2 Owner's Participation

The Owner reserves the right to audit and verify procedures set forth in the Engineering Quality Assurance Plan. This audit right in no way relieves the Contractor from performing the control verification procedures outlined in the plan.

1.3 Engineering Quality Assurance and Quality Control Requirements

Following are the minimum Quality Assurance and Quality Control requirements for the project. The Contractor's Engineering Quality Assurance Plan shall set forth in detail the procedures to satisfy these QA/QC requirements:

1.3.1 **Design control**

The Contractor will define, document and advise the appropriate handling of the following design controls:

(a) Establish internal as well as external discipline relationships.
(b) Qualifications of personnel assigned for each task.
(c) Establish audit procedures to ensure that the design conforms to the requirements.
(d) Define and outline the number of multi-discipline design reviews.
(e) Establish procedures for handling design changes.
(f) Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-contractors.

1.3.2 **Document control**

The Contractor must include in its QA/QC Plan the document control procedures defining:

(a) Authorized use of documents.
(b) Receipt, logging and distribution of documents.
(c) Procedure for updating and implementation of additions and revisions.
(d) Procedure for document transmittal to Owner / Engineer. Some of the requirements for document transmittal maybe covered in other parts of this specification.

1.3.3 **Audits**

All documents shall be audited by the Contractor for conformance with the QA/QC procedures.

The Owner reserves the right to review design details, either directly or through their Consultants.

1.3.4 **Engineering Sub-contractor**

The subcontracting of detailed engineering to third parties does not relieve the Contractor the responsibility for Engineering Quality Assurance.

1.4 **Procurement**

1.4.1 **Source quality control**

It is the Owner's intent that the Contractor deal only with Sub-contractors and Manufacturers (Vendors) who have established and demonstrated effective quality assurance and quality control programs. Owner does require, however, that the Contractor perform such normal inspection of Sub-contractors'/ Vendors' work as is necessary to obtain equipment and materials conforming to the project specifications

and their supporting documents (applicable codes and industry consensus standards) and good engineering, fabrication practices as described herein. Source Quality Control is also a valuable input for confirmation of delivery performance.

The minimum inspection requirements in respect of major mechanical items have been included in this section. Minimum inspection requirements in respect of electrical and instrumentation/control equipment and civil works are covered in their respective specifications. Prior to finalization of the contract, the Contractor shall prepare and submit a Project Quality Assurance Plan that covers Procurement and requirements for procured items for the complete Works.

1.4.2 **After Award of Subcontract**

Once Sub-contractors and manufacturers are established, Owner and the Contractor shall review item-by-item all major engineered equipment and systems and any special fabrication/fitting to reach an agreement on the need for prefabrication/pre-inspection meetings.

1.4.3 **Owner's Participation**

The Owner reserves the right to audit the performance of the Sub-contractors/Manufacturers and the Contractors inspection effort. This is normally accomplished by visiting the Sub-contractors/Manufacturers with the Contractors' Inspector at pre-selected points during manufacture. Contractor will identify notification points so that the Owner's representative(s) can be present at particularly important stages of fabrication should the Owner wish to attend. The notification points are not hold points unless specifically identified as such. Should Owner elect not to or fail to attend, the Work shall proceed without interruption. The Owner reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-contractor and/or the Contractor's inspection effort. Owner may wish to hold technical meeting with the machinery Sub-contractor during the design and fabrication of the machinery. Should Owner desire to hold technical meetings, the Contractor will be advised at a reasonable notice.

During audit visits to fabricator shops, Owner may elect to spot-check base materials and welds to verify proper metallurgy using whatever methods Owner may wish to utilise, but only in the presence of Contractor's Inspector unless otherwise agreed. Some of these requirements have been identified in the minimum inspection requirements listed in this section.

1.4.4 **Communication**

Direct, timely communication between the Contractor's Inspectors and Owner's auditing Inspectors is mandatory, especially in notification points and in the event of problems, Owner shall be advised in a timely manner of all situations where changes

or compromises in specifications are considered or where non-conformances are being encountered. Suggested format for inspection request is enclosed with this section. The Contractor shall give advance notice of thirty (30) days for all overseas travel and fifteen (15) days for travel inside India.

Rejection reports shall be faxed from the Contractor's Inspector to Owner's Representative at the same time as faxed to the Contractor's home office. Reports shall be faxed to Contractor's home office for typing, editing and transmitting to Owner.

1.5 QA/QC Requirements

1.5.1 Inspection plan

Inspection plans with detailed instructions for the Inspector's guidance shall be provided for each item. The Contractor shall develop the QA plans for all other equipment / systems on a similar basis as in Tables above. The Contractor's Procurement Inspection function will begin with the award of the purchase order and concludes when the Inspector (including inspection by client's inspector wherever applicable) has duly released the equipment in the Sub-contractor's shop.

1.5.2 Inspection office

1.5.3 The Contractor shall identify the key inspection office located at its engineering and construction office. All inspection assignments, inspection instructions, after placement of the purchase order shall be covered from this designated office.

One individual will be nominated for inspection and will be hereafter referred to as the "Quality Control Project Inspector (QCPI)'.

For technical problems arising during manufacturing, after purchase orders are placed, the QCPI is responsible for clearing such technical problems with Engineering and/or Owner. All purchase orders shall have a clause requiring the Sub-contractor to submit all questions of a technical nature concurrently to the QCPI and requisitioning engineer in writing via fax or letter for resolution. The QCPI will be responsible for obtaining replies from engineering, documenting the response to the Sub-contractor and making distribution. The assigned QCPI shall be on distribution for all other correspondence. When technical requests arise from rejection made by the Contractor's source Inspector, the source Inspector's rejection report must be attached to the Sub-contractor's request for engineering evaluation.

1.5.4 Inspection Co-ordination and Responsibility

The QCPI shall have the overall coordination responsibility for inspection activities. The QCPI's responsibilities shall include, but not be limited to the following:

(a) Issue assignments for source inspection.
(b) Issue specific inspection instructions when required to the assigned source inspector.
(c) Indicate the required type of report forms.
(d) Coordinate and respond to questions of a technical nature.
(e) Monitor inspection reports to determine if inspections are being performed as per written instructions.
(f) Forward all related order correspondence to the assigned source Inspector.
(g) Receive inspection reports from the source Inspector and make distribution as required.
(h) Ensure that comprehensive files are maintained for each job.

1.5.5 **Inspectors' qualifications**

The Contractor shall submit with their QA/QC Manual resumes of Contractor's inspectors detailing their experience, education and qualifications for Owners review / approval. The Inspectors shall have sufficient prior experience and qualifications for the equipment assigned.

1.5.6 **Inspector's responsibilities**

After receiving the assignment from the QCPI, the source Inspector shall review the order, conduct a pre-inspection meeting (when instructed), perform the inspections outlined, maintain field file in an organized manner and report the results to the key office and Owner. The following is a more detailed, but not inclusive, list of what Owner typically expects from the Contractor's source QCPI:

(a) Pre-fabrication meeting - The Contractor's Inspector shall conduct a pre-fabrication meeting with the Sub-contractor prior to start of fabrication. The discussion shall include, but not be limited to a review of the following items:

(i) Purchase order requirements with emphasis on any special requirements (technical and quality)
(ii) Code Requirements
(iii) Inspection Agency for ASME Code Requirements/IBR requirements
(iv) Sub-contractors Quality Control Programs
(v) Fabrication Schedule
(vi) Critical Component or Sub-contractor Fabrication
(vii) Major Sub-contractors
(viii) Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Records (WPR).
(ix) Special Welding Procedure Requirements
(x) Qualification of Non-Destructive Testing Personnel
(xi) Non-Destructive Examination Requirements
(xii) Heat Treatment Requirements

(xiii) Testing - Hydrostatic and Pneumatic
(xiv) Manufacturer's Data Reports
(xv) Preservation, Packing and Shipping
(xvi) Extent of Owner / Contractor Inspection
(xvii) Witness Points and Hold Points and Notice requirements.

(b) Initial inspection visit: The Inspector shall perform as a minimum, the following inspection activities prior to start of fabrication:

(i) Review fabrication schedule to ensure required Quality Control examinations and other intermediate tests have been included
(ii) Establish approval of major Sub-contractors
(iii) Verify that Welding Procedures and Procedure Qualifications have been approved
(iv) Verify that all welders assigned to job are qualified
(v) Review Mill Test Reports to verify materials meet specifications
(vi) Review Sub-contractor's Examination and Inspection Plan
(vii) Review Sub-contractor's procedure for identifying and transferring material markings
(viii) Make a visual examination of major materials, verify Sub-contractor's examination of all materials, and verify proper storage facilities (environment and security).

(c) Progressive inspection visits: The following minimum activities, where applicable, shall be executed and reported upon by the Inspector:
(i) Monitor on a random basis the transfer of material marking throughout the fabrication
(ii) Initial and random inspection of edge preparation, root gap and fit up for all vessel and fabricated machinery components
(iii) Initial and random witnessing of production welding to verify approved procedures, qualified welders and proper techniques are being used
(iv) Ensure that preheat requirements are followed
(v) Ensure that welding materials are being properly controlled
(vi) Inspect major weld seams, nozzle and attachment welds, overlay welding and any weld repairs
(vii) Perform random check of back gouging of pressure retaining welds
(viii) Inspect critical/major materials from sub-Sub-contractors
(ix) Check nozzles / man ways for size, rating and extension
(x) Check dimensions and workmanship of internal tubing, coils and components
(xi) Examine gaskets and bolting against specifications

(xii) Check location and attachment welds for support clips, lugs, brackets and saddles
(xiii) Make final visual inspection for quality of work and for damage
(xiv) Make complete dimensional inspection
(xv) Verify post weld heat treatment meets specifications
(xvi) Witness all hydrostatic and pneumatic testing
(xvii) Witness routine and special testing as may be outlined in project specifications or data sheets for Electrical and Instrumentation
(xviii) Assure electrical and instrument function and operational checks have been performed as per project specifications.

(d) Non-destructive Examination (NDE) - The Inspector shall perform as a minimum the following NDE activities during progressive inspections:

(i) Radiographic examination (RE)
- Review Sub-contractor's radiography procedures for approval
- Review all radiographs progressively throughout fabrication
- Evaluate for acceptable film quality and weld quality.

(ii) Ultrasonic examination (UE)
- Review Sub-contractor's procedures and Inspector qualifications
- Witness at least 25% Ultrasonic examinations..
- Review certified results.

(iii) Magnetic particle examination (MPE)
- Review Sub-contractor's procedures and Inspector qualifications.
- Witness the initial MPE examinations and 10% minimum of all MPE examinations, as well as all examinations after repair.

(iv) Liquid penetrant examination (LPE)
- Same as for MPE.

(v) Hardness testing - production welds.
- Review procedure and witness initial tests.
- Verify 10% of hardness values during progressive inspections.
- Review all hardness readings for acceptance per specifications and require certified results.

(e) **Shipping**

(i) Verify that all shipping requirements related to cleaning, dry out, surface preparation
(ii) Verify that pressure equipment is appropriately code stamped and all "Manufacturer's Certified Data Reports" are complete and properly signed
(iii) Verify required documentation for acceptance and record is complete.

1.5.7 **Inspection reports**

Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found/ corrected at that time. Final check lists should indicate all items inspected during interim inspections.

Inspection rejection reports shall be by telefax to the key office and Owner when the Sub-contractor's proposed resolution deviates from order specifications, or would require repairing.

Final inspection reports shall be by check off for all major equipment and bulk piping components. The check off indicates the inspections were performed and would be covered on an interim inspection report.

Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order have been met. The Sub-contractor shall be given the inspection release certificate as authorization to present final billing to the Contractor and a copy of same shall be attached to the packing list to serve as notification to the job site of inspection approval.

1.6 **Construction**

1.6.1 **Owner's Participation**

Owner will have a Quality Assurance/Quality Control organization to audit the Contractor's QC effort. The assigned Owner's personnel will provide assurance to Owner's management that the Work meets specifications, however, the basic inspection and quality control responsibility is vested with Contractor.

Owner's auditing may include spot checks of materials in the field to assure that inadvertent substitutions have not been made in the fabrication shops or in field ordered materials.

1.6.2 **Communication**

Direct, informal communication between the Contractor's field Inspectors and Owner's auditing Inspectors is mandatory. Further Owner shall be advised when major problems related to design or fabrication is uncovered.

Contractor's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Owner's auditing Inspectors during the course of the Work.

At the end of the Work, Contractor's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be turned over to Owner in an organized, agreed upon format. Contractor shall verify

that all of the required documentation of the equipment has been received and placed in the equipment files. The Contractor is responsible for obtaining any outstanding documentation from the suppliers.

1.6.3 **Construction QA/QC requirements**

It is the Owner's intent that the Contractor (and any Sub-contractors employed) provide sufficient qualified Inspectors to assure that facilities are installed in accordance with the plans and Owner's specifications and intents and that the level of quality called for therein is obtained. Prior to finalization of Contract award, the Contractor shall submit a detailed Field Quality Assurance Program for Owner's review. The program must be tailored to show compatibility with engineering design, compliance with applicable codes, specifications, standards, drawings, support documents, governmental regulations and this document.

For the construction period, the Contractor shall provide a full time, dedicated Quality Assurance Organization. As a minimum the Contractor's Construction Quality Assurance Program shall include the following:

(a) **Quality control program**

Details of the program to be implemented, its use, control and identification of hold and inspection points shall be submitted to Owner/ Owner's Representative for approval.

(b) **Organization, authority and responsibility**

Delineate the Contractor's Quality Control organization, responsibility and authority for performance of QC functions by discipline.

(c) **Inspector qualifications**

The Contractor's Construction Assurance organization will consist of people with qualifications similar to the requirements outlined in the Procurement clause mentioned elsewhere. The field QA organization will be a full-time organization, with no other construction related duties. As with engineering and procurement, Owner will review Construction QA staffing plans.

(d) **Document control**

This system shall ensure that the latest issues of drawings, specifications, standards, and supporting documents are being used for fabrication and installation and that field changes are incorporated into final "As Built" drawings.

(e) **Receiving control**

Procedure for receipt of purchased items delivered at the job site initial identification, qualification and review of supporting documents shall be described. In addition the procedure shall ensure that spare parts supplied by Contractor are properly labeled by the Sub-contractor with description and purchase order number.

(f) **Receiving inspection**

This shall establish the method of notification and inspection to be performed on received items to verify the condition and conformance to the appropriate acceptance standards reference or contained in the purchased documents.

(g) **Sub-contractor non-conformance**

This shall provide for documentation and disposition of non-conformances resulting from Sub-contractor errors and shipping damage to material, fabrications and equipment received at the job site. It also provides for interface with the design engineer when the non-conformance does not comply with the engineering design.

(h) **Storage and Maintenance of Materials and Equipment**

This system shall describe the controls and inspection performed to show that the handling, storage and preservation of materials and equipment are performed to prevent damage or harmful deterioration to the materials and equipment received at the job site.

1.6.4 **Inspection, examination and testing of on-site fabrication and installation**

This section shall establish the responsibility for performance and recording of examinations, tests and inspections as required by the engineering design.

Inspection of work in progress to determine conformance with drawings, specification and any field definition agreed to shall be included. Some of the inspections are listed below:

(a) Soil testing
(b) Pile driving record data (if applicable)
(c) Structural concrete
(d) Performing random dimensional check and visual material verification of field fabricated pressure equipment and of any piping, vessel, electrical and instrument installation.
(e) Internal checking of all vessels for:
    i) Cleanliness

ii) Proper internals. This involves opening the vessel man ways and removal of internals.

(f) Witness testing and installation of items such as:

(i) Welder testing and qualifications and maintenance of records thereof

(ii) Weld examination and maintenance of records thereof in accordance with applicable codes and specifications

(iii) Monitor selected field post weld heat treating

(iv) Hydro tests, hydro-pneumatic tests, pneumatic tests, lead and service tests

(v) Electrical inspection and testing which includes witnessing of Hipot testing, merger testing, AC power factor testing etc.

(vi) Instrument model/name plate data verification

vii) Instrument installation checkout

(viii) Instrument loop checks

(ix) Mechanical and electrical equipment bearing flushing and filling

(x) Mechanical equipment cold alignment checks and rotation verification

(xi) Witness verification that piping loads on machinery equipment meet specifications

(xii) Pump installation check out

(xiii) Coating and lining tests

(xiv) Surface preparation, paint application and thickness verification.

(g) Final checking of installed facilities, completing check out forms, and signing on behalf of the CONTRACTOR documents attesting completion of the Work, as called for in the Contract documents.

(h) Monitoring or inspecting the work of Sub-contractors This requires pre-award and pre-field start meetings for major subcontracts with Contractor's / Sub-contractor/ Owner participation to establish quality (QA/QC) requirements and how they will be met. Typical areas/ disciplines may include, but not be limited to the following:

1) Foundations

2) Mechanical

3) Piping

4) Civil

5) Electrical

6) Instrumentation

7) Painting

8) Buildings

(i) Execute Contractor's standard quality tracking program

(j) Perform final check of installed facilities with Owner's representatives to verify completeness and accuracy in accordance with P and ID's / Engineering Flow Diagrams and other scope documents as may be required

(k) "Source" inspect/monitor any field award shop fabrication orders.

(l) See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

1.6.5 **Non-conformances of on-site fabrication and installation**

This section shall control on-site fabrication and installation items which do not conform to the engineering design or for which the engineering design is incorrect.

1.6.6 **Calibration of test equipment**

Calibration of tools, gauges, instruments and other measuring and testing devices shall be included.

1.6.7 **QA personnel qualification and certification**

The qualification required of QA/QC personnel shall be outlined.

1.6.8 **Quality assurance/Quality control records**

The system which shall ensure, that all quality assurance records are maintained for ready reference and shall also provide for the accumulation, evaluation, retention and distribution of QA/QC records.

1.6.9 **Interface with statutory authorities**

Participation of statutory authorities which require testing, witnessing and inspection shall be provided.

1.6.10 **Mechanical completion acceptance**

CONTRACTOR shall perform final inspection of the Work in accordance with the Contract documents.

INSPECTION REQUEST FORM

From :

To :

Attn: Mr

Dear Sirs,

Items detailed below are ready for inspection. Please arrange inspection and confirm the date of inspection:

1. OWNER :
2. Project :
3. OWNER's order reference :
4. Consultant's reference :
5. Sub-order reference :
6. Sub-contractor's name and Full address :
7. Place of Inspection (Full address) :
8. Contact person, telephone no. and fax no. :
9. Description of item and Quantity :
10. Nature of inspection required :
11. Proposed date(s) :
12. Weekly holiday :

We confirm that the items have been fully inspected/tested by us at all stages, of inspection as per quality plan, and all material test certificates, QC records., test Reports, calibration records of measuring/testing instruments with tractability to national level are available with us.

Thanking you and awaiting your confirmation,

Yours faithfully,

cc : Sub-contractor

NOTE: 1. Following clear notice periods (date of receipt to date of inspection) are required:

(a) Local Inspection (within India) - 15 days
(b) Overseas Inspection (Outside India) - 30 days

2. Weekly Holidays for OWNER / ENGINEER : 2nd Saturday & Sunday.

3. General Holidays : As per Karnataka State Govt.

1.0 GENERAL

The Contractor shall offer a Plant so as to meet the pollution control requirements of statutory authorities. Emissions and discharges of solid, liquid and gaseous effluents from the Thermal Power Plant shall fully comply with all requirements and limits specified in Environmental (Protection) Act, 1986, Minimum National Standards (MINAS), along with all latest amendments to all of the above requirements, stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF) and State Pollution Control Board (SPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement.

The Contractor shall be responsible for obtaining all necessary approvals, licenses and permissions which are related to design, construction, installation and operation of the Plant. These shall be obtained at appropriate time to ensure that the construction and commissioning program can be realised.

2.0 GASEOUS AND PARTICULATE EMISSIONS

For the complete range of fuels specified, including fuel oil, the gaseous and particulate emission from the stack shall comply with the requirements stipulated by statutory authorities.

The Contractor shall provide continuous monitoring equipment to measure particulate matter (e.g. cross-stack optical density or equivalent), carbon monoxide, Sulphur dioxide, nitrogen oxides, temperature and oxygen content of the stack gases. The monitoring instruments must be carefully located to ensure that representative sampling is obtained and sampling should be to a recognized standard.

The monitoring systems should incorporate the means to record various time averaged values as required by the performance requirements. Monitoring data should be displayed in the control room, with provision of alarms to notify the operator of any deviation from the specified values. The Contractor shall furnish a list of monitoring equipment he intends to provide with their location in the Plant.

3.0 DUST CONTROL

Dust emission to the air from the site, roadway, etc. shall be controlled by providing suitable dust control systems.

4.0 NOISE CONTROL

4.1 An integrated approach shall be taken by the Contractor to control noise emission which shall include but not be limited to :

(a) Design and layout of building to minimize transmission of noise, segregation of particular items of Plant and to avoid reverberant areas.

(b) Specification of permissible noise levels for bought-out items.

(c) Choice of materials for civil construction
(d) Acoustic design of building
(e) Use of lagging with attenuation properties on Plant components / installation of sound attenuation panels around the equipment.

4.2 Where the requirements stated above are not met within the basic design of the Plant they shall be achieved by the supply under the Contract of suitable means of noise control, which shall conform to the following requirements :

(a) The noise control system shall, as far as possible, be designed to form an integral part of the Plant.
(b) The abatement system shall, wherever practicable, be applied to the source of excessive noise rather than to the entire item or component.
(c) If above means are not adequate and enclosures are used for noise abatement, close fitting enclosures shall be provided.

4.3 Noise in Control Areas

(a) Control Rooms

The noise levels in control rooms must be such that intelligible speech communication is always possible and mental concentration is not hindered.

(b) Other Control Areas

The noise levels in other control areas must be such that intelligible conversation (telephone and person-to-person) is possible and operator fatigue is minimised.

(c) Station Noise Criterion

The criterion for environmental noise is that the design of the station and its components shall not exceed, in any continuous mode of operation, the level stipulated by MOEF and/or Pollution Control Board at any point on the site boundary. Presently the norm is such that the noise level shall not exceed 85 dB at 1.5 m from equipment surface and 70 dB at Plant boundary.

5.0 DISCHARGE OF LIQUID EFFLUENTS

a) State Level Environment Impact Assessment Authority (SLEIAA) – Karnataka, has accorded environmental clearance as per the provisions of Environmental Impact Assessment notification-2006 and its subsequent amendments, subject to strict compliance of the terms and conditions. Clause no. PART A-Specific Conditions para 3 states that: ***"The treated effluents conforming to the prescribed standards only shall be recirculated and reused within the plant".***

b) Karnataka State Pollution Control Board accords consent for establishment of New Gas based Power generating Plant, subject to the condition, clause no. II Water Pollution Control, para 3 states that, "***There shall be no bypass or discharge of effluents either within or outside the factory premises under any circumstances***".

6.0 Online monitoring system

The vendor/instrument supplier shall make provisions to provide/upload data continuously to CPCB/KSPCB/KPCL directly from the analysers as per their requirements.

The vendor shall ensure that the instrument manufacturer of monitoring systems shall be in position to provide maintenance contract to owner after installation and the technology provider/ instrument manufacturer shall ensure availability of spare parts for at least 07 years after installation of the system.

PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES FOR PERFORMANCE:

1.1 General Requirements

a) The contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

b) The guaranteed performance parameters furnished in the offer, shall be inclusive of all tolerance values including measurement uncertainties. No other tolerances shall be applicable for.

c) The contractor shall demonstrate all the guarantees covered herein during performance guarantee /acceptance test as well as integrated operation of all equipment. The various tests which are to be carried out during performance guarantee/ acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of OWNER.

d) All costs associated with the tests shall be included in the price.

e) In case during tests it is found that the equipment / system has failed to meet the guarantees, the contractor shall carry out all necessary modifications and/or replacements to make the equipment/ system comply with the guaranteed requirements at no extra cost to the Employer within reasonable period agreed with the Purchaser. However, if the contractor is not able to demonstrate the guarantees, even after the above modifications/ replacements within a reasonable period allowed by the Purchaser after the tests have been completed, the Purchaser will have the right to either of the following:

Reject the equipment/system/Plant and recover the payments already made

OR

Accept the equipment/system/Plant after levying liquidated Damages as specified hereunder. The liquidated damages, for shortfall in performance indicated in Clause 1.2 for this sub-section. The liquidated damages shall be pro-rata for the fractional parts of the deficiencies.

1.2 GUARANTEES

The contractor shall guarantee the following:

1.2.1 Performance guarantees of Zero Liquid Discharge System as per schedule of guaranteed parameters – F3

1.2.2 Guaranteed Power Consumption as per schedule of guaranteed power consumption-F4.

1.2.3 Noise level shall be less than 85 db A, measured all around the pump and motor set at distance of 1m from the nearest surface of the pump and at a height of 1m from the floor level.

2. Performance Liquidated Damages

2.1.1 In the event that the equipments fail to meet the performance guarantees, Contractor will pay to owner Performance Liquidated Damages as indicated in the schedule of guaranteed parameters – F3.

2.1.2 For increase in Guaranteed power consumption of the plant: Penalty will be levied at **Rs**. **7,93,439/-** per kW differential over and above the total guaranteed power consumed.

Note:

i. The guaranteed power consumption shall be calculated using the criteria specified in Schedule F4.

ii. Contractor's aggregate liability to pay liquidated damages for failure to attain the functional guarantee shall not exceed 10% of the Contract Price as per Clause No 19.2.2 of Section A-4, Vol -I Part-I- GCC.

1.0 SCOPE

This section covers the general requirements regarding the spares and maintenance tools and tackles for all the equipment and systems in the power System.

2.0 SPARES

2.1 The Contractor shall include in his scope:

(a) Start-up & commissioning spares as necessary and

(b) Essential spares / Mandatory spares as per specification

2.2 The spares shall be delivered at the site well in time before the start up and commissioning of the System.

2.3 Startup Spares

Startup spares (also termed as 'commissioning spares') are those spares which will be required during the startup and commissioning of the equipment / systems and until performance testing. It is the responsibility of the Contractor to supply all necessary spares as required until the equipment / systems are handed over to the Owner. The prices of the startup spares should be included in the price of the respective equipment / systems. An adequate stock of startup spares shall be made available at the site such that the startup and commissioning of the equipment / systems, performance testing and handing over the equipment / systems to the Owner can be carried out without hindrance and delay.

2.4 Mandatory Spares/Essential Spares

2.4.1 Mandatory spares/Essential spares are those spares considered as critical spares by the Owner for the normal plant operation. When a particular item of spares is indicated as 'percentage', it shall be considered as percentage of total number of that item for scope of work, unless specified otherwise. The fraction shall be rounded off to the next higher whole number. Whenever the item of spares has been indicated as 'set' for the Unit or the station, the same shall include total supply of that item, as specified and where it is not specified, 'set' shall mean the supply for single equipment / system. One set of spares for particular equipment shall mean the total quantities of that particular spares for the single equipment e.g., 'set' of bearings for a pump shall include the total number of bearings in a pump. The 'set' shall however, include all components required to replace the item of spares.

2.4.2 The contractor shall also provide a list of Mandatory spares/Essential spares along with the bid indicating the list and price breakup.

3.0 Tools and Tackles:

List of tools and tackles to be included in the supplies which are found to be necessary during the engineering and erection stage of the contract, the same shall be supplied by the Contractor.

4.0 Recommended Spares

Bidder shall furnish the list of recommended spares as per the schedule F-8

5.0 GENERAL

5.1 In the event of any equipment being changed during engineering, the Contractor shall supply start up spares, pertaining to this equipment.

5.2 The Contractor shall also note that the Owner, if required, shall approach directly the individual equipment manufacturers / suppliers for procuring recommended spare parts. The Owner shall not necessarily procure these spare parts through the Contractor.

1.0 SITE SERVICES

These services shall be rendered by the Contractor as part of the overall project management service. The services shall broadly include but not be limited to the following:

- Distribution of construction water and construction power supply.
- Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody, etc. as required
- Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner
- Providing 'Industrial Relations' unit and 'Medical 'unit to take care of his erection staff. The Owner shall have no obligation in this regard.
- Securing necessary permits / clearances from authorities for construction.

2.0 SITE ORGANISATION

The Contractor shall maintain a site organization of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organization shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organization shall be headed by a competent construction manager having minimum 20 years' experience in supervision of construction of power Systems and adequate authority to take decisions at site.

3.0 SITE FACILITIES

3.1 The Contractor's Site Office Accommodation

Before the erection of any temporary site accommodation, the Contractor must obtain approval from the Owner of the size, type, condition, location, access and services proposed. The Owner's approval shall be obtained before any accommodation is dismantled or removed from the site. The site office accommodations shall be reasonably maintained and suitably identified with the Contractor's name and that of his site Engineer.

3.2 Telecommunication Facilities

The Contractor shall provide his own on-site / off-site telephone facilities.

The Contractor shall obtain permission from the appropriate authorities before any radio wave emanating system is used at the site. This includes radio telephones and pagers, transceivers, cordless and cellular telephones and such any other systems. The Contractor shall ensure that the radio communication systems do not cause interference to control and instrumentation and communication systems installed in the power Plant.

3.3 Employee Food Service

A food facility shall be provided on the site by the Contractor for the reasonable use of both his and his sub-Contractor's employees, the Owner and his staff and employees of other Contractors. Either a central site canteen or dispersed messing facilities of suitable standard may be provided. There shall be an appropriate canteen for professional managerial staff.

3.4 Site Records Office

The Contractor shall maintain a suitable records office to maintain updated records of all relevant documentation and test certificates and to ensure that these are available to meet obligations to all statutory bodies and to any commissioning committee, working parties or test teams which are established to meet the needs of the contract. These records shall be maintained and retained until hand over on completion of all works at site and shall be subject to Audit by the Owner.

The relevant documents envisaged will include:

(a) Site Register for lifting appliances, cranes, slings, hooks, lifting beams and tackle for construction of the works either mobile or fixed

(b) Scaffold Register

(c) Commissioning documents

(d) Test Certificates from works and site

(e) Operation and Maintenance Manuals

(f) Quality Assurance Documents

(g) Site Register for all portable electrically powered apparatus and tools, both temporary and permanent

(h) Site Registers of all modifications carried out during execution by deviating from the approved drawing giving modification number against each. Such modifications shall have to be authorized / approved by the Owner

(i) Measurement, inspection & alignment protocols

(j) Mechanical completion protocol

(k) Performance test protocols

(l) Handing over / taking over protocols

(m) Final Acceptance Protocol

(n) Contract drawings and specifications

(o) Applicable codes and standards

3.5 Construction Camp of the Contractor

The Contractor shall provide himself and his Contractors adequate lodging facilities for his entire work force. This facility shall have adequate sanitation and recreation facilities for clean safe and healthy accommodation of his workforce.

3.6 Site Security

(a) The Contractor shall provide security facilities for the site and temporary storage areas.

(b) Manned road access gates during construction by uniformed security personnel.

(c) Security fencing: The location shall be agreed with the Owner. The type shall be proposed by the Contractor and approved by Owner.

(d) A manned security building / stores / compound for receipt / temporary storage of equipment prior to erection.

The Contractor shall have responsibility for the security of the site. Security for all or part of the site will be taken over by the Owner at a time to be agreed with the Contractor on completion of the works.

3.7 The Contractor's Storage Areas

The Contractor shall be responsible for provision of suitable temporary storage facilities.

3.8 Sign Boards

The erection of sign boards or posters will not be allowed without the Owner's approval of the size, type, location, wording, etc.

3.9 Use of Motor Vehicles, Parking and Cycle Sheds

Parking facilities and cycle sheds shall be provided by the Contractor in a compound within the site boundary but outside the security fence of the construction area and as near to the site access as possible. Only authorized vehicles shall enter the construction area and these must display the vehicle pass issued by the Contractor.

Designated parking spaces shall be allocated near the main site office for the Contractor's and Owner's senior staff.

4.0 SITE RESTRICTIONS

The Contractor and his employees shall not trespass beyond the boundary limits of the site on to any adjoining land and the Contractor shall take necessary action to prevent trespassing.

5.0 SITE ACCESS

The Contractor shall be responsible for any road improvement required for construction traffic access and for the provision of traffic control where the site access road joins the public road. Public traffic shall not be impeded during the construction period and access must be maintained for emergency vehicles.

6.0 GENERAL GUIDELINES FOR FIELD ACTIVITIES

6.1 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards and cleanliness.

6.2 The Contractor shall co-operate with the Owner and any other Contractors / Agencies working at site and arrange to perform his work in a manner so as to minimize interference with other Contractors' / Agencies works. The Owner shall be notified promptly of any defect in other Contractor's / Agencies works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the

Owner in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

6.3 The Owner may hold meetings of all the Contractors / Agencies at site at a time and a place to be designated by the Owner. The Contractor shall attend such meetings if called upon to do so, take note of the decisions of the Owner and shall strictly adhere to those decisions in performing his work.

6.4 The Contractor shall be responsible for performance of his work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good such delays or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to Engineer satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

6.5 The works under execution shall be open to inspection and supervision by the Owner at all times. The Contractor shall give reasonable notice to the Owner before covering up any work or otherwise placing it beyond reach of inspection.

6.6 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation, etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to Contractor's account.

6.7 All the works such as cleaning, levelling, aligning, assembling, temporary erection, opening, dismantling, surface and edge preparation, fabrication, machining, chipping, scraping, fitting up, bolting / welding, etc. as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.

6.8 Equipment and material which are wrongly installed shall be removed and reinstalled to Comply with the design requirement at the Contractor's expense to the satisfaction of the Owner.

6.9 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be of prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of the Owner.

7.0 SITE HEALTH AND SAFETY MANAGEMENT

7.1 The Contractor shall be responsible for :

- The management organization for implementation of health and safety on site
- The identification of site hazards and assessment of risks
- The system of notifying all employees of the site safety plan, method statements and site safety rules
- A schedule of safety meetings. The arrangements for site induction course, training and security. The arrangements for emergency plans, safety inspections and auditing

7.2 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.

7.3 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled or prohibit the use of the same for safety reasons. Contractor shall abide by Owner's decision in such cases. No claim for compensation due to such prohibition will be entertained by the Owner.

7.4 Storage of petroleum products & explosives for construction work shall be as per rules and regulations laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.

7.5 The Contractor shall be responsible for safe storage of his and his sub-Contractor's radioactive sources.

7.6 All requisite tests and inspection of handling equipment, lifting tools & tackle shall be periodically done by the Contractor. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.

7.7 All combustible waste and rubbish shall be collected and removed from the work site at least once each day. Use of undercoated canvas, paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.

7.8 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony, etc.

Personnel trained for firefighting shall be made available by the Contractor at site during the entire period of the contract.

7.9 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.

7.10 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.

7.11 **First Aid**

A central fully equipped first aid post shall be provided at site by the Contractor. The facilities shall comprise first aid personnel including a registered / qualified male nurse, the provision and manning of an ambulance, and the retention of the services of medical practitioners for advice and attendance where necessary, along with an emergency evacuation Plant. These arrangements shall not relieve the Contractor of any legal/ statutory obligations. This facility will be available to the Owner until such time as the permanent facilities are available for the operating Plant.

8.0 STORAGE AND PRESERVATION

8.1 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.

8.2 All empty containers, packing materials, gunny bags, transport frames as also surplus and unused materials shall be the property of the Owner and returned to the Owner by the Contractor.

9.0 CLEANLINESS AND WASTE DISPOSAL

9.1 Throughout the period of construction of the works the Contractor shall maintain the whole area of his operations in a clean, tidy and safe condition and shall arrange his materials in an orderly manner, all to the satisfaction of the Owner.

9.2 All rubbish, etc. shall be systematically cleared from the working areas and if not removed directly from the site, shall be deposited at general collecting points provided by the Contractor and agreed with the Owner, pending removal from the site. Where practicable, screening shall be provided to prevent the ingress of dust and dirt to any part of the works. The Contractor shall clearly state, in the

appropriate schedule, what provision is being made for disposal of waste materials both on and off-site.

9.3 The Contractor shall not cause pollution of the site land drainage system or any water course by waste products from any source whatsoever. Whenever any pollution is attributable to any act or omission on the part of the Contractor, the Contractor shall clear the pollution as soon as possible and make early arrangements to remedy the cause.

9.4 The Contractor shall make himself familiar with all statutory requirements relating to the discharge of effluent from the System and shall take all steps to ensure that these are not contravened by the disposal of effluent from site. No dangerous or noxious waste products, chemicals or materials shall be disposed of, on or off the site without proper treatment to make the quality comply with environmental regulation.

9.5 The Contractor shall take all necessary measures to ensure the safe collection and disposal of waste oils pertaining to those works or System for which he has responsibility and to ensure the prohibition of :

(a) Any discharge of waste oils into surface waters, ground waters or drainage systems of any kind

(b) Any deposit and/ or discharge of waste oils on to the ground or floors of buildings and any uncontrolled discharge of residues resulting from the processing of waste oils or the cleaning of oil contaminated surfaces with solvents. In order to ensure compliance with this requirement the Contractor shall provide suitable vessels for the collection of all waste oils. Where large quantities of waste oils need to be stored prior to being disposed off in bulk, suitable storage tanks shall be provided by the Contractor for this purpose.

10.0 DAMAGE TO PUBLIC OR EXISTING SITE ROADS

The Contractor shall make good damage to roads, drains, foot ways, paved areas, boundary walls and fences etc. and clean all fouled roads an paving etc. whether public or existing at site, caused by or in any way attributable to the handling / transport of System or materials by the Contractor or his sub-Contractors and indemnify the Owner against loss, damage or claims by the Local Authority or others for damage to or fouling of roads, pavings, etc., by reason of unusual traffic or other causes.

11.0 CLEANLINESS OF PUBLIC OR EXISTING SITE ROADS

The Contractor shall at all times ensure that the public roads, giving access to site, are kept clean of any materials deposited by traffic from the Contractor or his sub-Contractors. The Contractor shall also ensure dust suppression of site roads.

12.0 SANITATION AND DRAINAGE

12.1 The provision and maintenance of all temporary and permanent foul drainage and sewage disposal at site shall, during the construction period, be the responsibility of the Contractor, who shall ensure that all national and local statutory requirements for the effluent discharge are complied with.

12.2 The permanent and the temporary surface and foul water drainage systems shall all be separate. The Contractor shall make his own arrangements for foul drainage from the site during the construction period. A sewage treatment Plant of the requisite capacity to meet the permanent requirements for the site shall be installed under this contract. This must be capable of producing an effluent to meet the required national and local discharge standards at all times.

13.0 CLEAN CONDITIONS

Where relevant, the Contractor shall include his supply of temporary works, maintenance and operation of clean conditions changing facilities including changing areas, ablutions and amenities.

1.0 MECHANICAL COMPLETION

1.1 Mechanical Completion is defined as the state of readiness of Works under the scope of Contract to undergo the pre-commissioning checks, followed immediately thereafter by commissioning including Preliminary Operation, Initial Operation, Performance Tests for functional or operational occupation of the Works.

1.2 Mechanical Completion shall be deemed to occur when the erection/ installation/construction Works are completed as per Specifications for all equipment / system including standby. It also includes but not limited to, the following.

a) All installation/erection checks duly carried out,
b) All defects/deficiencies notified by ENGINEER/OWNER during installation/erection rectified to the satisfaction of ENGINEER/OWNER save those which, in the opinion of ENGINEER/OWNER, will not affect the safe operability and maintainability of the Works,

and

c) The Contract Works, in the opinion of ENGINEER/OWNER, subject to sub-clause (b) above, being fit, sound, safe and operable for undertaking the pre-commissioning checks, Preliminary Operation, Initial Operation and Performance Tests without interruption for reason of defect/deficiency or unfulfilled obligations of the CONTRACTOR in the erection/installation work.

2.0 SPECIFIC REQUIREMENTS OF MECHANICAL COMPLETION

Mechanical completion in different disciplines shall be determined based on the following characteristics, signifying the readiness of the Works/ Plant and Systems for undertaking the pre-commissioning/commissioning checks and subsequent Preliminary Operation, Initial Operation and Performance Tests as applicable to the Contract Works:

a) All Plant construction/installation in various disciplines, as detailed under (c) below and as applicable to the Contract are completed including aesthetic and workmanship aspects, with all installation/construction checks as per specification, relevant codes, standards and practices ensuring conformity to Contract and meeting any applicable statutory requirements.
b) All contractual obligations up to the stage of completion of construction/ installation are fulfilled to the satisfaction of the OWNER/ENGINEER.
c) All Contract Works are otherwise ready to be taken into service, or for functional or operational occupation save pre-commissioning/commissioning

checks, Preliminary Operation, Initial Operation, Performance Tests including but not limited to the following if applicable:

(i) Areas inclusive of all roads, accesses, structures, housings, platforms, walkways, stairs, ladders, safety/protective guards, covers, hand rails and such items of work are constructed as per Specification and approved for use.

(ii) Drains, sewers, waste disposal channels, vents, chutes, ducts and such works are constructed and connected to treatment and other disposal systems.

(iii) Equipment and piping in different systems/disciplines with all appurtenances, auxiliaries and accessories along with supporting structures, hangers, mounts, etc., are erected/installed, supported, anchored, aligned, grouted and adjusted for operating conditions.

(iv) Electrical power supply, control, communication and lighting equipment along with control panels, control desks, switchgear, local starters and such accessories along with protective systems, interlocks and integral and auxiliary systems are permanently installed, aligned and adjusted, with megger, continuity and specified installation checks duly carried out.

(v) Cables are laid, routed, supported, dressed, clamped, tagged, ferruled and terminated with clamp terminals designated and all continuity and megger checks duly carried out

(vi) Safety/relief valves are calibrated and set to operating conditions and tried out. All safety systems are installed, calibrated, checked and accepted

(vii) Specified pressure/vacuum/leak/NDT checks for acceptance and any heat treatment are carried out on Plant equipment and piping

(viii) Cleaning including chemical cleaning, flushing, draining and drying are completed

(ix) Plant identification numbers, colour codes, tags, name plates are duly mounted/painted/affixed

(x) All painting, lining and insulation works are completed with specified checks to the satisfaction of the OWNER.

3.0 OTHER PRE REQUISITES FOR MECHANICAL COMPLETION

CONTRACTOR shall also meet the following prerequisites for Mechanical Completion:

a) Submit a compilation of all reports of shop tests, material tests and various stage inspection establishing total compliance to Contract Specification in manufacturing items of supply of Contract.

b) Submission of a certificate by CONTRACTOR in a format agreed with the OWNER that the Contract Works have been designed, selected, manufactured, furnished and installed under the full responsibility of CONTRACTOR.

c) All erected Plant, structures, equipment and systems are maintained and preserved in sound condition and are fit and sound to undertake pre-commissioning checks and 'Tests before Commercial Operation' for operational and functional occupation immediately thereafter.

d) All areas and constructed works are cleared of all construction materials, temporary works, debris, rubbish water and all such impediments to render the Contract Works safe, sound and operable.

e) All safety features and safety equipments are functional.

f) Any specific statutory approvals pre-requisite to commissioning of the Plant are duly obtained.

4.0 PRELIMINARY OPERATION

Preliminary Operation shall mean all activities undertaken as part of Commissioning after Mechanical Completion up to commencement of Initial Operation and shall include mechanical and electrical checkouts, calibration of instruments and protection devices, commissioning of sub/supporting systems and static chemical cleaning covered under the Contract.

5.0 INITIAL OPERATION

Trial Operation shall include al operations undertaken as part of Pre Commissioning/commissioning after completion of Preliminary Operation upto commencement of Reliability Operation. It shall be the first integral operation of the complete Plant covered under Contract and shall include first light up / initial equipment rolling, equipment stretch-out, dry-out and operational chemical cleaning, no-load / partial load/ full loads runs for mechanical / electrical tryout and gathering of operational data; calibration, setting and commissioning of controls systems; and shutdown inspection and adjustment after running trials of the Plant under the Contract.

6.0 PERFORMANCE GUARANTEE TESTING AND ACCEPTANCE PROCEDURES

6.1 Performance Guarantee Testing

The Performance /Acceptance test shall be carried out as per the agreed procedure.

6.1.1 The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection.

6.1.2 The Contractor shall make the Plant ready for the performance guarantee tests.

6.1.3 The tests shall be binding on both the parties of the 'Contract' to determine compliance of the 'Plant' / 'Equipment' with the performance guarantees. No separate performance tests need be done on equipment which is already tested at shop.

6.1.4 All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test institute. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All costs associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the bid price. All calibration procedures and standards shall be subjected to the approval of the purchaser. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

6.1.5 Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc., and any special equipment, required for the successful completion of the tests, shall be provided by the contractor.

6.1.6 The contractor shall submit for purchaser approval, the detailed Performance Test procedure containing the following:

a) Object of the test.
b) Various guaranteed parameters & tests as per contract
c) Method of conductance of test and test code.
d) Duration of test, frequency of readings & number of test runs
e) Method of calculation
f) Correction curves.

g) Instrument list consisting of range, accuracy, least count, and location of instruments.
h) Scheme showing measurement points
i) Sample calculation
j) Acceptance criteria
k) Any other information required for conducting the test

6.1.7 After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to purchaser promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Employer after completing each test run.

6.2 Notice of Tests

The CONTRACTOR shall issue 21 days' notice to the OWNER of the date after which he will be ready to commence the tests and the Contractor shall commence the tests promptly thereafter.

6.3 Retesting

If the Plant fails to pass the test (which in the case of performance tests means not achieving the acceptable limits), the OWNER may require such tests to be repeated On the same terms and conditions save that only reasonable notice of the date and time of such tests shall be required to be given by the CONTRACTOR to the OWNER.

6.4 Delayed Tests

If the tests could be carried out but are being unduly delayed by the CONTRACTOR the OWNER may by notice inform the CONTRACTOR to conduct the tests within 14 days after the receipt of such notice. The CONTRACTOR shall conduct the tests on such days within that period as the CONTRACTOR may fix and of which he shall issue notice to the OWNER.

If the CONTRACTOR fails to conduct the tests within such notice the OWNER may himself proceed with the tests. All tests so conducted by the OWNER shall be at the risk and cost of the CONTRACTOR and the cost thereof shall be deducted from the contract price or charged to the CONTRACTOR. The tests shall then be deemed to have been conducted by the CONTRACTOR and the test results shall be binding on the CONTRACTOR.

6.5 Independent Inspector

The Owner reserves his right to appoint an independent inspector at his own cost as his representative to discuss the test program, to approve the instrumentation, to witness the tests and to analyze the test results.

It is CONTRACTOR's responsibility to co-ordinate for suitably carrying out the performance tests. The duration of the test shall be in accordance with the agreed test codes at the loads after necessary stabilizing period to obtain steady state conditions. All other tests to prove the guarantees as indicated in the CONTRACTOR's offer shall also be conducted.

The Plant parameters during the performance test shall be adjusted as far as practicable to the guaranteed performance test conditions. The tests shall be conducted to prove guaranteed parameters as defined in the contract.

The performance test results shall be reported as computed from the performance test observations with corrections for site conditions, variations in fuel, etc., and test conditions. Such correction curves shall be submitted along with the bid. No additional allowances for errors in measurement are permissible. The measurement uncertainty on the performance test guarantee values, as reported on the basis of above tests shall not exceed the uncertainty limits specified.

6.6 Reporting of Test Results

Immediately after the conclusion of the performance test, the Contractor shall submit a test report (Six copies of each test) to the OWNER stating whether the unit has passed or failed such test, accompanied by sufficient test data and calculations to demonstrate the level of performance attained with respect to each of the tested parameters.

The report(s) shall include as a minimum, the following:

(i) Description of the test procedures.
(ii) Standards that were used.
(iii) Instrumentation details and calibration.
(iv) Full schematic diagrams with indication of instrument test location and identification tag of same.
(v) Test logs and summary of test readings used for performance calculations.
(vi) Full set of correction curves.
(vii) Computation of test results.
(viii) Computations to prove measurement uncertainty is within acceptable limits.
(ix) Conclusions of performance tests: test passed or not.

6.7 Acceptance Of Test Report

Within fifteen (15) days of receipt such test report(s), the OWNER shall submit a notice to the CONTRACTOR stating either:

(a) That OWNER concurs with the information provided in the CONTRACTOR'S test report(s), or

(b) That OWNER disputes some or all of the information provided in the CONTRACTOR's test report(s), the areas being disputed and the levels of performance being disputed.

If OWNER concurs with the information in the CONTRACTOR's test report(s), the OWNER shall, within fifteen (15) days of receipt of the test report, provide a written notice to the CONTRACTOR accepting the results of the tests.

If OWNER disputes any or all of the results contained in the CONTRACTOR's test report(s), representatives of the CONTRACTOR, OWNER and the ENGINEER shall meet within fifteen (15) days of the receipt of the OWNER's notice at a mutually acceptable location to review and discuss the dispute.

6.8 Disagreements as a Result of Tests

If the OWNER and the CONTRACTOR disagree on the interpretation of the test results, each shall give a statement of his views to other within reasonable time after such disagreement arises. The statement shall be accompanied by all relevant evidence. The Owner and the contractor shall mutually discuss and agree regarding the results of the test.

1.0 SCOPE

This section covers the painting requirements for the power System equipment, structures, piping etc. and any other surface required to be painted.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job:

IS:5	:	Colors for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Color code for identification of DE pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:6278	:	*Code of practice for white washing and color Washing*
IS:3140	:	Code of practice for painting asbestos cement building products
IS:158	:	Ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and heat resisting
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel, synthetic, exterior (a) undercoating (b) finishing

3.0 PREPARTION OF SURFACES

All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust and any other foreign matter. Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations were power tool cleaning cannot be carried out, sand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above

have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the OWNER / ENGINEER.

4.0 PRIMER PAINT

After the surface is prepared, one coat of Zinc Phosphate primer conforming to IS: 2074 shall be applied. After this first coat is dried up completely, second coat of red oxide primer shall be applied. Primer shall be applied by brushing to ensure a continuous film without 'holidays'. The dry film thickness of each coat shall be minimum 30 microns.

5.0 FINISH PAINT

Synthetic enamel paint conforming to IS: 2932 shall be used for finish coats. The color/shade shall be as approved by the OWNER. After cleaning the dust on the dried up primer, first coat of synthetic enamel shall be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to a smooth finish and ensuring that at no place the first coat is completely removed. After allowing the water to get evaporated completely, the second finish coat of synthetic enamel paint shall be applied.

6.0 SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5 Grade	COLOUR (BAND)	IS-5
1.0	Structures, platforms, galleries, ladders and handrails	Dark Admirality Grey	632	-	-
2.0	Crane				
2.1	Crane structure	Golden Yellow	356	-	-
2.2	Trolley and hook	Crimson	540	-	-
3.0	Fans, pumps, motors, compressors	Light Grey	631	-	-
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium	-	-	-
4.2	Indoor	Light grey	631	-	-
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-

6.0	Switchgear	Light grey	631	-	-
7.0	Control & relay panels	Light grey	631/70 78 of IS 1650	-	-
8.0	Machinery guards	Signal red	537	-	-
9.0	Piping (without insulation and cladding_)				
9.1	Water System				
	Bearing cooling water	Sea green	217	French blue	166
	Potable & filtered water	Sea green	217	French blue	166
	Service & clarified water	Sea green	217	French blue	166
	Raw water	Sea green	217	White	-
	Cooling water	Sea green	217	French blue	166
9.2	Air System				
	Station air	Sky blue	101	-	-
	Control air	Sky blue	101	White	-
9.3	Drainage	Black	-	-	-

7.0 Clari-floculators:

Outside of clariflocualtor can be painted with Cement paint. Inside of clarifloculators can be painted with Epoxy coating to avoid leakage as given below:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.
ARALDITE GY 250 - 100 Parts by weight
HARDENER HY 840 - 50 Parts by weight
Over the primer, the uneven surface of concrete should be filled with leveling putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion:
ARALDITE GY 250 - 100 Parts by weight
HARDENER HY 830 - 45 Parts by weight
HARDENER BY 850 - 15 Parts by weight
SILICA FLOUR - 20 Parts by weight
FLOW CONTROL AGENT - 2 Parts by weight
Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat to be applied.

Notes:

1. This colour code basically refers to IS:2379 for piping with necessary modifications

2. Where band colour is specified, same shall be provided at 30 metre intervals on long uninterrupted lines and also adjacent to valves and junctions.

Contractor shall furnish the following data/documents/drawings/ information with the bid.

1.0 **GENERAL**

1.1 Completely filled-in Schedules as given in Volume -III- Schedules

1.2 Project execution network schedule.

1.3 Features provided in the System to achieve guaranteed availability.

1.4 Electrical load list for each system identifying individual drives rating.

1.5 Data as called for in the Technical Requirements of Mechanical Works, Electrical works, C&I works and civil works of the Specification.

2.0 **WRITE-UP**

Write-up covering process flow details, diagrams and complete technical details of Zero Liquid Discharge Plant including sizing calculation for all components of ZLD.

3.0 **MECHANICAL, CIVIL, ELECTRICAL & I&C**

In addition to above, drawings /data/information as called for in Technical Sections shall be submitted along with the bid.

1.0 The Contractor shall submit the following data/information documents/drawings to the OWNER/ENGINEER, who in turn will review and furnish comments on only important drawings/documents. Contractor shall furnish a list of data/ drawings/documents which will be submitted to the OWNER/ENGINEER with due dates of submission immediately after award of Contract. The list shall be updated by the Contractor on fortnightly basis. All drawings shall be generated in AUTO CAD Rel-14 OR Latest.

2.0 **Zero Liquid Discharge Plant:**

2.1 Sizing criteria for all equipments shall be provided by the contractor. The sizing criteria shall include the basis of all assumptions if any, detail calculation procedure together with formula, characteristic curve and relevant codes. This shall be detailing the items furnished in project design manual.

2.2 For the equipment / system where datasheet is not available, CONTRACTOR shall furnish detailed technical data sheet for all equipments.

2.3 All process and instrumentation diagrams (PID) and process write-up clearly indicating process operations. All primary instruments shall be tagged and correlated suitably in the write-up. Performance / other test points to be clearly identified on the PIDs. Recommended measurement and control for the systems shall also be shown.

2.4 Characteristic curves of pumps.

2.5 Equipment general arrangement drawings including elevation cross section of the equipment with major dimensions and all connection details and other relevant data.

2.6 Foundation design, criteria including loading details of individual equipment system.

2.7 Detailed piping layout drawings (plan and section) and fabrication drawings for all systems

2.8 **ELECTRICAL SYSTEM DRAWINGS** / documents / data / list / schedules / particulars / literature etc., listed in Technical Requirements: Electrical Works.

2.9 **INSTRUMENTATION AND CONTROL SYSTEM** / documents / data / list / schedules / particulars / literature etc., listed in Technical Requirements: Instrumentation and control Works.

3.0 GENERAL

a) Contract network schedule

b) Flow diagram for all systems indicating equipment, piping valves, specialities and instrumentation including performance test scheme, technical write-ups and performance test procedure

c) Quality Assurance Plan for all equipment's.

d) Details of paints and painting material.

e) Final technical data sheets for all equipment

f) Installation drawings and manuals for all equipment/systems.

g) Detailed write-up for shop tests and site performance tests.

h) Integrated operation and maintenance manuals for the complete plant as well as for all individual equipment.

i) Test certificates for type/routine and standard acceptance tests.

j) As-built drawings for all equipment/systems supplied under this contract and all buildings / structures / works executed under this contract incorporating all changes/modifications upto the time of commissioning / handling over to the Owner.

k) Project Design Manual consisting of studies of all the systems, design criteria, sizing calculations of all major equipment/systems etc.

l) Materials test certificates and performance test certificates for all equipment tested at works.

m) Detailed interface schedule for all terminal points identifying terminal point no., size, material, type of connection, design flow, pressure and temperature at the terminal points.

n) Storage instructions for all equipment.

o) Drawings/data to be required/ submitted to statutory authorities.

p) Schedule of instruments for performance tests.

q) Schedule of shop tests/inspections on all equipment.

r) Schedules of places of shop test and inspection for all equipment.

s) Detailed write-up on all pre-commissioning and commissioning activities.

NOTE :

1. Any other details relevant to the contract sought by purchaser during the period of contract/detail engineering.

2. All documents, data sheets, drawing, schedules, lists, etc., to be submitted by the Contractor/Sub-Contractor against this Contract shall be submitted on compact disks in addition to the required number of prints/ reproducible.

CONTRACT CO-ORDINATION PROCEDURE:

1.0 The bidder is responsible for submission of design documents/ drgs to KPCL.

2.0 The bidder has to provide online portal i.e PEDM (Project Engineering Documentation Manager), where bidder will upload drawings / documents, QAP and vendor list for approval from KPCL. KPCL will review the drawings / documents and will provide comment / approval through this online portal. Inspection call will also be raised through PEDM / any other web based system/letter as applicable.

3.0 The bidder shall furnish a MDL "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be submitted during the detailed engineering. This Master List will be updated in the PEDM for uploading of drawings / documents. Such list shall clearly indicate the purpose for submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY" along with schedule date of submission.

4.0 Master List shall be updated every quarter. Covering letter will identify the changes made to the Master list.

5.0 **Correspondence & Co-ordination**

All correspondence related to Engineering & QA, design drawings, O&M Manual, test procedure etc. shall be addressed directly by the bidder to KPCL through PEDM. Similarly, KPCL shall upload consolidated comments in the PEDM against MDL which will automatically move to the bidder, with a copy to KPCL. All these correspondences will be done through PEDM.

6.0 **DRAWING/DOC SUBMISSION AND APPROVAL PROCEDURE**

a) The bidder shall use a standard transmittal for submission of drawings/documents to KPCL.

b) The bidder while submitting the drawings /documents to KPCL shall ensure that these are fully in compliance with the KPCL spec. /contract and MDL. All drawings shall be sent in .pdf format. The comments shall be in MS Word / Excel. Drawing / document will be commented / approved on soft copy of drawings. KPCL shall use digital stamp on the approved copy which will be uploaded in PEDM. This approved copy will be used for erection purpose.

c) In case of fresh submission of drawings/documents KPCL shall review and furnish their comments/approval within 15 (fifteen) working days from the date of receipt of soft copies of drawings/documents. Upon review of each drawing/documents, depending on the correctness and completeness, the same shall be categorized and approval accorded in one of the following categories:

	CATEGORIES MEANING
A	Drawing Approved as submitted. Release distribution prints.
B	Drawing Approved with comments. Proceed with fabrication / Manufacture / Construction considering comments and resubmit for approval and stamping.
C	Drawing Not Approved. Correct the original.
D	Correct the original drawing duly incorporating our comments and submit for records.
H	Drawing not for approval, only for Information. Information furnished in the drawing is noted.

d) The drawings/documents commented or not approved by KPCL in Cat. B to D shall be revised and resubmitted by Bidder within 07 (Seven) working days from the date of receipt of comments. In cases of revisions, KPCL shall furnish their approval/comments within 07 (Seven) working days.

e) In case the bidder does not agree with any of the specific comments, Bidder shall furnish the explanation for the same to KPCL for consideration and acceptance. In all such cases Bidder shall necessarily enclose documents (taking care of balance comments) to avoid any delay and / or duplication in review work.

f) In case Bidder explanation is not found acceptable to KPCL, the same shall be communicated to Bidder in writing.

g) Wherever, drawings/document is approved in Cat. B, the work can be carried out on the basis of comments furnished on the drawing/documents. However, the comments of KPCL will be taken care by Bidder while submitting the revised drawings/documents for formal approval in Cat. A.

h) The bidder shall not make any changes in the portions of the drawings/documents, other than those commented. If changes are required to be made in the portions already approved, Bidder shall re-submit the drawing/document specifically

identifying all the changes along with the reasons for each change so made, for KPCL's review and approval.

i) Final distribution copies of all approved drawings/documents shall be uploaded in PEDM with digital stamp. Bidder, KPCL can use the stamped copy during erection work or for further engineering.

j) In case, any change is necessitated in approved drawings due to the site conditions at erection and commissioning stage, the same shall be brought to the notice of KPCL and drawings revised accordingly and resubmitted for approval. Any critical change will require KPCL prior approval. All such changes / modifications necessitated due to site conditions shall be highlighted on the drawings along with the reasons for such changes. The distribution shall be similar to that of final approved drawings/documents.

k) ERECTION DRAWING / DOCUMENTS:

Bidder shall furnish a Master list of Erection Drawings / Documents covering various equipment, plant & systems. Bidder shall update this list every month. The Revision No. Reason for revision (Commented letter No & dt) Revised by Checked by Approved by Date updated list shall be submitted to KPCL Yelahanka Site / Bengaluru. The drawings under this category shall be submitted to KPCL Site office at least three (3) months in advance before start of the related activity at site.

l) ERECTION / INSTRUCTION MANUAL /O & M MANUALS:

The bidder shall submit Erection Manual/ Pre-Commissioning / Commissioning check lists/ commissioning procedures in respect of the entire requirement at least three months prior to the scheduled date of commencement of erection of respective equipment/ precommissioning activity respectively. O & M manuals of related equipment shall be submitted by the bidder at least 3 months prior to commissioning of the equipment.

All erection manuals in 5 nos. copy shall be furnished by the bidder, out of which 3 copies shall be forwarded by bidder directly to KPCL site and 1 copy of all erection manuals will be forwarded to CE(TD), KPCL, Bengaluru for information & record.

7.0 DRAWING/DOCUMENT DISTRIBUTION SCHEDULE

All documents & drawings shall be in English and in metric units

Sl. no.	Document/Drawing	CONSULTANT If any	KPCL- (CETD/ CECD)	KPCL-SITE	VENDOR SITE	VENDOR
1	Master list of drawings/ doc (duly indicating schedule of submission)	Soft copy	Soft copy	Soft Copy	-	S
2	Drawings / doc for Approval/Information(First Submission)	Soft copy	Soft copy	Soft copy	-	S
3	Return with comments/ approval	S	Soft copy	Soft copy	-	Soft copy
4	Drawings / Documents for approval (second & subsequent submissions till approval)	Soft copy	Soft copy	Soft copy	-	S
5	Drawings / documents for distribution(Approved by KPCL, in cat. A or H)	Soft copy	1 print +	3 print+	3 prints +	S
6	Erection Drawings / documents	-	1 print	3 prints	3 prints	S
7	Final Erection / Installation Manual for distribution	-	1 print + Soft copy	3 prints+ Soft copy	3 prints+ Soft copy	S
8	As built Drawings / documents	Soft copy	1 print+ Soft copy	3 prints+ Soft copy	1 print+ Soft copy	S(As applicable)
9	Operation & Maintenance Manual	-	2 prints + Soft copy	3 prints+ Soft copy	1 print + Soft copy	S
10	Performance & functional Guarantee test reports	Soft copy	1 prints + Soft copy	2 prints + Soft copy	1 print + Soft copy	S
11	Type Test Certificate	Soft copy	1 prints+ Soft copy	2 prints+ Soft copy	1 print + Soft copy	S
12	Commissioning & Performance Procedure Manual	-	1 prints+ Soft copy	2 prints+ Soft copy	1 print + Soft copy	S
13	Project Completion Report	Soft copy	1 prints+ Soft copy	2 prints+ Soft copy	1 print+ Soft copy	S
14	Progress report	Soft copy	1 print+ soft copy	2 print+ soft copy	1 print+ Soft copy	

NOTES:

1. The above schedule of submission does not include Docs/Drgs. of quality assurance/inspection and delivery/dispatches.
2. Date of submitting soft copy is to be taken as date of submission.
3. S – Source for generation of document.
4. PEDM shall be used for all relevant communication.

8.0 GENERAL

The technical drawings/ documents/ data will be submitted by the successful Tenderer in two stages in addition to those to be submitted along with the tender.

(i) For approval: Based on which procurement and manufacturing activities can be taken up by the Successful Tenderer. Necessary reference drawings to facilitate clearance of approval category drawings shall also be submitted.

(ii) As final technical documents: For record and reference and to facilitate erection, testing, commissioning, operation and maintenance of plant and equipment supplied.

(iii) All the drawings/ documents shall be in English language only and all dimensions/ weight shall be in SI/ metric units.

(iv) The technical parameters/ details data/ drawings given by the Successful Tenderer with the tender shall be considered tentative and these shall be subject to prior approval of Purchase during basic / detailed engineering stage.

(v) All documents / drawings / performance curves / manuals, etc. including the revised ones, design calculations, final drawings, as-build drawings/ document will be submitted in required copies for KPCL approval / information / review / records.

(vi) The successful Tenderer will furnish a comprehensive list of drawings / documents/ manuals along with schedule of their submission for KPCL's approval.

(vii) Submission of drawings shall commence within 4 weeks of effective date of Contract and shall be submitted in a sequential order and completed within the agreed time frame.

(viii) Successful Tenderer will observe strict logical sequence in submission of drawings/ documents/ manuals for KPCL's approval. To facilitate KPCL's approval, each set of drawings submitted for approval shall be complete with technical specification /parameters, detailed bill of materials giving quantities, material specifications, unit weight, total weight and applicable codes in respect of each item reference during

basic and detailed engineering stage, shall also be submitted by the Successful Tenderer. Characteristic and performance curve for various equipment such as pumps, motors, etc, as applicable, shall be submitted.

(ix) The successful Tenderer will submit required copies of all final drawings/ documents along with one set of microfilms of silver halide archival quality.

9.0 DRAWINGS AND DOCUMENTS

The successful Tenderer shall supply design calculations, drawings, documents, schedules, specifications, manuals and reproducible to the KPCL as part of the contract and within the contract price. These shall include, but not be limited to, all design calculations, scheme drawings, general arrangement and layout drawings, details and construction drawings, wearing parts drawings, specifications, bill of materials, manufacturers' equipment catalogues and technical literature, test and inspection certificates operation and maintenance manuals, list of spare parts, as-built drawings, reproducible, etc. At each submission the Successful Tenderer shall submit prints/sets of all drawings and documents to the KPCL.

The successful Tenderer shall be liable for any discrepancies, errors or omissions in the drawings and other information supplied by him, irrespective of whether these have been approved by the KPCL or not, provided that such discrepancies, errors or omissions be not due to incorrect information or particulars furnished in writing to the successful Tenderer by the KPCL, unless the successful Tenderer as designer and manufacturer of such equipment could have known or discovered the said discrepancies, errors and omissions.

The successful Tenderer shall submit the drawings and documents in logical sequence for the KPCL's approval, and information/ review according to the agreed time schedule.

Drawings and documents submitted by the successful Tenderer for the KPCL's approval, and information/review shall be certified as correct for use and shall bear the signatures of responsible persons of the successful Tenderer whose names shall be notified in advance to the Purchaser by the successful Tenderer in writing.

The drawings and documents shall be sent for approval / information of KPCL

10.0 Drawing List and Schedule

The successful Tenderer shall supply to the KPCL within two weeks of the placement of order the list of drawings of all major facilities which the Successful Tenderer plans to furnish against the contract with a detailed schedule for submission of the drawings. The

detailed time schedule for submission of drawings shall be in conformity with the overall completion schedule of the project.

The successful Tenderer shall update this list every one months' interval in conformity with the progress of detailed engineering work and submit the updated list to the KPCL.

11.0 Drawing Format

The format and size of various types of drawings will be as per standard.

All drawings shall be dimensioned in the metric system and title and written notations shall be in English language. The title block of the drawing and drawing numbering scheme shall be as approved by the KPCL.

All layout drawings shall be made with the north arrow pointing to the top of sheet. There shall be sufficient reference notes on the drawings to permit identification of all related drawings and documents which are required for proper understanding. Drawings and bills of materials shall give quantities of all materials required for the work and shall be cross referenced for easy identification.

The successful Tenderer's standard drawings used for the contract shall have information pertaining to the specific item under consideration properly identified to distinguish it from information pertaining to other items which may be contained on the same drawing. Standard drawings of the successful Tenderer shall bear a reference in the drawings to the present contract only. Reference pertaining to other contracts entered into with other parties shall not appear in the drawings or any other documents submitted to KPCL.

When a drawing is revised by the successful Tenderer, every change made shall be identified on the drawing (and not in the covering letters) by circling the changes made and placing the revision number in a small triangle so as to be easily recognizable. When a subsequent revision is made, the circles made for the previous revisions shall be erased and the current changes circled. However, all revision numbers in the small triangles shall be retained. In addition, a record of revisions along with the co-ordinates showing the location of revisions shall be indicated at the left hand bottom corner of the drawings as per standard practice. In case of revision of a drawing, for which a different number is allotted, the new drawing shall clearly indicate the number of the drawing, which it supersedes.

12.0 General Arrangement and Layout Drawings

The successful Tenderer shall submit general arrangement and layout drawings including cross-sections for approval of the KPCL prior to commencement of detailing and manufacture.

General arrangement and layout drawings for equipment shall include equipment outlines, overall dimensions, locations of equipment, centre lines and working point elevations and functional clearances. Assembly, sub-assembly and sectional drawings shall be furnished detailing various components along with their material of construction. These drawings shall be sufficiently detailed such that if the KPCL so desires, he can procure spares and replacements from a suitable component manufacturer. Details of mechanical equipment shall include grade of finish, heat treatment and tolerances.

General arrangement and layout drawings for piping work shall include physical location of pumps, equipment, valves and instruments on the general pipeline routing.

For electrical system, layout drawings shall indicate locations of all electrical equipment, including motors, controls, limit switches, motor list with ratings, list of electromagnetic valves, single-line interlocking and sequence diagrams for control, signaling and communication system, location of devices on switch-gear control panels, desks etc. including sectional views. The details furnished shall include complete cabling drawings giving details of power and control cables, terminal details, layout of trenches and cable racks, conduits, etc.

General arrangement drawings for instrumentation shall include the control schemes and instrumentation flow diagrams and sequence logic diagrams and GA drawings of instruments and control panels. In addition, the drawings shall be furnished

The details furnished shall be accompanied by necessary design data and design calculations (in A4 size sheets) and shall conform to applicable specifications and acceptable codes of practice.

The successful Tenderer shall furnish comprehensive performance data including characteristic curves, efficiency, power, NPSH and other pertinent curves for approval of the KPCL. With the delivery of equipment, the successful Tenderer shall submit all test and Inspection certificates including material test certificates along with invoices. Another Three (3) sets of test and inspection certificates arranged in classified manner in bound volumes shall be furnished after completion of work for records before Preliminary Acceptance.

A list of wearing parts such as bearings, glands, gaskets, bolts, chains, etc. shall be furnished showing quantities supplied and installed, dimensions, materials of construction and expected life. The information furnished shall include complete specifications for all wearing parts indicating their grade of finish, heat treatment, tolerances, etc. along with their manufacturing drawings.

The successful Tenderer shall submit certified foundation outline drawings including dimensioned anchor/foundation bolt location plan and loading drawings for equipment foundations and structures giving the size and specifications of all foundation/anchor bolts, sleeves, inserts, supports, and other materials which have to be imbedded in concrete.

The successful Tenderer shall furnish erection drawings showing all details and particulars in sequence required for erection and installation of the plant, equipment and piping works.

Instructions for re-conservation during storage of individual equipment along with manufacturer's recommended frequency for re-conservation / preservation shall be indicated.

Bills of materials shall be supplied along with the drawings to which they pertain. BOM shall include list of equipment and materials covered in the drawings along with their brief specification, quantity, identification number, and reference drawings/applicable Standard Code.

The successful Tenderer shall supply a comprehensive list of spares clearly identifying commissioning spares, Essential spares for normal operation and maintenance and insurance spares. The spare parts list shall be accompanied by manufacturer's specifications, identification number, and reference drawing number and manufacturers catalogues.

13.0 Approval of Drawings

Approval of successful Tenderer's drawings and documents shall amount to their checking for conformity with applicable specifications and general fitment in the system covered. Approval by the KPCL does not include checking for drafting errors.

Approval of successful Tenderer's drawings shall not relieve the successful Tenderer of his responsibility to comply with the intent of the contract. Manufacture / fabrication /procurement prior to approval of drawings and documents shall be at the successful Tenderer's risk.

The successful Tenderer shall submit drawings for approval in number of prints as specified. If the drawing is approved, one print stamped "Approved" will be returned to the successful Tenderer. If the drawing is "Not Approved" or "Approved as Noted", one marked up print with appropriate comments and status duly stamped will be returned to the successful Tenderer for correction and resubmission.

The successful Tenderer shall resubmit the revised drawing after incorporating all the comments within one week of the receipt of the commented drawing for approval by the KPCL.

Upon approval by the Purchaser/Consultant, the drawings shall become Contract drawings and thereafter the successful Tenderer shall not depart from them in anyway whatsoever except with the written consent of KPCL.

Should it be found at any time after approval has been accorded by the KPCL that any design, drawings or documents submitted by the successful Tenderer are not consistent with any design, drawing or documents submitted or approved earlier or deviate from any aspect of the Contract Document, then such alterations or additions as may be deemed necessary by the KPCL shall be made therein by the successful Tenderer and the work shall be carried out accordingly.

The responsibility for approval of drawings in time for meeting the completion schedule of the project shall solely lie on the successful Tenderer. Delay in approval of drawings shall not be entertained as a cause of any delay in commissioning of the project.

14.0 Operation and Maintenance Manuals

The successful Tenderer shall supply Operation and Maintenance Manuals in durable bound volumes with elaborate instructions for erection, operation and maintenance of the plant and equipment.

The manual shall present the following categories of information in practical, complete and comprehensive manner prepared for use by operation and maintenance personnel:

i. Instructions for initial installation.
ii. Instructions for operation, preventive maintenance, and repairs including check list for trouble shooting.
iii. Recommended inspection points and frequency of inspection.
iv. Ordering information for all replaceable parts.
v. Lubrication chart.

As far as possible electrical maintenance manual shall be supplied separately and shall contain similar details about fault finding and rectification along with necessary technical literature, characteristic curves and manufacturer's catalogues. The manual shall include lists of various electrical components and protective devices, preventive maintenance schedules and final setting values of all control and regulation equipment.

The information shall be presented in a logical and orderly sequence. The general description of the equipment including significant technical characteristics shall be included to familiarize operating and maintenance personnel with the equipment.

Drawings and other illustrations shall be included or copies of relevant drawings shall be appended with the manual. Test and adjustment instructions, as appropriate, shall be identified to the specific equipment.

15.0 Drawings and Documents at Completion of Work

The successful Tenderer shall supply soft copy on CD and eight (8) prints of as-built drawings of each original drawing, specification, bill of materials, etc. made by the successful Tenderer or his sub-contractors incorporating modifications, if any, carried out during the execution of work including those made at site during construction, erection and start-up.

One set of design data and design calculations made by the successful Tenderer or his sub-contractors shall be furnished in soft copy on CD and eight (8) sets of hard copies on plain paper neatly filed in hard binders and suitably indexed to facilitate reference for undertaking modification and extension work at a future date. The design calculations for different disciplines, e. g. hydraulics, structural steel works, civil engineering works, electrical system, etc. shall be submitted in separate volumes.

Data drawings to be furnished by the tenderer with the offer

(i) Plan and cross-sectional drawing for the installations with major dimensions, technical characteristics and operating parameters. GA and cross sectional drawing of all units showing the disposition of all equipment, piping, valves, electrical equipment, material handling facilities, ventilation equipment with dimensions.

(ii) Layout drawing showing the battery limits and various pipelines

.

(ii) General description of design considerations and assumptions as applicable.

(iii) P & I diagram of each circuit of the complete ZLD System.

(iv) GA drgs. of major equipment Write -up detailing the control logic in the entire treatment system.

(v) List of special tools and tackles.

(vi) List of commissioning spares.

(vii) List of essential spares for normal operation and maintenance.

(viii) Methodology on project implementation along with Bar chart.

(ix) Details of various drives, instruments, handling & hoisting facilities, air conditioning & ventilation facilities, etc.

(x) Tentative Bill of Quantities covering all equipments, valves, strainers, pipelines, etc. and associated civil, structural, electrics, instrumentation, handling & hoisting facilities, air conditioning and ventilation facilities etc.

(xiii) Pipeline materials and specifications considered for various systems.

Drawings/ Documents to be Furnished after Placement of Order

Drgs/ documents for approval of Purchaser/ Consultant

i. List of drawings
ii. Layout drawing showing battery limits and coordinated plan of units and facilities including requirements of utilities with their parameters of the battery limits.
iii. Plan and cross-sectional drawings of the installation with major dimensions, technical characteristics and operating parameters. Plan, Elevation & Cross section drawing of complete Zero Liquid Discharge plant including pipelines as per scope of work.
iv. GA drawings for units/ equipment with technical parameters, dimensions, material of construction, weight of equipment and complete bill of materials for each equipments.
v. Specifications of equipment, pipe, valves & fittings etc.
vi. Data sheets, characteristic curves and technical details of all the equipments, valves and piping.
vii. Make & G.A. and cross section drawings of all bought-out items.
viii. Process & instrumentation diagrams for the Zero Liquid Discharge plant indicating location of all instruments, alarms and interlocks functions using ISA symbols.
ix. List of instruments comprising bill of materials and instrumentation data sheets.
x. Water mass balance diagram.
xi. Layout of piping system indicating pipe routing, location of supports, valves and other fittings as required.
xii. P&ID and list of safety interlocks
xiii. Control philosophy of water system
xiv. Test procedures for preliminary and final acceptance tests.

xv. Quality Assurance Plan.
xvi. All equipment and piping sizing calculations.
xvii. GA drawings and details of air conditioning & ventilation facilities and material handling facilities etc.
xviii. GA drawings of material handling equipments.
xix. Test certificates for the following:
a) Material test certificate for all major equipment and their components.
b) Hydraulic test of equipment, pipe fittings & valves.
c) Static and dynamic balancing of all rotary parts / equipments
d) Semi-permeable membrane

xx. Any other documents /drawings that may be needed at the time of approval of drawings.
xxi. Certificates in line with relevant clause.
xxii. Progress report as per relevant Clause.

Drawings/ Documents to be submitted along with delivery of equipment for record purposes.

i. All the drawings/ documents mentioned above
ii. Spare parts list and price of each part.
iii. Operating and maintenance manual
iv. Instruction for erection and commissioning.
v. Manufacturer's test certificates.
vi. Various equipment assembly drawings and bill of material.
vii. Weld procedure.
viii. Equipment GA drawings and bill of materials.
ix. Characteristics curves of the pumps, motors, blowers and other equipments.
x. Operation and maintenance manuals for all equipments, valves and complete treatment system along with soft copies.
xi. Test and calibration certificates.
xii. Warranty/ guarantee certificates.
xiii. Technical literature, catalogues and manufacturer's drawings for all brought out equipment, valves and other items.
xiv. All inspection/ test report/ certificates.
xv. Any other drawing/ documents as required by the Purchaser.
xvi. Material test certificates.
xvii. Any other drawings/ documents mentioned in technical specification or technical rules to tender.
xviii. Detailed manufacturing drawings for fast wearing parts, gear boxes and other imported components.

For List of drawings/ documents (to be submitted along with the offer and after placement of order) for Civil, Structural, Electrical, Instrumentation, Air Conditioning & Ventilation, Material Handling facilities etc.

Preparation and submission of monthly progress report in a format to be mutually agreed between the KPCL and the successful Tenderer.

By Successful Tenderer for Final Technical Documentation the successful Tenderer shall furnish operation and maintenance instruction manuals presenting the following basic categories of information in a practical, complete and comprehensive manner for use by operation and maintenance personnel. A general description of the equipment including significant technical characteristics shall also be included.

- Instructions for initial installation/erection.
- Instructions for operation, maintenance and repair.
- Recommended inspection points and period of inspection.
- Ordering information for all replaceable parts.

- List of consumables, chemicals and their consumption per annum Supply of necessary technical literature, drawings and documents such as general arrangement drawings, equipment layout & plan drawings, P&I diagram for the system, erection and operation and maintenance manuals including bought out items, specification of lubricants, chemicals and reagents and other consumables, as required. Design calculation and basis for selection of various equipments.

Documentary proof from membrane manufacturer/ software projections regarding selection of RO membranes, (number, array, flux rate, Beta factor, LSI etc.) shall be provided.

i. List of drawings/ documents for the project
ii. Operating and maintenance manual.
iii. Erection manual- containing instructions for assembly, erection, testing & commissioning.
iv. Recommended spare parts list.
v. Drawings/ catalogues/ technical literature for brought out items / components etc.
vi. All inspection / test report/ certificates.
vii. Test and calibration certificates.
viii. Warranty/ guarantee certificates
ix. Any other drawing/ documents as required by the Purchaser.

1.00 OPERATION & MAINTENANCE OF ZERO LIQUID DISCHARGE PLANT:

1.01 PERIOD OF OPERATION & MAINTENANCE

The successful tenderer shall be responsible for Operation & Maintenance of plant and equipment on 24x7 basis for a period of **one year** after handing over / issue of Notice To Proceed (NTP) as the case may be. Consumables & chemicals are in the scope of KPCL during O&M period.

1.02 SCOPE OF WORK

The successful tenderer shall be responsible for the Operation & Maintenance (O&M) for ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories and shall perform all necessary services in a prudent & efficient manner as listed below:

OPERATION:

1. Local operation of all equipments connected to zero liquid discharge plant (including auxiliary installations, lighting , dewatering pumps, power points etc.), instrumentation & automation systems (including calibration of instruments, measuring systems etc.) and other necessary services (make-up drinking water, Air conditioning and ventilation system, firefighting and other day to day safety) as required.

2. Running inspection of all equipments and related accessories, observation and recording of any abnormalities/defects during operation and maintaining logbook.

3. Monitoring the consumption of all utilities (power & make-up and drinking water) for optimum consumption and efficient operation.

4. Attend to consumer complaint immediately.

5. Co-ordination with KPCL for power etc.

6. Log sheet to be maintained for entering the technical / operating parameters of the system on hourly basis.

7. Log record is to be maintained for the activities carried out during the day and recording the defects noticed / complaints received from the owner. The successful tenderer should attend these complaints immediately and record the rectifications carried out in the same log book. On rectification of defects, the same has to be got inspected and certified by

Site-In-charge (Successful tenderer) on a regular basis. All the records/documents are to be submitted to KPCL on daily basis for scrutiny and safe custody.

8. Clearance of minor faults, which arises during the shift, to ensure smooth operation of plant. Any major problem noticed in the shift to be intimated to the site-in-charge Successful tenderer) for mobilization of any extra support needed. Site-in-charge (successful tenderer) will ensure to clear the fault in same shift itself, or in the next shift to be decided after consultation with KPCL. In case of major problem, time frame shall be mutually discussed and agreed.

9. Any co-ordination required with KPCL for arranging shutdown for rectification of any major problem noticed in the shift. In addition to the above the successful tenderer shall submit the Standard Operating Practices (SOP) of all operational activities for waste water collection system, pre-treatment system, tertiary treatment system, dewatering system, ZLD plant and its equipments based on technological suppliers manuals / recommendation before commissioning of the plant and the same shall be evaluated by KPCL.

MAINTENANCE:

1. The scope covers maintenance of all static and rotary equipments used in ZLD Plant and miscellaneous equipments. The scope of successful tenderer is 100 % maintenance of the plant (inside plant battery limits) round the clock (three shifts in a day) including Sundays and all holidays as per the need.

2. The preventive maintenance plants including breakdown repair and maintenance shall be made by the successful tenderer for the entire contract period. Subsequently, monthly schedules shall be Prepared. Maintenance shall be combination of predictive, preventive and condition based.

3. Running maintenance activities like lubrication, oil top up, gland tightening etc.

4. Lubrication schedules indicating quantity of lubrication shall be prepared by the successful tenderer in consultation with KPCL and a fulfillment records shall be kept for further reference.

5. Periodical inspection of all the equipments of the plant shall be carried out as per the inspection plan, detailed equipment wise inspection check lists which will be jointly finalized by the successful tenderer and KPCL. All running inspections like daily, weekly, fortnightly, monthly etc. shall be included. The inspection reports are to be submitted daily to the engineer. All defects noticed during inspection are to be rectified immediately to prevent major outages. The check list will be reviewed jointly by the successful

tenderer & KPCL and modified as per requirement to ensure the healthiness of the equipment.

6. Condition monitoring jobs to ensure the machines are running in perfect condition and to predict any problems shall have to be carried out by the successful tenderer.

7. The state of art condition monitoring equipments like vibration analyzers, bearing analyzers, shock pulse meters, acoustic based instruments shall be maintained and utilized to observe the health of the equipments, predict the trend, failures, analyze the problems of the equipments etc. The vibrations and temperature of the running equipments shall be maintained within the specified norms of the OEM and records maintained.

8. Maintenance work for all electrical equipment & system, Instrumentation & automation system of ZLD Plant on 24hrs. x 365 days basis. The complete maintenance activities include planning, co-ordination and execution of scheduled routine inspection, preventive, corrective and breakdown maintenance of all electrical equipments and systems including overhauling of HT & LT motors, instrumentation & control system, automation equipments and systems (routine / condition based) under the scope of work.

9. History records for all equipments to be maintained and handed over to KPCL. The records shall contain the information like alignment readings, bearing clearances, gear back lashes, details of assemblies/ subassembly replacements etc.

10. The health of the equipments after contract period shall be same as that of newly commissioned plant except the normal wear out that takes place during operation at the end of the contract period.

In-addition to the above successful tenderer shall submit the Standard Maintenance Practices (SMP) of all maintenance activities based on the equipment supplier's manuals / recommendations, his experience and other standard practices before commissioning of the plant and the same shall be evaluated by KPCL.

1.03 PERSONNEL

The successful tenderer shall deploy the minimum manpower and its qualifications for operation and maintenance of ZLD Plant as per the list indicated below:

TENTATIVE MANPOWER DEPLOYMENT PLAN

WORK DESCRIPTION: "Operation and Maintenance of ZLD Plant including all miscellaneous job"

Deployment of minimum man power for operation of ZLD Plant and Operation and maintenance of Electrical equipments.

Sl. No.	Activity	Frequency	No. of shifts per day	Man Power Deployment proposed per shift		
				SU	SK	USK
1.	Shift wise deployment of personnel to carry out various operational functions of ZLD Plant including electrical, Instrumentation & control system and automation systems.	Every shift	3	01	2*	1
2.	Maintenance of mechanical equipment, systems, piping, valves etc. of ZLD plant	As per Job requirements				
3.	Maintenance of electrical equipment, systems, Instrumentation & automation systems of ZLD Plant.	As per Job requirements				
4.	Supervisor maintenance (Mechanical)	G shift	1	1	1	1
5.	Supervisor maintenance (Electrical/ Instrumentation)	G shift	1	1	1	1
6.	Site in charge	G shift	1	1		

*** minimum one person shall be electrically qualified**
SU – Supervisor, SK – Skilled, USK – Unskilled

REQUIREMENT OF MINIMUM QUALIFICATION FOR MAN POWER

Sl. No.	Position/ Post	Min. qualification	Min. experience
1.	Site in charge	Graduate Engineer (Mech/ Chem/ Civil)	5 years of experience in running treatment plant, pump house and Piping system. Out of which at least 02 years as site in charge. He must have at least 02 years of experience in running treatment plant, pump house and piping system.
2.	Supervisor (Operation)	Graduate/ Diploma Engineer	3 years of experience in running treatment plant, pump house and piping system.
3.	Supervisor (Maintenance-Mechanical)	Graduate/ Diploma Engineer	2 years of experience preferably in ZLD plant & treatment system
4.	Supervisor (Maintenance-Electrical/ Instrumentation)	Graduate/Diploma Engineer	2 years of experience preferably in electrical & Instrumentation field.
5.	Skilled technician	+2 /I.T. I.	2 years of experience in treatment plant, pump house and piping system.
6.	Skilled technician (Elect)	+2 /I.T. I.	2 years in electrical & Instrumentation field
7.	Unskilled helper	-	Around 1 year experience

1.04 LIQUIDATED DAMAGE FOR NON-COMPLIANCE OF GUARANTEED PARAMETERS.

1.04.01 QUALITY OF TREATED WATER

Schedule of guaranteed performance figures for quality

1.04.02 PENALTY FOR NON FULFILLMENT OF GUARANTEED VALUES

In case of non-fulfillment of the performance values LD will be levied on the Successful tenderer. Nonperformance in respect of equipment / system means that the equipment(s) considered individually as well as a system comprising all the equipments fail to meet the performance requirement as indicated in technical specification. That is, shortfall in the performance of individual equipment(s) shall be considered to be shortfall in the performance for the entire system, since it is a turnkey package. In case of non-fulfillment of

performance values the Successful tenderer will have to bear a Penalty to be levied for the various guarantee parameters shall be as follows:

1.04.03 LD for non-performance: If the contractor fails to achieve any one or more of the guaranteed values of the parameters indicated in Performance guarantee for 3 days in a month, KPCL will levy penalty at the rate of 1% of total contract value for the O&M subject to maximum of 5% of total contract value for O&M. If such deviation of parameters is observed for a period of continuously 3months, the O&M contract will be liable for termination.

1.04.04 LD for non-availability: The monthly system availability shall be minimum 95% during the O&M contract period. For every 1% drop in availability below 95% and upto 90% for the reasons attributable to the contractor, 1% of the total contract value for the O&M contract will be levied as a penalty subject to maximum of 5% of total contract value for O&M. If the availability factor is continuously < 90% for 3 months, then the O&M contract is liable for termination.

In case of the system availability is less than 90%, the Successful tenderer shall carry out repair/ replacement/ modification of particular equipment/ system at his own cost within a period of 15 days and thereafter, bringing the system availability to the minimum guaranteed level of 95%. The availability of the system shall then be observed for one month after the repair/ replacement/ modification are completed to decide whether or not the stipulated requirement is met during this period. The Successful tenderer in the event of failure to restore shall extend the validity of Contract Performance Bank Guarantee suitably at his own cost till the matter is decided. In case after all such repairs and replacement, the availability of the system is still less than 90%, then the O&M contract is liable for termination.

$$\text{Monthly Availability in \%} = \frac{((24 \times \text{No of days in a month}) - \text{Scheduled maintenance hours} - \text{breakdown hours})}{((24 \times \text{No of days in a month}) - \text{Scheduled maintenance hours})} \times 100$$

1.05 Cumulative Liquidate Damages for non-fulfillment of Guarantee and non-availability of the system for the operation and maintenance period

Cumulative Liquidated Damages for non-fulfillment of Guarantee values as mentioned in the relevant clauses of this technical specification are independent of each other and are applicable separately and concurrently subject to total maximum limit of 10% of the total contract value for operation and maintenance.

1.05.01 The owner may, without any prejudice to any other method of recovery, deduct the amount of such damages and LD from any amount payable, due, or which may become due, to the Successful tenderer under the contract. The payment of deductions of such damages

and penalties shall not relieve the successful tenderer of his obligations to complete the works or from any other of his obligations and liabilities under the contract.

1.05.02 In addition to the above, KPCL shall be free to cancel the contract or a portion thereof and get the balance works executed through other agency or agencies at the risk and cost of the successful tenderer. In the event such action is taken, the successful tenderer shall be liable to pay KPCL for any loss, which the owner may sustain but he will not be entitled to any gain of such action made against default. The manner and method of such contract shall be at the entire discretion of the KPCL whose decision shall be final and binding. This right shall be without breach/without prejudice to the other rights of KPCL to recover damages for breach of contract by the successful tenderer.

1.05.03 The penalty for not maintaining the guaranteed parameters for CW Make-up water shall be as follows:

The final blended water quality in CW make up tank (RO permeate water, Crystallizer distillate and bypass stream of water from CMB) shall be as detailed below:

SL. NO	DESCRIPTION	UNIT	VALUES	Rate of LD
1.	PH		7.0-7.5	If such deviation of parameters is observed frequently, Notice will be served. Further the O&M contract will be liable for termination
2.	TSS	ppm	5.0	
3.	TDS	ppm	< 800	
4.	HARDNESS as CaCO3,	ppm	< 220	
5.	Silica dissolved	ppm	< 24	
6.	Chloride	ppm	< 60	

1.05.04 AVAILABILITY OF PLANT

Breakdown

If the individual equipment fails to perform or breaks down the standby equipment will be put under operation. The overall system availability is not affected. The equipment shall be attended and restored within a reasonable time to be decided by KPCL. If because of breakdown of certain equipment the system availability is affected and runs at partial output or the complete system is out of operation. In such case if the system under partial breakdown then is to be restored back to in operation at rated capacity within 4 hrs. If there is complete breakdown of the system the same is to be restored back to 50% of rated output within 4 hrs and 100 % of rated output in total 8 hrs.

1.05.05 MANPOWER DEPLOYMENT

The successful tenderer shall deploy manpower as per clause no. 1.03. However the successful tenderer shall ensure that such personnel are on duty at the plant at all times, twenty four (24) hours a day and seven (07) days a week commencing from the date of NTP. If the successful tenderer fails to adhere the man power deployment plan as per clause no.1.03, they shall be liable to pay the penalty as per details mentioned below.

Sl. No.	deployment Manpower	Penalty
1.	Site in-charge & Supervisor/ Shift-in-Charge	Rs (4 times the minimum wages of skilled labour prevailing during the time of contract in Karnataka x no. of days of non-deployment)
2.	Skilled technician	Rs (2 min. wages of skilled labour prevailing during the time of contract in Karnataka x no. of days of non-deployment)
3.	Other work force	Rs (2 min. wages of semi-skilled/ unskilled labour prevailing during the time of contract in Karnataka x no. of days of non-deployment)

1.06 SUPPLY OF SPARES & CONSUMABLES

1.06.01 Supply of all Chemicals & consumables required for One year of operation and maintenance of ZLD Plant is in KPCL scope.

1.07 TRAINING

Successful tenderer shall provide on-job training to KPCL personnel during this One year of operation and maintenance period.

1.08 HANDING OVER THE PLANT AFTER EXPIRY OF TERM

After the expiry of term & extension of term as the case may be, the Successful tenderer shall hand over the plant to KPCL with all guaranteed parameters as achieved during PG test. The Successful tenderer will organize a joint inspection with KPCL and original equipment manufacturers of all the major & critical equipments and a joint inspection report/defect list of the equipments will be prepared in accordance to the norms of manufacturer which will be decided during plant hand over. The Successful tenderer will eliminate all the defects (if any) before expiry of the contract. Otherwise KPCL may proceed to do the work at Successful tenderer risk and expense and deduct such extra expenditure from the bills/final bill such amount as may be decided by KPCL. While handing over the

plant the Successful tenderer will hand over all technical documents, literature, instruction manual, tools & tackles and all the relevant record documents. All the aforesaid safeguards / rights provided for KPCL will not prejudice its other rights/remedies elsewhere provided herein and/or under law.

1.09 HANDING OVER CERTIFICATE

On completion of term, the Successful tenderer will apply to KPCL for the issue of handing over certificate and the same will be issued within 30 days of the handing over in all respects, after verifying from the documents and tests and satisfying himself that the operation and maintenance has been completed in accordance with details set out in the contract documents.

1.10 TERMS & CONDITIONS

- The objective of the proposed specification is to operate and maintain ZLD Plant along with all auxiliary services in such a way that, there will not be any interruption in the services intended.

- The Successful tenderer will observe all the safety procedures of the Power plant and rules, regulation of State of Karnataka.

- The ZLD plant will be operated and maintained round the clock including Sundays & Holidays. The Successful tenderer will deploy sufficient man power in A, B & C shifts as mentioned in Cl.1.03 to carry out operational and maintenance activities of ZLD Plant. The Successful tenderer will ensure that the plant is never kept un-manned.

- The Successful tenderer will deploy sufficient man power in 'G' shift to carry out maintenance activities of Mechanical, Electrical, and Instrumentation & Automation equipments. However, in case of exigency of work, maintenance activities will have to be carried out beyond 'G' shift hours also. The decision of KPCL is final in this regard.

- The Successful tenderer will deploy qualified and experienced persons in ZLD Plant as detailed in Cl. 1.03 above. Bio data along with proof of experience of site in charge, supervisors and all workmen will be submitted to KPCL for verification/approval. Only accepted persons will be deployed at site. The persons engaged for electrical jobs will be qualified and experienced electricians and have exposure in doing trouble shooting of instrumentation & control system.

- ZLD Plant and connected equipments will be operated strictly as per the instructions provided by the Original Equipment Manufacturer / as per standard operating procedures duly approved by KPCL. Similarly, maintenance of equipments including routine

preventive maintenance will be done in accordance with the relevant standard maintenance practices duly approved by KPCL.

- The equipments/units, where standby is available will be operated in a systematic pattern in rotation so as to ensure that all the equipments are available in working condition. If any unit breakdowns / fails to function, the standby unit will be put in operation. The failed equipment/unit will be treated as standby unit and maintenance jobs will be carried out and made available for operation within the allowable time as agreed with KPCL.

- At the start and end of every shift the shift –in-charge will give status report to the representatives of KPCL. Any major breakdown, power failure etc., should be intimated immediately. The Site-in-charge will meet authorized representative of KPCL to finalize the schedule of jobs for carrying out the maintenance activities and to evaluate the performance of equipment.

- The Successful tenderer will keep all related tools and tackles including the calibrated testing and measuring instruments required for attending all types of maintenance jobs and day to day works at his own cost. The successful tenderer will ensure calibration of all measuring instruments and to maintain calibration records as per KPCL requirement.

- In the event of any breakdown, the Successful tenderer will continue the breakdown job without any delay till the equipment is brought in to operation. If necessary, Successful tenderer will arrange and deploy additional manpower to reduce the breakdown period. Also, if the services of any expert are required, the Successful tenderer will arrange the same in the most expeditious manner at his own cost. The Successful tenderer will ensure availability of the services of Original Equipment Manufacturer at his own cost. The Successful tenderer will submit failure analysis report related to the breakdown equipment and action plan for prevention of further breakdown to KPCL. The action plan will be implemented by Successful tenderer after due approval by KPCL.

- The responsibility of the Successful tenderer is not limited to mere replacement of the spares. The Successful tenderer is also responsible for the testing & commissioning of the replaced parts along with satisfactory performance of the whole system.

- The successful tenderer will maintain the following records /data books as per KPCL prescribed format.

_ LOG BOOK: The Successful tenderer will maintain daily log record (job detail register/file) for the work done, spares/consumables used, any breakdown and the applicable penalties levied etc. will be recorded and the same will be got signed by Site in charge or his representatives at the end of the shift/day.

_ EQUIPMENT DATA REGISTER: The Successful tenderer will maintain all relevant information about each equipment and systems. Equipment data sheet will contain information like description of the equipment, supplier's name, reference of spares drawings, assembly drawings, maintenance manuals etc.

_ EQUIPMENT HISTORY BOOK: The Successful tenderer will maintain equipment history record of each and every equipment and system. This is a record of all spares, overhauls, modifications, replacement done on equipment and spares used for these purposes.

_ BREAKDOWN REPORT BOOK: The Successful tenderer will maintain breakdown report for keeping a record of breakdown, its analysis and recommendations.

_ ATTENDANCE REGISTER: Shift wise attendance register for the personnel engaged is to be maintained and got it signed by the Site in charge or his representative at the end of the shift/day. The attendance sheet shall be furnished to KPCL.

_ The reports / records prepared will be in soft form and will be sent to all concerned decided by Site in charge / his representatives. One hard copy will be submitted to Site in charge / his representatives.

The Successful tenderer will ensure the ZLD plant and connected equipments are always available and maintained at guaranteed parameters.

KPCL reserves the right to terminate the contract without assigning any reasons with a Notice period of two months.

KARNATAKA POWER CORPORATION LIMITED
(A PREMIER POWER GENERATING COMPANY OF GOVERNMENT OF KARNATAKA)

YELAHANKA COMBINED CYCLE POWER PLANT (YCCPP)

(1x370 MW)

BID DOCUMENTS

FOR

"ZERO LIQUID DISCHARGE PLANT COMPRISING OF WASTE WATER PRE-TREATMENT PLANT WITH RO SYSTEM AND CRYSTALLIZER SYSTEM AND ACCESSORIES"
FOR YCCPP-1X370MW

VOLUME-I

PART III

TECHNICAL SPECIFICATION

OFFICE OF THE CHIEF ENGINEER (THERMAL DESIGNS)
KARNATAKA POWER CORPORATION LIMITED
No. 22/23, SUDHARSHAN COMPLEX, 2nd FLOOR
SESHADRI ROAD, BANGALORE-560 009

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1.0 SYSTEM DESCRIPTION

1.1 MECHANICAL

KPCL is setting up 1x370 MW Combined Cycle Power Plant at Yelahanka, Bangalore. The water source for this project is tertiary treated sewage water supplied by BWSSB and the raw water analysis is as annexed in table-1.

The total waste water generated after processing at several stages in the plant is 230m3/hr. The break-up is as follows:

- CW blowdown(CTBD) – 212 m3/hr
- RO reject - 12 m3/hr
- Neutralization Pit water - 6 m3/hr

All the above waste waters are collected in existing Central Monitoring Basin – CMB (Guard pond). The water analysis at CMB is as annexed in table-2.

In order to meet the statutory obligations, KPCL is required to set up waste water recycling Cum Zero Liquid Discharge Plant ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories in order to process the waste water collected in CMB and reuse for plant applications and dispose the solid waste generated to KSPCB approved Treatment, Storage, Disposal and Facility.(TSDF) agency/ies.

1.1.1 Process Description

The waste water recycling cum zero liquid discharge (ZLD) system is designed to handle 150 m3/hr. blended water at CMB (CT Blow Down, Neutralization Pit water and RO Reject) at about 2,084 ppm of total dissolved solids (TDS). The Design Feed Chemistry of waste water stream to be treated is shown in table-2. The waste water from different systems of the plant are collected and blended in an existing Central Monitoring Basin of capacity 5600 M3. The waste water to be treated through RO plant plus ZLD plant shall be 150m3/hr. and 80m3/hr. water shall be bypassed to CW make up water tank. The RO permeate water, distillate shall also be blended further in the cooling tower make-up tank. This treated water of around TDS of ≤ 800 ppm is further pumped to CW fore bay.

The Blended - Equalized water in CMB is treated in Lime soda softening High Rate Solid Contact Clarifier (HRSCC) for reducing TSS, Hardness & Alkalinity present in the waste water. The clarified and softened water is further treated in Ultra Filtration and RO systems. In the ZLD system, the RO reject stream is sent to forced circulation Crystallizer cum Evaporator with Mechanical Vapour Recompression (MVR). The Crystallizer concentrates

the brine and precipitates mixed salts for disposal in a landfill. High quality distillate (TDS < 100 ppm) is recovered and returned to the power plant for reuse and the Schematic of Zero liquid Discharge system is as annexed as KPCL/Bid drawing/001

1.1.2 COMPONENTS OF ZLD

Transfer pumps from Central Monitoring Basin (CMB)

Waste water with an average flow of 230 m3/hr. (Cooling tower blowdown, N Pit Waste, RO Reject) is collected in existing Central Monitoring Basin. Two pumps (1W+1S) are used to transfer the effluent from CMB. 150 m3/hr. is treated in the proposed ZLD plant. The balance 80 m3/hr. is pumped without treatment to CW make up tank (Bypass line). 150 m3/hr. blended waste water is pumped to a High Rate Solid Contact Clarifier.

High Rate Solid Contact Clarifier

The High Rate Solid Contact Clarifiers (HRSCC) shall be provided as a part of pre-treatment before taking the water to UF-RO plant.

HRSCC shall be suitably designed for hardness and suspended solids load from the incoming blended water streams. The precipitated mass settled down as sludge shall be swept by a raker arm which shall further be discharged into a sludge pit by gravity. Proper valves and flushing arrangements shall be provided. The tank and structural support design is completely self-supporting for continuous service and compatible for supporting external loads such as walkways and ladders. The raker arm shall have load cell for overload protection/lifting. Torque transmitter shall be provided with indication in PLC. HRSCC torque rating shall be designed for 20% (w/w) sludge consistency.

The underflow sludge from the HRSCC shall be removed under gravity by means of timer operated knife edge Gate valve to a sludge sump. Depending on the consistency of sludge, the operation timing of the valve (Pneumatic on/off valve + manual isolation) shall be set. Proper valving and flushing arrangement shall be provided to avoid clogging of the sludge line. The HRSCC shall be rugged and robust in design and shall be provided with higher capacity drive head and induction motor having high torque rating, centrally located, with positive sludge raking by means of two raking arms. Both the raking arms should have scraper blades fitted at the bottom, so that the sludge from scraper blades is pushed to the sump on every rotation. The unit shall have mechanical overload arrangement with a torque (load cell) indicating arrangement along with necessary contacts for tripping the motor in the event of overloading. This condition shall be annunciated. The unit shall have push button station, with continuous digital indication of torque, near the motor. Starter with push button shall also be provided in the control room, along with continuous torque indication and necessary switches and transmitter.

Indicative list of dosing systems for the HRSCC is as under:

1) Ferric chloride
2) Polymer

3) Lime Slurry
4) Soda Ash
5) Acid
6) Dolamite

The clarified water shall reduce the total suspended solids to match the design system requirement for letting into UF system.

UF Pre-Treatment

A UF system shall be installed to provide optimum feed water quality to the RO. It shall ensure that all particulate matter is removed from the feed water. The UF system shall be designed to provide full plant capacity with two trains in operation (50% x 2). 50% x 3 UF feed pumps shall be provided (2W+1S).

HIGH RECOVERY Reverse Osmosis

The UF effluent water from UF permeate tank is then pumped to RO units. The RO units consist of Cartridge filter to remove particles from the water > 1 micron. Sodium Bi-sulphite, Antiscalant shall be dosed at the inlet of cartridge filter for de-chlorination and scaling control respectively. The RO feed water passes through the cartridge filter and is sent to a high-pressure pump to overcome the RO membrane's osmotic pressure.

Sludge Treatment Units

The Sludge Blowdown from the HRSCC will be sent to a Sludge Thickener. Polymer will be added to further concentrate the sludge. The Thickener's Supernatant will be pumped back to the HRSCC feed, while the concentrated sludge will be pumped to a Centrifuge / filter press. The Drain of the Centrifuge / filter press shall be sent to the HRSCC, while the caked sludge shall be collected and stored properly.

Zero Liquid System

Crystallizer

RO reject waste from RO reject storage tank shall be fed into vapour compressor through Evaporator cum Crystallizer feed tank. Provisions shall be made to add Sulphuric acid or HCL / Caustic (NaOH), Anti scalant & Antifoam to the feed if required for process aspects. The Crystallizer shall generate crystal form of mixed salt, which shall be further processed through Pusher type salt centrifuge for disposal & dewatering.

1.2 Electrical:

The bidder shall provide all material, equipment and services so as to make a total Electrical System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Electrical System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

1.3 C&I:

The bidder shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Instrumentation and Control System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

2.0 BRIEF SCOPE OF WORK

1.0 The scope of work of the Tenderer covers design, engineering, manufacture/ fabrication, shop painting, shop testing, packing, transportation, transit insurance, unloading, storage at site, watch and ward, handling at site, erection, site testing, final painting and commissioning of entire mechanical equipment, Piping with valves and fittings, handling & hoisting equipment, associated civil work, steel structural work, electrical, instrumentation & control, illumination, telecommunication, air conditioning & ventilation etc. in accordance with the requirement of the proposed plant complete with interconnecting pipes and cables for the proposed Zero Liquid Discharge plant of inlet capacity 150 m3/hr. as per the technical specification outlined hereinafter on turnkey basis and the specifications laid down in various chapters in this document and also as per General Technical Specification.

The scope of work shall include the following activities:

i) Supply of all technical literature, drawings & documents, general arrangement drawings, assembly & sub assembly drawings of all the plant & equipment, construction & erection & as-built drawings, operation & maintenance manuals, etc.,

ii) Submission of all design calculations, data sheets, Inspection categorization plan, Quality assurance plan (QAP), Field quality plan (FQP) for various equipment's, pipeline sizing calculation and calculation for sizing of various sub systems and integrated systems for approval of KPCL / Consultant and finalizing the same as per approval of KPCL / Consultant.

iii) ZLD plant shall in general comprises of the following facilities:-

a. Collection and Treatment of the waste water in the existing CMB of RCC construction of capacity 5600 M3 with 24 hrs retention period. (KPCL Scope)

b. Pumping of waste water from CMB to Pre-treatment and Tertiary treatment facilities, which comprises of Flash mixer, HRSCC, Filter feed tank, Pressure sand filter, UF feed tank, UF system, RO feed tank, RO system, CW make up tank, RO reject collection tank, Back wash treatment tank etc. to process the total waste water collected in the existing Central Monitoring Basin as mentioned in the relevant chapters.

c. Zero Liquid discharge plant complete in all respect including Evaporator cum forced circulation Crystallizer with Mechanical vapour Recompression, Salt Centrifuge system and accessories.

d. Chemical dosing facilities for pre-treatment, UF-RO system and ZLD system.

e. Sludge handling and dewatering plant - HRSCC.

f. Drinking water system.

g. Make-up Water system from the ZLD system to CW forebay.

h. Service water system.

i. Area drainage /storm water drainage system of complete ZLD plant. The drainage, sewerage shall be connected to the nearest respective plant network.

j. Separate toilets 1No. each for Gents and Ladies for ZLD plant shall be provided. Fecal/sanitary sewage disposal from toilets/wash basin to main plant sanitary network / STP.

k. Associated electrical (HT & LT switch gears, MCCs, transformers, Cables, Laying of cables etc.) and Controls & Instrumentation/ Automation.

l. Material handling and hoisting facilities.

m. Civil and structural work.

n. Air conditioning / Ventilation system for applicable buildings and control room / MCC room.

o. Road connection/ interconnection road from Network of Road in the ZLD plant interconnecting different buildings/ units and connection to nearest Road.

p. Site levelling to terrace level, etc., including any approval required from statutory authorities.

q. Extension of instrument air pipeline from the nearby instrument air pipeline upto ZLD plant and further distribution inside ZLD plant.

r. A mini Laboratory with testing facility for analysis of important parameters like pH, residual chlorine, conductivity etc. shall be provided with necessary equipment. All chemicals, consumables shall be in the scope of the bidder till taking over.

s. Extension of Power required for the ZLD plant from the existing 6.6kV switchgear.

t. Extension of Steam required for the plant from LP steam line of HRSG of main Power Plant and further distribution inside ZLD plant.

u. Extension of Potable water and fire hydrant water from the nearest tapping point and distribution of the same inside/outside the ZLD plant.

v. Other miscellaneous systems required for completeness of work.

iv) Supply of commissioning spares & consumables till taking over.

v) Supply of Essential spares.

vi) MCC building with control room, PLC and other panels required for C&I, office room, and maintenance shed with a store in ZLD plant with furniture and Air conditioning and Ventilation facilities.

vii) Submission of MSDS (Material safety data sheet) for all chemicals used.

viii) Illumination facilities for the entire premises including roads.

ix) Pipe lines shall be laid above ground to the extent possible or underground and the same shall be decided as per site condition/during detail engineering.

x) Tenderer shall submit the tentative list of ten years Recommended spares along with the offer. However they shall submit final list of ten years operation and maintenance spares during detailed engineering along with technical specification and catalogues.

xi) Supply and handing over of special tools & tackles required for the system.

xii) All necessary connections for hook up with KPCL system at specified Terminal points/nearest available network.

xiii) Supply of erection, testing & commissioning materials.

xiv) Network flushing fluids, chemicals & consumables.

xv) First fill of oils, lubricants, filter media, chemical reagents and other consumables including supply till taking over.

xvi) Procurement and supply of dosing chemicals required for water treatment and disposal of empty cans/container from the plant area till taking over.

xvii) Handing over the entire system in good running condition after completion period with the fulfilment of above.

xviii) Participation in design review / site co-ordination meetings with KPCL / Consultant as and when called for.

xix) Fulfilment of guarantee of all plant & equipment, sub systems.

xx) Pipeline structural stockades, bridges, R.C.C pedestals for overhead pipelines.

xxi) Pipeline supports, thrust blocks / anchor blocks, etc.

xxii) Inspection and performance testing of individual equipment and system as a whole.

xxiii) Statutory Clearances required for the successful establishment and operation of the ZLD Plant, if any.

xxiv) Facilities to hook up the required data of the ZLD system / water parameters to the pollution control boards or any other statutory authorities.

xxv) Operation & Maintenance of plant and equipment on 24x7 basis for a period of one year after handing over / issue of Notice To Proceed (NTP) as the case may be. Consumables and Chemicals are in the scope of KPCL during O&M period.

xxvi) ZLD Plant shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant will be deemed to be included under the scope of work of the Tenderer. Detailed scope of work for electrical, Instrumentation, Automation and control, Civil, Architectural, Structural, Material Handling, Air Conditioning and Ventilation, Instrument Air etc. have been specified in the relevant chapters of this specification.

1.01 ZLD plant buildings / sheds / structures housing equipments like pump sets, filters, treatment plant, handling facilities, valves, pipe & fitting, along with associated electrical, instrumentation, material handling in complete manner.

1.02 Back wash water tank & waste water tank comprising pumps, handling equipment, valves, pipe & fitting along with associated electrical, controls & instrumentation.

1.03 Fire fighting facilities, as per TAC and NFPA norms (Portable fire extinguishers, Water spray system, Fire detection & Alarm system and if any).

1.04 Water based fire fighting system comprising valves, pipe & fitting, along with requisite nos. of Yard hydrants and landing valves, piping network etc. Tapping to be taken from nearest fire water network of Power Plant.

1.05 The Tenderer shall prepare and submit along with his offer the detail layout drawing, P & I diagram and duly dimensioned general arrangement drawings of each unit of ZLD system taking due consideration of maintenance space and approach roads.

1.06 Collection / generation of design and site data within 15 days from the date of issue from the award of Contract with respect to the following.

a. Collection of all input design data. However indicative data is provided separately in the specification.

b. Safety and security for man, machine, materials etc.

c. Construction of temporary road, stores, offices, etc. for movement of man, machine and material wherever required.

d. Arrangement of water and power for office, yard, stores, fabrication and construction works, pipeline testing, flushing etc.

1.07 Tenderer shall furnish comprehensive mechanical engineering, civil engineering, electrical & Instrumentation engineering and structural engineering design drawings for pump houses, tanks, waste water pre-treatment plant with HRSCC & UF-RO System, Zero Liquid Discharge plant, electrical rooms, pipe trestles, area drainage network, sewerage system etc. for approval.

1.08 Pumps, waste water pre-treatment plant, pressure filters, material handling facilities, chemical dosing system, Filtration plant, UF-RO based treatment plant, sludge handling plant, zero liquid discharge plant, Salt centrifuge, valves, pipes, fittings and accessories along with associated electrical, instrumentations, PLC and other equipment selected for the project shall conform to relevant Indian or other reputed international standards with regard to materials of construction, dimensions, manufacture, testing and acceptance criteria.

1.09 Detailed Chemical analysis of water parameters at all stage of the process and relevant UF and RO projection certified by the OEM shall be furnished with the offer.

1.10 ZLD Plant shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant will be deemed to be included under the scope of work of the Tenderer. Detailed scope of work for electro-mechanical, Control & Instrumentation, Automation, Civil, Architectural, Structural, Material Handling, Fire fighting facilities, Air Conditioning and Ventilation etc. have been specified in the relevant chapters of this specification.

Scope of work given is only indicative. Detailed scope has been described in the bid document which is binding on all the bidders. Any other item not covered herein but essential for successful installation and commissioning of the system and integration of the system shall be included in the scope by the bidder.

3.0 TERMINAL POINTS AND EXCLUSIONS

3.1 TERMINAL POINTS

3.1.1 MECHANICAL

1.0 Scope of collecting the waste water from different points and to collect the same in existing CMB lies with KPCL. Bidder scope starts after CMB.

2.0 CMB Blended Waste water analysis (CW blow down, RO plant reject and N-pit) is appended in table-2 and the tenderer shall consider this waste water analysis as a basis for designing the ZLD Plant.

3.0 DRINKING WATER

Tenderer shall plan to extend drinking water for the said plant from the proposed drinking water network which will be made available to the successful Tenderer at only one point.

4.0 FIRE WATER SYSTEM

Tenderer shall plan to extend firefighting water with an isolation valve for the entire area (inside & outside up to peripheral area of the proposed ZLD plant covering roads) from the existing fire water network of the power plant which will be made available to the successful Tenderer at only one point (Coordinates shall be finalized during engineering). Tenderer will indicate pipe size, end connection, MOC of pipeline, etc. at the tap-off point.

5.0 TREATED WATER FOR REUSE AS MAKE-UP

Treated water pipeline from CW make up tank shall be laid upto the CW fore-bay and the co-ordinates points to be decided during the detailed engineering. Pipe lines shall be laid above ground to the extent possible or underground and same shall be decided as per site condition/during detail engineering.

6.0 TAKE OVER POINT FOR STEAM

Tenderer shall plan to extend the steam piping with necessary isolation valves for the proposed system from the existing HRSG LP Steam piping with or without using the PRDS at only one point. Coordinates are shall be finalized during detail engineering.

7.0 TAKE OVER POINT FOR INSTRUMENT AIR

Tenderer shall plan to extend the instrument air piping with necessary isolation valves for the proposed system from the existing network of instrument air piping at only one point. Coordinates shall be finalized during detail engineering.

3.1.2 ELECTRICAL

1.0 For Construction power supply, 11kV AC power supply from nearest source/ substation shall be provided.

Bidder shall supply construction power distribution boards and power cables from nearest source / substation. Supply, laying, erection, testing and termination at both ends of incoming power cable to bidder's construction power distribution boards lies with bidder.

2.0 Two nos. of 630A spare feeders in 6.6kv switchgear, one transformer feeder and one motor feeder in section A & B will be provided to the bidder for his further establishing the required switchgear for ZLD system. All necessary modification like upgradation of breakers, down comers, relays & related protection components wiring etc. to suit the ZLD system are in bidder scope. The laying of cable from breaker onwards, cable termination (both ends), etc., is also under the scope of the bidder.

3.1.3 CIVIL

The terminal points for Roads, Sewerage line and Drains are as under:

1.0 **Roads:** All approach roads interconnecting all facilities under ZLD plant and their connections to the Main plant roads at suitable locations.

2.0 **Sewerage line:** Upto existing connection chamber / manhole nearest to the toilets. However, if no chamber / manhole exists, the bidder shall provide the same with proper connections.

3.0 **Drains:** All garland drains/ local drains for effective drainage of rain water at all facilities and roads under ZLD plant and their connections to the Main storm water drainage network at suitable locations.

3.2 EXCLUSION

3.2.1 Mechanical:

1. Central Monitoring Basin (CMB).
2. Disposal of HRSCC Sludge cakes from Centrifuge / Filter press.
3. Disposal of Mixed Salt from Salt Centrifuge.

3.2.2 Civil

1. STP

4.0 TECHNICAL SPECIFICATION AND DESCRIPTION OF WORK

In order to comply with the statutory requirements, it is envisaged to install a ZLD Plant to treat waste water generated from different areas of the Yelahanka Combined Cycle Power Plant mainly comprising of Cooling tower blow down water, RO reject and Neutralization Pit outlet collected in existing Central Monitoring Basin. It comprises of Pre-treatment plant, Sludge handling system, Ultra Filtration-Reverse Osmosis (UF-RO) system to obtain acceptable quality of water for reuse for CW make up along with Zero liquid discharge concept with Evaporator cum Crystallizer and salt centrifuge.

Please refer the Process Flow Diagram - KPCL/Bid drawing/001

Tenderer shall prepare layout for the treatment units in ZLD plant based on available space and shall design, supply, erect, commission and establish guaranteed performance parameters of the ZLD Plant.

The equipments/units mentioned below are tentative and the same shall be finalised during engineering. Any other equipments required for successful completion of primary treatment system shall be supplied by bidder and the same shall be as per System requirement.

i) Waste water feed pumps from CMB to Flash mixer – (1W+1S)
ii) Flash Mixer – 1 No
iii) HRSCC - 1 No.
iv) Underflow sludge collection sump - 1 No.
v) Sludge transfer pumps - 2 Nos. (1W+1S)
vi) Sludge thickener - 1No
vii) Centrifuge / Filter press -1No.
viii) Sludge sump agitator - 1 No.
ix) Clarified water storage tank – 1 No.
x) NaOCl Dosing System, Lime/ Dolomite, FeCl3, Polymer dosing facilities – 1 complete set as reqd. with chemical dosing tank (1 No.) and dosing pumps (2 Nos. - 1W+1S) for each type of chemical.
xi) Sludge drying bed

Tertiary treatment units.

The equipments/units mentioned below are tentative with 2 stage RO and the same shall be finalized during Engineering. Any other equipments required for successful completion of tertiary treatment system shall be supplied by bidder and the same shall be as per system requirement.

i) Filter feed pumps – 2 Nos. (1W+1S)
ii) Pressure sand filter – 2 Nos. (1W +1 S)
iii) PSF Backwash water pumps - 2 Nos. (1W+1S).

iv) Blowers for PSF Backwash - 2 Nos. (1W+1S).
v) Common Backwash collection tank – 1No.
vi) Backwash transfer pumps - 2 Nos. (1W+1S)
vii) UF feed tank - 1No.
viii) UF feed pump with VFD – 3 Nos (2W+1S).
ix) UF Self-cleaning strainer - 3 Nos (2W+1S).
x) Ultra-filtration system with advanced membrane technology - 2 Trains (2W), each train of 50% capacity.
xi) UF Air blower - 2 Nos. (1W+1S).
xii) UF Permeate storage Tank (1No)
xiii) UF Back wash pump - 2 Nos. (1W+1S)
xiv) Required Chemical cleaning system (CIP) for UF
xv) RO feed Pumps - 3 Nos (2W+1S for each RO stage)
xvi) Cartridge filters – 3 Nos. (2W+1S for each RO stage)
xvii) High pressure pumps with VFD– 3 Nos. (2W+1S for each RO stage)
xviii) RO modules – 2 trains (2W, each train of 50% capacity for each RO stage)
xix) RO-1 reject collection tank – 1 No.
xx) Chemical dosing facilities for UF & RO system – 1 complete set as reqd. with Chemical dosing tank (1 No.) and dosing pumps (2 Nos. - 1W+1S) for each type of chemicals.
xxi) Chemical cleaning for RO (CIP) and flushing facilities – 1 set common for all stages.
xxii) CW make up storage tank - 1 No.
xxiii) CW make up transfer pumps – 2 Nos. (1W+1S)
xxiv) pH correction system for CW make up water.
xxv) Final RO Reject storage tank - 1 No. (Capacity 500m3)
xxvi) RO reject transfer pumps - 2 Nos (1W+1S)

Zero Liquid discharge Plant comprising of (Tentative):

i) Evaporator based system along with Auxiliary – 1 complete set
ii) Chemical dosing tanks & pumps - 1 complete set as reqd. with Chemical dosing tank (1 No.) and dosing pumps (2 Nos. - 1W+1S) for each type of chemicals.
iii) Any other facilities required for successful commissioning of ZLD Plant
iv) The equipments/units mentioned below are tentative and the same shall be finalised during engineering. Any other equipments required for successful completion of ZLD system shall be supplied by bidder.

Table-1

Sl. No	Equipment
1.	Crystallizer feed Tank – 1 No.
2.	Vapour Head & Brine concentrator – 1No.
3.	Deaerator with Packing Ring Bed – 1 No.
4.	Forced Circulation Heat Exchanger – 1No

5.	Feed Pre-Heater – 1No.
6.	Distillate Tank – 1No.
7.	Mechanical Vapour Compressor – 1W
8.	Salt drying system (salt centrifuge) – 1No.
9.	Crystallizer recirculation Pump – 1W
10.	De- aerated Solution Feed Pump – 1W+1S
11.	Condenser – 1No.
12.	Distillate tank – 1No.
13.	Distillate transfer Pump- 1No.
14.	Centrate tank with pump – 1W+1S
15.	Crystallizer Dump tank with pump – 1No.
16.	Caustic Dosing Tank – 1No.
17.	Caustic Dosing Pump-1W+1S
18.	Recirculation Duct - 1No.

Table-2

Sl. No.	Description
1.	Crystallizer feed Pumps with Motor – 1W+1S
2.	Hcl dosing Tank – 1No.
3.	Hcl dosing pumps – 1W+1S
4.	NaOH dosing Tank – 1No.
5.	NaOH dosing pumps – 1W+1S
6.	Antifoam dosing Tank with Agitator – 1W
7.	Antifoam dosing pumps – 1W+1S
8.	Antiscalant dosing Tank with Agitator – 1No.
9.	Antiscalant dosing pumps-1W+1S
10.	Boil out / dump Pumps with motor
11.	Valves for ZLD system
12.	ZLD alloy Piping

NOTE: Number of effects shall be as per system requirement.

Following associated works shall be considered by bidder.

1. Pipe trestles for inter plant pipelines.
2. Any other treatment process which is essential for proper functioning of Evaporator shall be proposed and adopted by the Successful bidder.
3. Sanitary sewerage system for toilets / wash basins.
4. Area drainage/ storm water drainage for the ZLD Plant.
5. Supply of treated effluent as make-up to cooling tower of existing plant.
6. Make-up, drinking, fire water system.
7. Service and potable water and instrument air facility.
8. Associated electrical and Control & Instrumentation/ Automation.

9. Material handling and hoisting facilities.
10. Civil and structural work.
11. Air-conditioning and ventilation system.
12. Fire protection and detection and alarm system.
13. Other miscellaneous systems required for completeness of work.

Indicative list of chemicals for the ZLD system are as indicated below. Tenderer shall submit the quantity of chemicals to be dosed along with dosage calculations.

1. Lime
2. Dolomite
3. FeCl3
4. Polymer
5. Hypo
6. Antiscalant
7. SMBS
8. Acid (HCl)
9. Poly Electrolyte
10. Poly dosing
11. Caustic dosing
12. Chemical dosing for pH correction
13. Chemically Enhanced Backwash (CEB) chemicals/Clean-In-Place (CIP) chemicals
14. Chemicals for reject hardness removal

a) Lime
b) Soda ash
c) FeCl3
d) DWPE

15. Chemicals for evaporators
16. Any other chemical required for successful operation and commissioning

Data sheet, GA & CS of chemical dosing system and all the equipments to be submitted during detailed engineering along with material safety data sheets.

4.1 DESIGN CONSIDERATION

ZLD plant comprising of waste water pre-treatment plant with UF-RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories is proposed for the treatment of waste water generated from the Power Plant for further reuse as make up to cooling tower of the plant. The ZLD plant shall consist of pre-treatment plant to treat the incoming effluent to the quality as acceptable for the RO plant.

The Tenderer shall, in general, give careful attention to pre-treatment programme to protect the RO elements and in particular, the compatibility of various processes adopted. The design of the system shall be based on 25 percent degradation in the incoming effluent water quality indicated in Table-2. If the hardness in the RO reject (which will be fed to Evaporator) is on higher side which may affect the evaporator then necessary treatment facilities shall be provided by the bidder.

To satisfy the performance requirements, it will be imperative to consider both pressure and temperature effects and to size the RO trains accordingly within the limitations of the selected high pressure pump performance.

The UF-RO system shall be sized to produce the rated output and quality for the entire system for 25 years life with warrantee as follows.
3 years of pro-rata warrantee for the RO membrane.
3 year CLIF warrantee and 5 year pro-rata warrantee for UF Membrane.

Tenderer shall also include necessary additional pre-treatment facilities for removal of any other specific constitutes which may be detected during subsequent detailed analyses of waste water collected and may cause membrane fouling.

4.2 PROCESS DESCRIPTION

The ZLD plant shall have following stages of treatment scheme for satisfying the norms of treated water quality.

1. Primary Treatment comprising of Equalization cum collection tank, Flash Mixer, High Rate Solid Contact Clarifier, sludge drying plant.
2. Tertiary Treatment comprising of Multi Grade Filter and Advanced membrane technology comprising of Ultra Filtration and Reverse Osmosis.
3. Zero Liquid discharge Plant

Whereas basic pre-treatment required for membrane separation process have been highlighted in this specification, the Tenderer shall, in general, give careful attention to pre-treatment programme to protect the RO elements and in particular, the compatibility of various processes adopted.

4.2.1 Main Components of the System

1. FLASH MIXER WITH AGITATOR AND MOTOR

The raw effluent from equalization tank shall be pumped to flash mixer unit, where Lime, Dolomite etc., as per design shall be added to increase the PH of effluent, for reduction in silica content of effluent and to enhance the settling of solid particles present in effluent.

2. HIGH RATE SOLID CONTACT CLARIFIER (HRSCC)

After Chemical reaction with the lime and dolomite etc., the effluent shall enter under gravity to Ultra High Rate Solid contact clarifier where FeCl3 and Polyelectrolyte etc., as per design shall be dosed in the effluent.

The incoming solids brought in contact with a solid layer near the bottom. The incoming solids rise and come in contact with solids in the sludge layer.

This layer act as a blanket and the incoming solids agglomerate and remain enmeshed within this blanket.

The clarified water rises upward while a distinct interface retains the solids below.

The Solid contact clarifier has better hydraulic performance and has minimum retention time for effective solids removal.

HRSCC shall be suitably designed for hardness and suspended solids load from the incoming blended water streams. The precipitated mass settled down as sludge shall be swept by a raker arm which shall further be discharged into a sludge pit by gravity. Proper valves and flushing arrangements shall be provided. The tank and structural support design is completely self-supporting for continuous service and compatible for supporting external loads such as walkways and ladders. The raker arm shall have load cell for overload protection/lifting. Torque transmitter shall be provided with indication in PLC. HRSCC torque rating shall be designed for 20% (w/w) sludge consistency.

The underflow sludge from the HRSCC shall be removed under gravity by means of timer operated knife edge Gate valve to a sludge sump. Depending on the consistency of sludge, the operation timing of the valve (Pneumatic on/off valve + manual isolation) shall be set. Proper valving and flushing arrangement shall be provided to avoid clogging of the sludge line. The HRSCC shall be rugged and robust in design and shall be provided with higher capacity drive head and induction motor having high torque rating, centrally located, with positive sludge raking by means of two raking arms. Both the

raking arms should have scraper blades fitted at the bottom, so that the sludge from scraper blades is pushed to the sump on every rotation. The unit shall have mechanical overload arrangement with a torque (load cell) indicating arrangement along with necessary contacts for tripping the motor in the event of overloading. This condition shall be annunciated. The unit shall have push button station, with continuous digital indication of torque, near the motor. Starter with push button shall also be provided in the control room, along with continuous torque indication and necessary switches and transmitter.

Indicative list of dosing systems for the HRSCC is as under:
1) Ferric chloride
2) Polymer
3) Lime Slurry
4) Soda Ash
5) Acid
6) Dolamite

The clarified water shall reduce the total suspended solids to match the design system requirement for letting into UF system.

The sludge generated from HRSCC will be collected in sludge sump and will be pumped to sludge handling system.

Flax mixer and HRSCC shall be of RCC construction conforming to civil specification indicated in the technical specification.

3. Clarified Water Storage Tank

The treated effluent from the HRSCC is collected in the filter feed tank. The tank is provided with sufficient retention time and RCC of construction. Acid dosing is provided to reduce the pH. The effluent from the filter feed tank is pumped to the Multi grade Pressure Sand Filter with the help of filter feed pumps.

4. PRESSURE SAND FILTER (PSF) and Filter Feed Pump

The water from the clarified water storage tank shall be transferred to PSF via filter feed pumps, where it removes the suspended solids from the water and also to reduce the load on next filtration unit so that the UF can be operated at low load without frequent shutdowns.

The Pressure Sand Filter consists of a multiple layer of sand with a variety in size and specific gravity. These Filters are designed to remove turbidity and suspended particles present in the feed water with minimum pressure drop. These Filters are custom designed to suit the process requirement.

The arrested solids/ turbidity in the filter shall be removed by back washing and collected in back wash tank.

The design, fabrication, inspection and testing of the PSF shall confirm to IS: 2825- 1969 (RA 1984).

- Back wash cycle for each filter shall be once in every 24 hrs. The unit is isolated for backwash, when the pressure drop across the bed increases than specified limit (0.5 Kg/cm^2) or quality of filtered water deteriorates, whichever is earlier.
- The surface loading shall be 12 m3/h/m2.
- Media traps shall be provided at the outlet of each filter.
- Suspended solids content in the filtered water shall not exceed 5 ppm.
- PSF shall be of vertical/horizontal type and shall be provided with built in legs with proper supports to the concrete.
- PSF shall be made of MS epoxy painted vertical/horizontal vessel.
- Minimum shell thickness shall be 10 mm and for dish end minimum thickness shall be 12 mm. 20 % spot radiography of weld shall be carried out.
- The filter shall be provided with unfiltered water distributors and header lateral type under-drain collecting system.
- Maximum pressure loss across the filters should not be more than 5 mWc.
- The minimum depth of filtering media bed shall be decided on the basis of the filter media offered and shall not be less than 750 mm. Atleast 60% of free board shall be provided over the filtering media bed.
- The PSF shall have air scouring facility prior to backwashing for which the Tenderer shall provide two air blowers (1W + 1S) complete with accessories and entire piping with valves.
- Process of the backwashing and bringing the filter to the normal stream to be done automatically. Backwash water collection tank and pumps (1W + 1S) of suitable capacity and head shall be provided.

- Necessary piping system and control valves shall be provided for the filter for smooth operation. The same shall include influent water inlet, filtered water outlet, backwash water inlet, waste wash water outlet, air scouring inlet, air vent, drain cock, sampling cocks etc. All valves shall have flanged connections and shall be supplied by the Tenderer with matching flanges, nuts, bolts and gaskets.

- PSF shall be provided with access manholes of minimum 500 mm size for enabling the filling and changing of filter media and for maintenance purposes.

- Sampling points along with valves for inlet and outlet water shall be provided.

- Inspection opening shall be provided to inspect the internals and filtering media.

- The PSF vessel shall be internally painted with 3 coats of anti – corrosive paint and shall be coated externally with a protective paint.

- An orifice board for indicating the wash water flow. It shall be fitted in the drain sump.

- An initial charge of filter media.

- Valves used in frontal piping for PSF shall be pneumatically operated, diaphragm valve.

5. UF feed tank and UF feed pumps

The treated water from the PSF shall be collected at UF feed tank. UF feed tank is provided with sufficient retention time and RCC of construction. The water stored in UF feed tank is pumped to the Ultra filtration through self cleaning strainers with the help of UF feed pumps with VFD where the suspended solids are removed.

Requirement of feed tank shall be decided by the bidder as per the design and system requirement.

6. Ultra Filtration Treatment

Filtered water collected in the UF feed tank shall be transferred to UF system via UF feed pumps with VFD through self cleaning strainer to provide optimum feed water quality to the RO. It will ensure that all particulate matter is removed from the feed water. The UF system will be designed to provide full plant capacity. The train configuration shall be 2X50%.

Piping MOC from UF feed tank to UF system shall be of CPVC / GRP.

Type of UF system shall be Pressurised or Sub merged one with membrane MOC of PVDF. Minimum 90% recovery shall be considered for the UF system with a minimum net flux rate of 50LMH @ 28 deg C with 3 year CLIF warrantee and 5 year pro-rata warrantee for UF Membrane.

ULTRA FILTRATION MEMBRANES filtration module shall be used for the removal of colloidal matters, suspended solids & pre-treatment to reverse osmosis system. It also helps in removing COD, BOD to some extent due to separation of solids.

Pressurized / Submerged automatically operated Filtration system shall be provided. Removing of solids from the water will help in reducing the COD, BOD, organic matter content in the water.

The reject / Waste generated from the Ultra filtration shall be taken back into the common back wash collection tank and from where it will be pumped inlet of HRSCC / Flash mixer Tank.

This system will have the facility of automatic valves provided on the backwash & reject line to facilitate on-line backwashing. This function shall be controlled and monitored by PLC operation and hence avoid any manual operation or supervision.

FOR PRESSURIZED UF:

Contractor shall use Hollow Fiber type Ultrafiltration, each train assembled as a skid complete with piping, valves (Manual, On/Off and Control), instruments, junction boxes, motor starters panel (if applicable) and PLC based controls with HMI (when common plant PLC and HMI is not available). The piping material shall be UPVC, FRP, SS 316 or eq as necessary to the plant design. The plant shall be designed for automatic operation with integral controls and interlocks for safe operation.

The hollow fiber shall be of PVDF (Polyvinylidene Fluoride) material, having 0.02 Micron Nominal pore diameter and shall be of reinforced type, and the fibers shall be fixed at both the ends. The flow path configuration shall be outside-in with air scouring facility during the backwash.

The contractor may choose to use Modular, Rackless PUF modules to reduce foot print, simplify piping etc. with the above hollow fiber modules specifications.

Proper screening (≤ 500 Micron screen) of feed water / wastewater to the PUF system shall be provided to remove larger particles.

Each PUF train shall be provided with minimum of 15% spare space as blank spaces within the rack design or as approved by the membrane manufacturer.

Flux: The design flux rate shall be selected to filter all flow conditions at the lowest specified design temperature. The net flux rate shall not exceed 50 lmh @ 28^0C.

Minimum Recovery of 90% shall be provided in the PUF system.

The membrane should have cleaning pH range of 2-12 and maximum chlorine concentration of 1000 ppm (as NaOCl).

Membranes shall be capable of regular backwashing automatically through backwash pump with and without cleaning chemicals to minimize pore fouling.

Clean-In-Place System: The membranes shall be cleaned “in-place” without removal from the membrane tank or as recommended by the membrane manufacturer.

Automation & Control:

- PLC based automation system with application software. Automation to control pumps, blowers, agitators, VFDs, limit switches (if applicable) and Instrumentations in the system, including I/Os with 20 % spares, power supplies, UPS, etc.
- Standalone/ or integrated PLC panel having Suitable PLC.
- Instrumentation shall include Flow Indicating Transmitters, Pressure Indicators, Pressure Switches, Pressure Transmitters, Turbidity meters, Level Transmitters, Level Switches and any other Instruments as needed for proper operation and maintenance of the plant.
- HMI Panel to comprise of entire process and operator software with dynamic flow charts, pictures, screens, alarms, historical trends, reports etc.

FOR SUBMERGED UF SYSTEM:

UF feed water shall be sent to the membranes tanks via a flow control valve that will be used to maintain the membrane tank level.

The UF membranes are submerged into the membrane tanks and UF permeate is pulled through the membranes (from out to in) by a vacuum

created by the permeate pump. The flow rate of the permeate pump is decided from a level in the permeate tank.

To reach the required recovery, the permeate volume should be integrated over time for each filtration cycle. When the calculated permeate volume is reached, the feed valve to the train will close and the permeate pumps will remain on until the water level drops to the cleaning level. At this point, permeation will stop and the tank will go into aeration/backwash mode followed by a tank drain.

UF permeate is stored in the RO feed tank. To maintain optimum performance of the UF membranes the system will periodically perform the following processes.

Backwash

To maintain permeability that is lost as the membrane fouls over time, the system periodically reverses the permeate flow direction while simultaneously scouring the outside of the fibers with air.

No water is drained during the backwash sequence. When a backwash is due the feed valve to the train to be backwash will be closed and the permeate pump will be allowed to draw down the tank level to a level set point. Once this set point is reached the permeate pump will stop and the system will be allowed to backwash.

After the backwash has finished the feed valve will open and the permeate pump will
start once the operating tank level is reached.

This procedure shall typically happen approximately every 15 - 20 minutes (but may be adjusted dependent on the nature of the feed water) and can last approximately 60 seconds including for valve changeovers.

No chemicals are added during this procedure.

Tank Drain

To maintain the system recovery and control the solids accumulation in the membrane tank the system will periodically drain the tank (Full Drain).

Time taken to drain and fill the membrane tank should take no longer than 4 minutes and the feed system should be suitable sized.

This procedure shall occur depending on the system recovery and will typically occur every 1.5 to 2 hours

Air Scour

To minimize solids accumulation in the membrane cassette the system shall introduced air to the bottom of the cassette which is allowed flow up the outside of the fibers providing a scouring effect.

This procedure shall typically only happen during backwash only.

Maintenance Cleaning

The system shall periodically (pre-determined set point) perform maintenance clean with the purpose of pro-actively maintaining membrane permeability and manage membrane fouling. These cleanings are fully automated.

The Clean in Place (CIP) tank shall be filled with permeate from the permeate channels. Before MC, the aeration and backwash sequence followed by the tank drain sequence (similar to the one described above during tank drain) shall be performed.

The water is pumped from the CIP tank to the membrane tank and the required dosing pump will start to dose the chemical to reach the set cleaning concentration. The duration for the soak in the membrane tank is about 15 min. After soaking the chemical solution is pumped back to the CIP tank to drain the filtration tank. The retained cleaning solution within the membrane fibers and permeate header has to be washed out by a rinse cycle, to avoid residual chemicals entering the clean water system. This is done by back pulsing for about 15 seconds into the empty filtration tank while the drain valve is kept open.

Finally, the membrane tank is refilled with influent by opening the feed valve until the required level within the tank is reached, and the filtration process will be resumed.

Recovery Cleaning

A Recovery Cleaning (RC) follows the MC-procedure but the re-circulation time is 5 hours instead of 15 minutes. Because of the occurrence of these subroutines the instantaneous flows through the system shall be higher than the net flow required. The backwash tank is sized to allow for buffer during backwashing, and subsequent buffer will be additional.

7. RO feed tank and RO feed pumps

The treated water from the UF system is collected at the RO feed tank. RO feed tank is provided with sufficient retention time and of RCC construction. The water stored in RO feed tank is pumped to the cartridge filters with the help of RO feed pumps where the particles greater than 3 microns are removed.

Piping MOC from UF systems and RO feed tank, Cartridge filter and upto RO stage -1 HP pumps suction shall be CPVC/GRP.

8. Micron Cartridge Filter (MCF) and RO feed Pumps

MCF shall trap colloidal particles up to a size of 3 microns. Micron filtration eliminates possibility of regular clogging of the membrane surface and is a standard prerequisite before RO membranes. The cartridge filter consists of disposable, integrally wound, polypropylene cartridges. The filter housing is designed for a suitable operating pressure and not less than 2.0 kg/cm2.

The Cartridge Filter acts as a safeguard unit before RO to remove any particles formed at the upstream of RO due to chemical reactions after chemical injection in the RO Feed and to remove any organic matter comes out of the feed tank over a period of time. Cartridge filter body along with internal support parts shall be of suitable MOC. The cartridge filter is provided with differential pressure switch. Differential pressure high alarm facility is provided in the Control Panel and it indicates cartridge replacement time.

Automatic online Silt density index measurement shall be provided after Cartridge filter to automatically and consistently monitor the silt density index of RO feed water.

9. REVERSE OSMOSIS SYSTEM AND RO HP PUMPS

The treatment system for the water from the cartridge filter shall be sent to RO system via RO HP Pumps with VFD. RO train configuration shall be (2X50%) with advanced membrane technology. The RO system shall be sized to produce the rated output and quality for the entire life of the system 25 years and RO Membrane shall be of pro-rata warrantee of 3 years. As such, initial operating pressure at any temperature shall be maintained at a minimum value to keep the membrane compaction rate within the design value. High pressure pumps shall be selected to permit inlet pressure adjustments to be made to compensate for membrane compaction and temperature variations.

REVERSE OSMOSIS SYSTEM

Pre-treated water after adjustment of pH and chemical conditioning shall be pumped by high pressure pumps (two working and one standby pump for two trains) into reverse osmosis trains (2 working trains with each streams of 50% capacity) with overall minimum RO system recovery of 95% with minimum net flux rate of 18LMH @28 deg C. MOC of the RO membrane shall be of Polyamide.

The permeate from pressure tubes of R.O. blocks shall be combined and shall flow to the Permeate water storage tank which shall be transferred to CW make up tank via RO permeate transfer pump.

Provision shall be made for flushing of the system automatically after each shutdown so as to prevent the precipitation of sparingly soluble materials on the membrane surface during periods of shutdown. pH of the permeate shall be corrected by caustic soda.

The alkali dosing system shall consist of one alkali preparation tank, one alkali day tank and two alkali metering pump. Alkali preparation tank shall be fitted with agitator for making solution using flakes.

The treated effluent after passing through filtration is taken into to RO system. Sodium Bisulphite and Antiscalant will be dosed in RO feed water prior to Cartridge Filter for trouble free and efficient operation of the RO system. Two Stage RO systems are provided for high recovery and to reduce the load on zero liquid discharge plant.

Sodium Bi-sulphite dosing system - The SBS Dosing System is provided to remove traces of chlorine present in raw water to protect the RO membranes. Also provision of shock dosing of SBS is made in case of any excess free chlorine coming in to safe guard RO membranes

Acid Dosing System - To adjust Feed pH and thus prevent carbonate scaling in the membrane elements. (if reqd as per process condition)

Dosing of SBS and anti scalant in the RO Feed is to be done to make sure that the Feed Water, free from Chlorine and Scaling tendency on the Membranes is controlled within the limits. The system comprises of two dosing pumps and one solution tank.

Micron Cartridge Filter (6 Nos., 2 (1W+1S) for each RO HP pumps) shall be provided to remove fine colloidal suspended impurities, which has escaped from upstream units. The unit shall reject fine solids upto 3 µ, which if carried over can clog the RO membrane. The unit shall be fitted with PP

wound cartridge, which shall have more dirt holding capacity compared to other standard type of cartridges.

The RO system shall comprise of R.O. membranes housed in FRP Pressure Vessels. All interconnecting low-pressure from and chemical dosing piping shall be of Extra Strong CPVC / GRP and high pressure piping shall be of Stainless Steel – SS316. Reject line piping shall be Duplex SS. Necessary instrumentation to be provided to monitor the operation of the system.

Dedicated Chemical Cleaning System comprising of a Chemical preparation tank, a Centrifugal Pump in SS 316 Construction and a cartridge filter unit (CSRL) shall be provided. Recovery from RO Plant shall be as indicated in Performance guarantee chapter.

AUTOMATION PHILOSOPHY

The Cross flow Ultra Filtration system will have automatic operation. Necessary tripping facilities shall be provided through PLC for safe operation of the system. When the system trips, there will be visual display in the panel and also annunciation to this effect. Necessary cleaning systems of Ultra filtration membrane as well RO membrane to be provided.

EQUIPMENT SPECIFICATION

The proposed UF-RO plant shall be housed in a building. The building shall house Self-cleaning strainers, cartridge filters, high-pressure pumps, UF modules, RO modules, various chemical dosing facilities, Permeate water pumps, chemical cleaning and flushing facilities and CIP system. The Tenderer shall plan the permeate tank outside the RO plant building. The building shall be provided with suitable material handling and ventilation facilities. All liquid chemical dosing systems shall be housed in a dyke area adjacent to UF-RO building.
All solid chemicals storage and dosing systems shall be envisaged in a separate chemical house.

Provision for storage of all chemicals for meeting at least one month requirement shall be kept.

ANTI-SCALANT DOSING

The Antiscalant Dosing System is provided to prevent precipitation of sparingly soluble salts and hence to inhibit scale formation on RO membranes. Two dosing tanks in MSRL construction will be provided along with SS 316 agitator for dosing of Anti-Scalant in the feed to the cartridge filter. The pumps are calibrated to dose a pre-set quantity of the chemical.

Pumps shall be provided as per the guidelines mentioned in relevant sections.

HIGH PRESSURE PUMPS

Each Reverse Osmosis Skid shall be fed with high pressure feed water from RO High Pressure pumps with configuration of 3X50%. The VFD RO High Pressure pumps shall be an inline pump made of Stainless Steel. The pump may be multistage or single stage as per system pressure requirements.

Pumps will be mounted on the respective RO skid and reserve pump shall be supplied which will also be mounted on RO skid. VFD shall be provided for each high pressure pump installed for RO system.

R.O. TRAINS (BLOCKS)

The R.O. train shall be installed having capacity to meet the required through-put. 2 Trains (2W) shall be provided each train of 50 % capacity of the total flow. RO train shall be equipped with valves, piping work, flushing and cleaning connections, instrumentation and control console. R.O. train shall be an integrated assembly of high strength fiber glass reinforced epoxy thermally cured pressure tubes housing the R.O. membrane elements, feed, product and concentrate piping, all mounted on a high strength steel structure.

RO train shall receive high pressure feed water through the control valve at discharge of each High Pressure pump and in Reject discharge of each RO Skid which will be preset to a specific operating pressure to maintain design permeate flow rate. Necessary protection device shall be provided against potential start-up surge pressures. High pressure alarm system shall be provided to prevent excess pressure on the feed side. In feed and Reject line magnetic type flow indicator transmitter to be provided.

Pressure tubes shall be arranged in a series/parallel array to achieve the desired water recovery.

The membrane elements shall be spiral wound composite polyamide membrane elements. Design of the system shall entail careful balancing of RO membrane distribution in various banks to simultaneously achieve both the capacity as well as quality for each train. Product water tube shall be fibre glass reinforced epoxy pipe.

An alarm system shall be provided for alerting the operators when fault conditions will occur and the plant shall be shut down automatically in the event of critical failure conditions.

RO MEMBRANE CLEANING SYSTEM (CIP SYSTEM)

The tenderer shall provide membrane cleaning system in the RO plant by chemical recirculation when the pressure drop across the system exceeds the preset value. The cleaning system shall comprise one chemical solution tank, two chemical recirculation pumps and one cartridge filter (CSRL). The chemical solution tank shall be provided with motorized stirrer to prepare chemical solution.

AUTO PH CORRECTION FACILITIES

Facilities shall be provided to dose either caustic soda or other alkali into the water followed by a static mixer and pH meter permeate tank for final pH correction these shall be done on automatic basis.
Alkali preparation tank in MSRL construction equipped with motor driven agitator. Alkali dosing tank and Alkali dosing pumps shall be in SS construction.

Common Backwash collection tank

The backwash waste from the Pressure Sand Filter, Ultra filtration and Chemical waste from UF & RO system unit are collected in common backwash collection tank. Backwash water with suitable chemical treatment if required shall be pumped back to the flash mixer with the help of backwash waste recycle pumps. The backwash waste recycle pumps are provided with adequate capacity and head.

10. LIST OF PRE-TREATMENT AND UF-RO COMPONENTS

SL. NO.	DESCRIPTION	MOC
PRE-TREATMENT COMPONENTS		
1.	**CMB water Transfer Pumps to flash mixer** Capacity: 230 m3/hr Type: Horizontal Centrifugal with all necessary accessories	Casing: CI, Impeller: SS 316
2.	PSF for bypass stream	Filter Vessel Material : Carbon steel Epoxy painted
3.	Flax mixer	MOC – RCC
4.	**Flash Mixer Agitator** Impeller: Turbine/Propeller Vertical top entry Gear Operated With all required fixing accessories (motor and reduction gear) with sufficient free board.	Shaft: SS 316, Blade: SS 316
5.	**HRSCC** Type; Peripheral driven, with Telescopic valve arrangement with sufficient free board.	RCC Structural Turbine: SS 316, Scrapper: SS 316, Weir: SS 316, All under water parts: SS 316, Handrail & bridge: MS- FRP , cheq. Plate: FRP coated
6.	**Agitator in sludge sump** Impeller: Turbine/Propeller Vertical top entry Gear Operated With all required fixing accessories (motor and reduction gear)	Shaft: SS 316, Blade: SS 316
7.	**Sludge Centrifuge / filter press Feed Pumps** Type : Progressive cavity Screw Pump	Pump Housing: IS 210 FG 220 Stator: Nitrile Black Rotor: SS AISI 410 Shaft: SS AISI 410 Pump Housing: CI as per ASTM 48 m CI 225 (IS 210 FG 220) Gland: Graphite Base Plate: MS
8.	**Centrifuge (Sound Proof)** Type: Solid Bowl, Solid Consistency: Min. 20% Min Solid Removal Efficiency: 90% with other required accessories	All wetted Parts: SS 316 Bowl: SS 316 (Centrifugally cast) Frame : MSEP Cover : AISI 316 Sheet Conveyor : AISI 316 with baffle disc Screw Conveyor : SS, Edge-Tungsten carbide alloy. Hopper/Chute: 3mm GI plate or 5mm FRP

CHEMICAL DOSING SYSTEM FOR PRELIMINARY TREATMENT		
9.	**Acid dosing pumps for pH correction** Type: Diaphragm / Metering with Pulsation Dampener, Trough Plate and Calibration pot	
10.	**Acid dosing tank**	FRP
11.	**Lime Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	SS 316
12.	**Lime Dosing Tank**	FRP
13.	**Agitator in Lime Dosing Tanks** Impeller: Vertical Turbine, Speed: High Speed Vertical top entry Gear Operated	Shaft: SS 316, Blade: SS 316
14.	**Dolamite Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	PP
15.	**Dolamite Dosing Tank**	FRP
16.	**Agitator in Dolomite Dosing Tank** Impeller: Vertical Turbine, Speed: High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft: SS 316 L, Blade: SS 316 L
17.	**Poly-electrolyte Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	SS 316
18.	**Polyelectrolyte Dosing Tank**	FRP
19.	**Agitator in Poly-electrolyte Dosing Tanks** Impeller : Vertical Turbine Speed : High Speed Vertical top entry Gear Operated With all required fixing	Shaft : SS 316 Blade : SS 316
20.	**Bulk Acid Tank**	FRP
21.	**Bulk acid unloading/transfer pumps** Type: Horizontal Centrifugal with all necessary accessories	Casing: SS Impeller : SS
22.	**Bulk Caustic Storage Tank**	FRP
23.	**Bulk caustic unloading/transfer pumps** Type: Horizontal Centrifugal with all necessary accessories	Casing: SS, Impeller : SS
FILTRATION SYSTEM		
24.	**Filter Feed Pumps** Type: Horizontal Centrifugal with all necessary accessories	Casing: CI Impeller: SS 316
25.	**Pressure sand filter**	Filter Vessel Material :

	Type : Vertical Cylindrical Operation: Fully Auto Min Thickness: 10 mm Corrosion Allowance for Vessel: 3 mm (min)	Carbon steel Epoxy painted
26.	**Media for PSF**	Sand Media Std.
27.	**PSF Backwash Pump** Type: Horizontal Centrifugal with all necessary accessories	Casing: CI Impeller: SS 316
28.	**PSF Backwash Air Blower** Type: Twin lobe type provided with suction air filter, silencer, dead weight pressure valve, pressure gauge, lifting arrangement and all necessary accessories	Casing - CI Lobe- steel/C.I. Shaft – EN 8
29.	**UF feed pumps with VFD** Type: Horizontal centrifugal with all necessary accessories	Casing: CI Impeller: SS 316
30.	**Service Water Pump**	Casing: CI Impeller: SS 316
UF SYSTEM		
31.	**UF Self Cleaning Filters** Type: Auto Backwash Filter, Vertical Cylindrical.	Body: CS Screens: SS 316
32.	**UF Membranes** Feed Flow: 150 m3/hr Min Recovery: 95%	PVDF Housing Shell/End, Caps: CPVC Fiber Support Netting: Polypropylene/Polyethylene Permeate Collection Tube: CPVC
33.	**UF Backwash Air Blower** Type: Rotary Twin Lobe Oil Free. Provided with suction air filter, silencer, dead weight pressure valve, pressure gauge, lifting arrangement and all necessary accessories	Casing - CI as per IS 210, Gr. FG 260 Lobe- CI as per IS 210, Gr. FG 260 Shaft – EN-8 to BS-970.
34.	**UF Backwash Pumps** Type: Horizontal Centrifugal (with VFD) with all necessary accessories	Casing: CI Impeller: SS 316
35.	**UF CIP Pumps** Type: Horizontal Centrifugal with all necessary accessories	Casing: CI Impeller: SS 316
36.	**CIP Tank**	MOC: FRP / Equivalent
37.	**Agitator for CIP Tank** Impeller: Vertical Turbine Speed: High Speed Vertical top entry Gear	Shaft: SS 316, Blade: SS 316

	Operated With all required fixing accessories	
38.	**UF - Micron cartridge Filters for CIP** Micron rating: 5 Type: Vertical Cylindrical Packing: Spiral Wound Disposable	SS 316
39.	**Hypo Dosing Tank** Type: Vertical cylindrical	MOC: FRP
40.	**Agitators/Mixer in Hypo Dosing Tank** Type: Propeller type Speed : High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft : SS 316 Blade : SS 316
41.	**Hypo Dosing Pumps** Type: Diaphragm / Metering Capacity :920 LPH Head : 30 m With Pulsation Dampener, Trough Plate and Calibration pot	PP
42.	**Acid Dosing Tank**	MOC: FRP / Equivalent
43.	**Acid Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	PP
44.	**Caustic Dosing Tank**	MOC: FRP / Equivalent
45.	**Agitators/Mixer in Caustic Dosing Tank** Impeller : Vertical Turbine Speed : High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft : SS 316 Blade : SS 316
46.	**Caustic Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	SS 316
47.	**Static mixer-** complete with all other accessories	Std.
48.	**SBS Dosing Tank – Neutralization** Type: Vertical cylindrical	FRP
49.	**Agitators/Mixer in SBS Dosing Tank** Type: Propeller type Speed: High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft: SS 316 Blade: SS 316
50.	**SBS Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	PP
51.	**Agitators/Mixer in Caustic Dosing**	Shaft: SS 316, Blade: SS 316

	Tank Impeller: Vertical Turbine Speed: High Speed Vertical top entry Gear Operated With all required fixing accessories	
52.	**Caustic Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	SS 316
RO SYSTEM		
RO - STAGE – I		
53.	**Cartridge Filter Feed Pumps** Type: Horizontal Centrifugal with all necessary accessories	Casing: SS 316 Impeller, shaft, mechanical seal: SS 316
54.	**RO - Micron cartridge Filters (RO-MCF)** Micron rating: 3 Type : Vertical Cylindrical Packing: Spiral Wound	Body / Housing: SS 316 Cartridge: PP wound
55.	**RO Feed High Pressure Pumps** Type: Vertical Centrifugal (multistage) with all necessary accessories and VFD	Casing: SS 316 Impeller: SS 316 Shaft, Sleeves, Wearing Ring : SS 316 Base Plate : MS, Fasteners : SS 316
56.	**RO Membranes & pressure tubes** Type: Spiral Wound (thin film) housed in filament wound, pressure tubes. Mounted on skid	Membrane pressure vessels: FRP External bolts, nuts, and fasteners: SS 316
57.	**Interstage Booster Pump – I** Type: Vertical Centrifugal (multistage) with all necessary accessories.	Casing: SS 316 Impeller: SS 316 Shaft, Sleeves, Wearing Ring : SS 316 Base Plate : MS, Fasteners : SS 316
58.	**Interstage Boost Pump – II** Type: Vertical Centrifugal (multistage) with all necessary accessories	Casing: SS 316 Impeller: SS 316 Shaft, Sleeves, Wearing Ring: SS 316 Base Plate: MS, Fasteners: SS 316
59.	**Acid (HCl) Dosing Tank** Vertical cylindrical with flat bottom.	FRP
60.	**Acid (HCl) Dosing Pumps** Type: Diaphragm / Metering with Pulsation Dampener, Trough Plate and Calibration pot	Housing: PP Diaphragm: Teflon Base Plate: CS
61.	**SMBS Dosing Tank** Vertical cylindrical with flat bottom.	FRP
62.	**Agitators/Mixer in SMBS Dosing Tank** Impeller: Vertical Turbine	Shaft: SS 316 Blade: SS 316

	Speed: High Speed Vertical top entry Gear Operated With all required fixing accessories	
63.	**SMBS Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	MOC : SS 316
64.	**Antiscalant Dosing Tank** Vertical cylindrical with flat bottom.	FRP
65.	**Agitators/Mixer in Antiscalant Dosing Tank** Impeller : Vertical Turbine Speed : High Speed Vertical top entry Gear Operated With all required fixing	Shaft : SS 316 Blade : SS 316
66.	**Antiscalant Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot	PP
67.	**RO Permeate Transfer Pump**	SS304
RO - STAGE – II		
68.	**Cartridge Filter Feed Pumps** Type: Horizontal Centrifugal with VFD with all necessary accessories	Casing: SS 316 Impeller, shaft, mechanical seal: SS 316
69.	**RO - Micron cartridge Filters (RO-MCF)** Micron rating: 3 Type : Vertical Cylindrical Packing: Spiral Wound	Body / Housing: SS 316 Cartridge: PP wound
70.	**RO Feed High Pressure Pumps** Type: Vertical Centrifugal (multistage) with all necessary accessories and VFD	Casing: SS 316 Impeller: SS 316 Shaft, Sleeves, Wearing Ring : SS 316 Base Plate : MS, Fasteners : SS 316
71.	**RO Membranes & pressure tubes** Type: Spiral Wound (thin film) housed in filament wound, pressure tubes. Mounted on skid	Membrane pressure vessels: FRP External bolts, nuts, and fasteners: SS 316
72.	**Inter stage Boost Pump (if required)** Type: Vertical Centrifugal (multistage) with all necessary accessories.	Casing: SS 316 Impeller: SS 316 Shaft, Sleeves, Wearing Ring : SS 316 Base Plate : MS, Fasteners : SS 316
73.	**Acid (HCl) Dosing Tank** Vertical cylindrical with flat bottom. Effective Volume: 500 lit 0.8 m Dia X 1.5 m HOS	FRP
74.	**Acid (HCl) Dosing Pumps** Type: Diaphragm With Pulsation	housing: PP Diaphragm: Teflon Base Plate : CS

	Dampener, Trough Plate and Calibration pot (If required) Code : API 675	
75.	**Antiscalant Dosing Tank** Vertical cylindrical with flat bottom.	FRP
76.	**Agitators/Mixer in Antiscalant Dosing Tank** Impeller: Vertical Turbine Speed: High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft: SS 316, Blade: SS 316
77.	**Antiscalant Dosing Pumps** Type: Diaphragm With Pulsation Dampener, Trough Plate and Calibration pot (If required) Code : API 675	SS 316 COMMON FOR BOTH RO SYSTEM
78.	**RO CIP Tank with heater** Type: Cylindrical flat end with open top	HDPE
79.	**Agitators/Mixer in RO CIP Tank** Impeller : propeller Speed : High Speed Vertical top entry Gear Operated With all required fixing accessories	Shaft : SS 316 Blade : SS 316
80.	**RO CIP Pumps** Type: Horizontal Centrifugal Speed : 1500 RPM (max) with all necessary accessories	Casing: AISI 316 Impeller: AISI 316 Shaft, Sleeves, Wearing Ring :AISI 316 Base Plate : MS, Fasteners : AISI 316
81.	**RO - CIP Micron cartridge Filters (RO CIP - MCF)** Micron rating: 5 Type : Vertical Cylindrical Packing: Spiral Wound Disposable	Body / Housing: SS 316 Cartridge: PP wound
82.	**RO Permeate Transfer Pump**	**SS 304**
83.	**Permeate Transfer Pumps from Permeate tank to CW fore-bay**	**SS304**
84.	**WEIGHING SCALE FOR CHEMICAL** Type: Platform, dial type. Number - Two (2) Capacity 0-1000 Kgs	
85.	**SAFETY ARRANGEMENT** Safety shower One number safety shower shall be provided near acid unloading area and one in chemical preparation area at chemical house. Personal protection: Four sets of safety equipment comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided	
NOTE		
1.	Combined RO recovery from all the stages of RO shall be minimum 95%.	
2.	Above list of Mechanical equipment are tentative in nature may	

	subjected to change as per the functional requirement. Same shall be decided by the bidder.
3.	Chemical dosages are indicative in nature may subjected to change as per the functional requirement. Same shall be decided by the bidder.
4.	Requirement of interstate booster pumps shall be decided by bidder.
5.	Although separate chemical dosage systems are envisaged for each RO stage, bidder shall use common dosage system for both the stage. Same shall be decided by bidder.

11. ZERO LIQUID DISCHARGE PLANT

PROCESS DESIGN BASIS

The feed to the Zero Liquid discharge Plant shall be the streams from RO reject from RO plant of the Tertiary treatment system which shall be transferred to Crystallizer feed tank via RO reject storage tank of 500m3 capacity. From the RO Crystallizer feed tank, 6m3/Hr of RO reject shall be transferred via Crystallizer feed pump (1W+1S) to Evaporator cum Crystallizer system, where it will further be concentrated to form the mixed salt which shall be dewatered further for disposal to landfill by owner.

PROCESS DESCRIPTION

The system shall be based on evaporation principle. Bidder shall optimize the design of the proposed ZLD system with respect to the consumption of steam and power. The high purity distillate produced in the system shall be fed to CW makeup tank. The reject from evaporator cum crystallizer shall be pumped to the salt drying system.

The moisture content of the final product at the outlet of salt centrifuge system shall be maximum 20% by weight. The salt drying system shall consist of Pusher type Salt centrifuge to achieve 20% moisture content.

Crystallizer

RO reject along with softener injection shall be fed into crystallizer feed tank from RO reject storage tank. Provisions shall be provided to add Sulphuric OR HCl / Caustic to the feed if required for process. A Crystallizer feed pump transfers the waste water from the crystallizer feed tank to the feed preheater. The plate and frame heat exchanger pre-heats the feed with the sensible heat of the vapour condensate (distillate) and is then fed into the crystallizer vapour body.

The circulation loop of the crystallizer recirculates the crystallizer slurry and pumped by the VFD centrifugal crystallizer recirculation pump through the shell and tube crystallizer heater. Start-up steam shall be drawn from the HRSG with suitable temperature and pressure. The brine is heated a few degrees (sensible heating) as it passes through the heat exchanger by gaining the heat from it and flashes when it re-enters the vapour body, effectively converting the sensible heat to latent heat in the form of vapour. Boiling within the tubes is suppressed by the liquid elevation in the vapour body. Evaporation takes place in the vapour head, thus concentrating the solution. The crystallizer heater is connected to the vapour body by the recirculation duct.

The process vapour is collected in the vapour body, passes through a chevron integral entrainment separator then into the suction of the compressor system. The compressor system consists of lobe blower / radial type fan that increases the saturation pressure of the vapour. The compressed and de-superheated vapour condenses in the shell of the crystallizer heater where it transfers the heat content to the salt slurry circulating in the tube side. The condensed vapour drains to a crystallizer distillate tank. The portion of the distillate is pumped out of the tank to the plate and frame heat exchanger to preheat the feed before it is returned to the facility and remaining distillate shall be collected in distillate tank from where it shall be transferred to CW makeup tank.

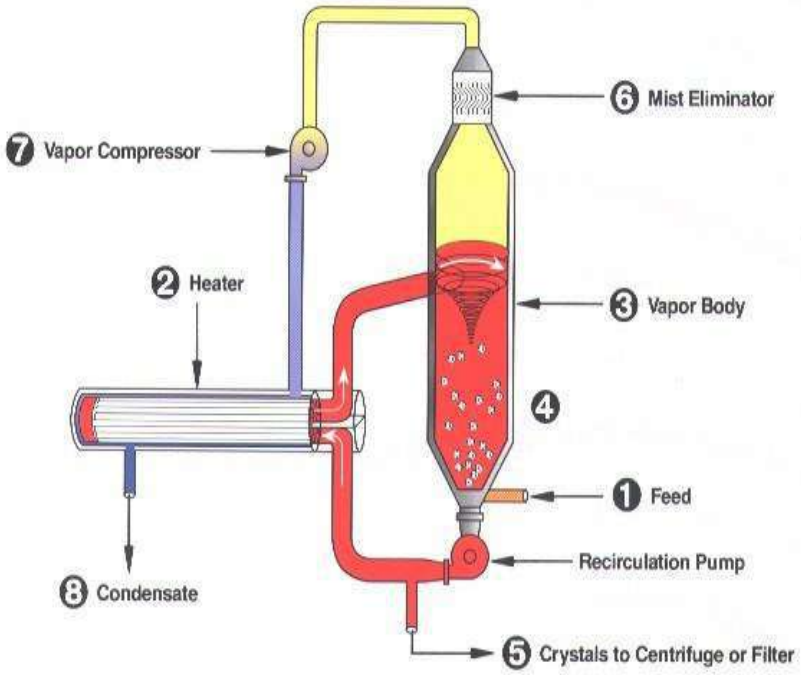
Foaming may occur in the crystallizer vapour body due to the presence of fine crystals, organic contaminants, and/or improper pH control. The crystallizer vapour body shall be designed with low vapour rise rates and extra disengagement height to minimize foaming potential and subsequent carryover. Small doses of antifoam can be metered into the process on a continuous basis to control foaming. Foam detection probes are installed so that if an upset occurs, a large dose of antifoam can be automatically pumped into the vapour body to reduce the foam.

Crystals are continuously formed within the brine slurry in the vapour body. As a result of the heating and flashing of the brine, water is removed in the form of vapour. The brine becomes supersaturated and the salts precipitate from solution.

A slip stream from the recirculating brine is directed to the pusher type salt centrifuge. The centrifuge recovers the solids containing approximately 15-20% moisture.

The solids will be suitable for disposal at a landfill. The liquid removed from the solids is directed to the agitated centrate tank and then pumped back into the circulation line of the crystallizer by the centrate pump. A crystallizer dump / boil out tank has been included to allow the contents of the crystallizer vapour body to be pumped into the tank during process upsets, unplanned outages, and cleaning operations. The vapour body contents are transferred from the crystallizer recirculation duct by the crystallizer drain pump to the crystallizer dump tank. Once the system is back online, the contents in the crystallizer dump tank can be pumped back in to the system through the crystallizer transfer pump into the crystallizer recirculation line.

MECHANICAL VAPOUR RECOMPRESSION CRYSTALLIZER - SIMPLIFIED FLOW SCHEMATIC



Wastewater is pumped to the crystallizer.

Wastewater joins the recirculating brine and is pumped to a shell and tube heat exchanger (heater).Because the tubes are flooded, the brine is under pressure and will not boil. This prevents scaling in the tubes.

The recirculating brine enters the crystallizer vapour body at an angle, where it swirls in a vortex. A small amount of the brine evaporates.

As water is evaporated from the brine, crystals form.

Most of the brine is recirculated back to the heater. A small stream from the recirculating loop is sent to a centrifuge to separate remaining water from the crystals.

The vapour from evaporation passes through a mist eliminator to remove entrained particles. The vapour is compressed in a vapour compressor. The compressor vapour heats the recirculating brine when it condenses on the shell side of the heater. (Plant steam can also be used to heat the slurry.) Distillate is collected and may be recycled to other processes requiring high quality water.

12. Crystallizer Features

Vapour Body Design

The waste water crystallizer solids consist of several salts, making it a "mixed salt" crystallizer rather than a commodity salt crystallizer. The vapour body shall be designed to minimize foaming and allow proper crystallization of mixed salts of differing size to allow the centrifuge to operate properly. The vapour body for a mixed salt system shall be generally larger than for a single commodity salt system based on differences in the design vapour and liquid rise rate and the brine recirculation rate.

Heater

The heater shall be designed for mixed salt heat transfer coefficients and for higher velocities than commodity salt systems. The heater temperature rise is also lower in mixed salt devices to maximize intervals between cleanings. The horizontal 2 or 4 pass configuration allows for simple cleaning of the tubes when necessary. The liquor boxes are flanged and can be easily dismantled if needed without removing the circulation piping.

Dewatering Device

Pusher centrifuge shall be provided to dewater the solids coming from Crystallizer unit. The mixed salt shall be collected and disposed off for landfill. The centrate water shall be again slowly fed to crystallizer to concentrate and process.

Foaming

Bidder shall provide sophisticated antifoam detection and delivery system and closed circuit TV camera to observe any foaming. The Crystallizer system has both low and high antifoam dosing pumps. Antifoam addition is automatically controlled with a foam detection capacitance probe in the crystallizer vapour body.

Cleaning

Since the salts in a mixed salt crystallizer are typically very soluble, a hot water rinse, or boil-out, using distillate or service water can be used to periodically clean the system. Regular boil-outs can prevent the need for more rigorous cleaning, such as chemical cleaning or hydro blasting chemical cleaning is accomplished by circulating a cleaning solution in the same manner that the brine is recirculated. In those occasional cases when a process or operator upset causes severe fouling, mechanical cleaning of

these surfaces can be accomplished to return all heat transfer surfaces to a clean condition.

13. INDICATIVE LIST OF EQUIPMENT AND MOC

Indicative list of equipments for zero liquid discharge plant and their MOC shall be as below. Any other equipments / facilities not listed below but required for the completion for the ZLD plant is in the scope of the Tenderer. Quantities and list of equipments shall be finalized during detail engineering.

Stages indicated for evaporators / Crystallizer is tentative it may vary depending upon the functional requirement / OEM recommendation / which shall be decided after finalization of supplier and during detailed engineering stage.

EQUIPMENT ITEM	**MATERIAL (Or Equivalent)**
Crystallizer Feed Tank	Coated Concrete
Crystallizer Feed Tank Mixer	Dup. SS 2507/ 6% Moly
Crystallizer Feed Pump & Motor	Cd4MCuN
Crystallizer Feed Preheater Plates	Ti Gr.1 / 6% Moly/Ti. Gr.11
Crystallizer Vapour Body	6% Moly / Inconel 625 / C-276
Mist Eliminators	Dup 2507/ 6% Moly
Crystallizer Heat Exchanger	
Tubes	Ti-2/Ti-12 / Ti-16
Tube sheets	Ti-2/Ti-12 / Ti-16 clad 316L SS / C-276
Shell	316L SS
Crystallizer Recirculation Ducts	2507/ 6% Moly
Vapour Ducts	SS 316L
Vapour Duct Expansion Joints	SS 316L
Centrifuge	6% Moly / 2507
Centrate Tank Mixer	6% Moly
Centrate Tank	Coated RCC
Centrate Pump	Cd4MCuN
Crystallizer Process Condensate Pump & Motor	316 SS
Crystallizer Condensate Tank	316L SS
Crystallizer Condensate transfer Pump	316SS
Crystallizer Recirculation Pump	Cd4MCuN / CK3McuN / Inconel 625
Mechanical Vapour Compressor	Centrifugal Fan, 2205 Casing, 2507 Impeller with IGV Or Rotary lobe PD Blower w/ silencers, Cast iron with Ni-Resist lobes, 316L SS silencers

Surface Condenser	SS316L tubes, heads, shell
Deaerator	6% Moly
Dosing tanks	FRP
Sulfuric Acid Pump	A-20/PTFE
Hydrochloric Acid Pump	PP/PTFE/ H-alloy C
Antifoam Pump	PVC/PP
High Capacity Antifoam Pump	PVC/PP
Antiscalant Pump	PVC/PP
Caustic Pump	316 SS
Crystallizer dump tank / Boil out tank	Coated RCC
Crystallizer dump transfer pump	Duplex SS
Note: 1.Mechanical Vapour compressor shall be provided with acoustic enclosure to restrict the noise level to 70 db at 1mt distance.	

4.2.2 Service Water

Required service water will be drawn from RO-1 permeate water storage tank through service water transfer pump for further storage and distribution. The storage capacity of service water overhead tank shall be as per system requirement.

Overhead tank shall be provided above the chemical house for distribution of Service water to the chemical solution preparation tanks and for other services. All tanks where Service water is being used shall be provided with float valves. Service water pumps (1W+1S) shall be provided for filling the overhead tank for further distribution in the plant.

4.2.3 DRINKING WATER

Tenderer shall plan to extend drinking water for the said plant from the Power Plant drinking water network which will be made available near the battery limit of ZLD Package. Co-ordinates shall be finalised during detail engineering stage.

Drinking water analysis shall be as per IS: 788888810500-1992.

Tenderer shall extend the same from tapping point with an isolation valve in a valve pit to their proposed systems for the entire need and the Tenderer shall indicate the quantity of drinking water requirement, pipe size, end connection, MOC of pipeline, etc. from the tapping point.

Tenderer to provide overhead tank of capacity 1m3 in each of the building, where drinking water facility has been considered.

Online booster will not be accepted. If pressure of drinking water is felt inadequate, a drinking water sump with pumps and piping, valves, valve pits etc. will be provided by the successful tenderer.

4.2.4 FIRE WATER SYSTEM

To cater the needs of water based fire-fighting system, an independent pressurized fire water piping network comprising internal/ external hydrants, hoses, hose reel, hose box, valves, nozzles, couplings and all other equipment shall be provided by the successful Tenderer. Tenderer shall plan to extend firefighting water with an isolation valve for the entire area (inside & outside up to peripheral area of the proposed building covering roads) from the existing fire water network of the Power Plant. Tenderer shall indicate pipe size, end connection, MOC of pipeline, etc. at the tap-off point.

4.2.5 TREATED WATER FOR REUSE AS MAKE-UP

The Tenderer shall supply treated water from ZLD plant for CW make-up system. Treated water pipeline shall be laid from the proposed ZLD plant upto the CW fore bay. Co-ordinates shall be decided during detail engineering.

The final blended water quality in CW make up tank (RO permeate water, Crystallizer distillate and bypass stream of water from CMB) shall be as detailed below:

SL. NO	DESCRIPTION	UNIT	VALUES
1.	PH		7.0-7.5
2.	TSS	ppm	5.0
3.	TDS	ppm	< 800
4.	HARDNESS as CaCO3,	ppm	< 220
5.	Silica dissolved	ppm	< 24
6.	Chloride	ppm	< 60

4.2.6 PRE-TREATMENT, UF-RO PLANT & ZLD Plant

1) UF-RO Plant building, Chemical house, ZLD structure etc., shall be provided with valves, internal piping, control room, material handling facility, ventilation facilities, illumination & instrumentation, etc.

2) Operation of all the pumps, motorized valves, etc. shall be centrally controlled from RO Plant building PLC, located near in the Electrical Control Room.

3) Hoisting and handling equipment shall be provided for lifting the equipments / material. The capacity of the hoisting and handling equipment shall be selected in such a manner that it is able to handle the single heaviest load of the location.

4) Air conditioning shall be provided for PLC & Control room.

5) One office room with furniture, toilet (1 for gents, 1 for ladies) shall be provided in UF-RO building for Executives and workers/ operators.

6) Clear walkway of width 2.0 m shall be provided on one side of the pump house with clear marked approach to all the pump set, motors, valves, filters etc. All operating platforms/ maintenance platforms shall be of minimum width 1.0 m.

7) Structural platform with ladder shall be provided so that the valves can be easily accessible for operation and maintenance.

8) Where ever required, the buildings shall be provided with drainage pumps.

4.3 MATERIAL SPECIFICATION

4.3.1 PIPING SPECIFICATION

- Feed pipelines from HRSCC, UF upto RO-1 Suction shall be of CPVC/GRP
  RO-1 HP pump discharge line shall be SS 316,
  RO-2 HP pump discharge & RO-1 & RO-2 Reject line shall be Duplex SS
  RO-1 & RO-2 Permeate piping shall be CPVC/GRP

- All dosing pipe shall be of CPVC SCH 40.

- Pipe carrying sludge shall be of MS.

- Pipe carrying instrument air or service air shall be of ASTM A 53 type E Gr-B galvanized/IS 3589 Gr 410 galvanised/ IS 1239 heavy galvanized to IS 4736 or equivalent.

4.3.2 PUMPS

1. Material of construction for slurry pumps shall be as indicated below:

Sl. No	ITEM	MATERIAL
1	IMPELLER	CHROME ALLOY, BHN-600-650
2	CASING	CHROME ALLOY, BHN-600-650
3	CASING RING / WEAR RINGS/LINER	CHROME ALLOY, BHN-600-650
4	SHAFT	EN8
5	SHAFT SLEEVE	CHROME ALLOY ,BHN-600-650
6	SEAL	GLAND PACKING
7	BASE FRAME	M.S FABRICATED
8	COMPANION FLANGES	CARBON STEEL IS 2062 Gr-B

4.3.3 VALVES

Adequate number of valves should be provided in the pipeline network for isolation of pipe sections and equipment, control of pressure, flow &level of fluids, venting, draining, pressure relief etc. The operation of valves shall be either of manual/motorised/pneumatic type which will be selected solely based on the system requirement at detail engineering stage.

Following valve MOC shall be considered

i) SPECIFICATION FOR SLUICE VALVES

Manual Operation / Pneumatic Operation/Motor Operated

1.	Type	Rising spindle type sluice valves for water works
2.	Body & Cover	ASTM A 216 Gr. WCB
3.	Disc	ASTM A 216 Gr. WCB,13% Cr
4.	Hand wheel	Carbon steel/SGI
5.	Pin	Stainless Steel, AISI-410
6.	Stem	SS, IS: 6603
7.	Gaskets	Neoprene rubber
8.	Gland packing	Rubber
9.	Gear	Alloy Steel, IS: 1570, 40Ni2Cr1MO28 Gr B
10.	Gear housing	Cast Steel, IS: 1030, 230-450 W
11.	Pinion & pinion shaft	SS, IS: 6603
12.	End connections	Flanged
13.	Pressure rating	PN = 1.6 N/mm2
14.	Manufacturing Standard	IS-14846-2000
15.	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
16.	Test certificates	Required for material/hydro test
17.	Service	Water
18.	Max operating temp	100 Deg 0C
19.	Type of operation	Upto DN300- Manual Beyond DN350 - Gear operated
20.	Operation	Manual / Pneumatic(As and Where specifically mentioned)

Flange drilling shall confirm BS EN 1092 PN16/ANSI B 16.5 CLASS 150 for IS 14846 STANDARD AND API 600 Standard respectively.

TESTING:-

The valve shall be tested at manufacturers' works for seat test and body test as per the following table and relevant material and Hydro test certificate shall be furnished to the Engineer as per IS 14846 Standard.

Pressure Rating	Body Hydro test Pressure	Duration	Seat Hydro Test Pressure	Duration
	Kg/Cm2	Minutes	Kg/Cm2	Minutes
1.6	24	3	16	2

ii) SPECIFICATION FOR CAST STEEL DUAL PLATE ZIP CHECK VALVE

1	Type	Dual Plate Zip Check Valve
2	Body	ASTM A 216 Grade WCB
3	Plate	ASTM A 351 Gr. CF8 M (SS 316)
4	Stop Pin	AISI SS 410
5	Hinge pin	AISI SS 410
6	Spring	INCONNEL
7	Retainer	CF8M (SS 316)
8	Body Bearing	AISI SS 316
9	Plate Bearing	AISI SS 316
10	Spring Bearing	AISI SS 316
11	Eye Bolt	Carbon Steel
12	Body Seal	EPDM
13	Plate Seal	Integral
14	Body Test Pressure	450 psi (g)
15	Seat Test Pressure	320 psi (g) (Max.) / 285 psi (g) (Mini)
16	Design Standard	API 594
17	Dimensions	As per API 594
18	Testing	As per API 598
19	Special features required	1. Arrow indicating the flow direction. 2. Embossed name plate giving details of tag No. size, etc.
20	End Connections	Flanged

iii) SPECIFICATION FOR GLOBE VALVE (CAST STEEL)

Sl No.	**Description**	**Material**
01	Type	Globe valve for water supply pipelines
02	Body/ Bonnet	CS A216 Gr. WCB
03	Disc	ASTM A351 CF8M
04	Stem	AISI 410
05	Body / Disc seat	AISI 410
06	Seating surface & rings	AISI 410
07	Hand wheel	ASTM A 216 Gr WCB
08	Gland, Gland plate, disc spindle nut	AISI 410
09	Gland Packing	25% Carbon filled PTFE rings
10	Manufacturing standards	BS 1873/ API 600
11	Operation	Manually operated hand wheel with

		open and close direction indication
12	End connection	Screwed upto 40 mm except Otherwise mentioned. Flanged end for 50mm and above
13	Service	water
14	Pressure Testing	As per BS 6755 Part I/API 598

iv) SPECIFICATION FOR BUTTERFLY VALVES

Manual Operation / Pneumatic Operation/Motor Operated

1	Type	Flanged type Butterfly valve for Water supply pipe lines.
2	Body & Cover	ASTM A 216 Gr. WCB
3	Disc	SS, IS: 3444-1987, Gr 6/ 7 / A 351 SS304 (CF-8)
4	Seat, Body/Disc	EPDM/ Neoprene
5	Pin	Stainless Steel, AISI-410
6	Spindle	SS, IS: 6603-72, 15 Cr 16 Ni 2
7	Bolting, internal	SS
8	Bolting, external	Carbon Steel, (HT)
9	End connections	Flanged/wafer/wafer lugged based on manufacturer design
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing Standard	IS-13095-1991/AWWA:C-504/ BS:5155/ IPSS-1-06-012 / API 609
12	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
13	Test certificates	Required for material/hydro test
14	Service	Water
15	Max. operating temp	100 Deg 0C
16	Type of operation	Upto DN250- Lever operated Beyond DN300- Gear operated
17	Operation	Manual / Pneumatic(As and where specifically mentioned)

v) SPECIFICATION FOR BALL VALVE

1	Type	Three piece/two piece, full bore/reduced bore, floating ball, PTFE seated
2	Body, Cover & Gland	CS as per ASTM A216 WCB
3	Ball	SS , ASTM A 351, Gr. CF 8M
4	Stem	AISI 316

5	Fasteners	HT, SS 304 only
6	Gland Packing	35% Carbon Filled PTFE/ Graphite
7	End connection	Socket welded / Flanged
8	Pressure rating	PN = 1.6 N/mm2
9	Manufacturing Standard	BS 5353/API 599
10	Test certificates	Required for material/hydro test
11	Service	For instrument fitting, air vent and for Regulation purposes.
12	Max. operating temp	100 Deg 0C

Remarks- Socket weld connection with nipple pipe of 100mm welded on all openings

vi) SPECIFICATION FOR AIR RELEASE VALVE

Air release valves shall be cast iron, single large orifice type, with flanged ends. Air release valve shall conform to IS: 14845-2000.

1	Type	Air release valves shall be cast iron, type S1 & S2 upto diameter 50 mm and type DS1 above diameter 50 mm and upto diameter 200 mm IS: 14845-2000.
2	Body	CI FG 200 as per IS:210
3	Body seat ring	Gun metal IS:318 LTB-2
3	Float	Timber core with vulcanite/ rubber coating
4	Disc	Gun metal IS:318 LTB-2
5	Stem	SS, IS: 6603, 04Cr17
6	Disc nut	Gun metal IS:318 LTB-2
7	Bolts/studs, nuts	Carbon steel IS:1367
8	Gland	CI FG 200 as per IS:210
9	Gland packing	Non asbestos/ jute/ hemp
10	Air release nipple	Gun metal IS:318 LTB-2
11	Gasket	CNAF 3 mm thick
12	Rubber ball	Vulcanite Ebonite
13	End connection	Screwed up-to DN40 and flanged for DN50 & above
14	Pressure rating	PN 1.6 N/mm2
15	Test pressure	Body : 24 kg/cm2 Seat : 16 kg/cm2 Test duration : 30 minutes

vii) SPECIFICATION FOR BALL FLOAT VALVE

Sl No.	Description	Material
	1Type	Single - beat type with balancing piston
2	Body/ Cover/ Gland/ Piston	Cast iron Gr 260 as per IS 210-1993
3	Seat ring/ valve guide	IS 318 Gr 2
4	Pilot valve seat/ face cap/ spindle	IS 318 Gr 2
5	Links	M.S. cadmium plated
6	Face ring/piston cups	Leather
7	Lever	M.S.
8	Float	Tinned copper
9	Pressure rating	PN = 1 N/mm2
10	End connections	Flanged end, IS:6392-1971(RA'88) 50 mm and above . Screwed end upto 40 mm . Threading as per IS: 554/BSP Thread.
11	Hydrostatic testing	Body - 15 Kg/cm2

viii) STAINLESS STEEL, BONNETLESS FLANGED KNIFE GATE VALVES

Sl No.	Description	MOC/ Specification
1.	Design Standard	MSS SP 81
2.	Type	Bi-directional with rising spindle
3.	Body	CF 8
4.	Seat / Sleeve	EPDM
5.	Gate	ASTM A240 Type 304 Hard Chrome Plated
6.	Packing	PTFE Imp. Sy Flber
7.	O-Ring	EPDM
8.	Insert Ring	CF8
9.	Packing Gland	ASTM A216 Gr WCB
10.	Yoke	MS
11.	Stem	SS
12.	Gasket	Non Asbestos
13.	Companion flange	MS
14.	Position indicator	Aluminium
15.	Valves mounting fasteners bolts / nuts	Zinc plated steel
16.	Gear Box	
i)	Worm	Aluminium Bronze

ii)	Worm Shaft	Carbon Steel
iii)	Encloser	Aluminium alloy
17	Pressure rating	PN 16

4.3.4 PIPES, FITTINGS & PIPE SUPPORTS

1. Pipe Specification to be followed for Carbon Steel pipes is mentioned below:

Type	**Dia. (mm)**	**Standard**	**Material**	**Thickness**	**Manufacture**
Black pipe	15-50	B36.10	A106	Sch 80	Seamless
Black pipe	65-150	IS1239:2004	Fe410	Heavy class	ERW
Black pipe	200-250	IS3589:2001	Fe410	6.35mm	ERW
Black pipe	300-350	IS3589:2001	Fe410	7.14mm	ERW
SW	400-450	IS3589:2001	Fe410	7.14mm	ERW
SW	500-1000	IS3589:2001	Fe410	7.92mm	Spiral Welded.
SW	1000-1200	IS3589:2001	Fe410	8.74mm	Spiral Welded.

2. Specification to be followed for Carbon Steel pipe fittings is mentioned below:

CS Fittings (Class 3000)	**Applicable standards.**
Pipe butt welded fittings	ANS B16.9 ANS B16.28 Material: ASTM A234 WP8
Forged fittings: - (Socket / Screwed fittings)	ANSI B16.11, thread to ASA B2.1
	Material: ASTM A105
Mitre Bend: -	To be made from parent pipe for sizes DN 250 and above. For sizes below DN 250 forged fittings shall be used.

3. Pipe Specification to be followed for stainless Steel pipes is mentioned below:

	Applicable standards.
Upto Dia. 50mm.	Dimensions as per ANSI B36.19, Schedule 40, Conforming ASTM A312 TP304
Beyond 65mm and above	Dimensions as per ANSI B36.19, Schedule 20, Conforming ASTM A312 TP304

4. Specification to be followed for stainless Steel fittings is mentioned below:

SS Fittings (Minimum class 3000)	**Applicable standards.**
Butt welding fittings	As per ANSI – 16.9, ASTM A304 WP304
Socket welding fittings	As per ANSI B16.11– A182 F-304
Screwed fittings	As per ANSI B16.11– A182 F-304

4.4 STEAM

Steam required for Evaporator/ ZLD system shall be tapped from the terminal point

(HRSG LP steam line) Branch pipe of suitable size shall be laid on overhead pipe trestle from the takeover point and connected to ZLD system as per system requirement. Necessary overhead trestle for laying of all the pipes (i.e Compressor Air, Steam etc.) upto the proposed ZLD plant premises is in the scope of the tenderer. For connection of steam pipe to the Evaporator/ ZLD System, valves shall be provided by the Tenderer at source and end point so that whenever the same is not in use steam pipe shall be isolated from the system.

1) The operating parameters of steam at tapping point for ZLD are 5.5 kg/cm2 (a) & 230 deg C.
2) The tapping point for LP steam line for crystallizer system of ZLD plant shall be tentatively near T-1 column in HRSG area.
3. Quantity of steam available at source is not more than 1T/hr

Condensate shall be discharged to drains at suitable intervals through steam traps and strainers.

Suitable insulation for the steam pipe shall be provided by the Bidder. Insulation and material of steam pipelines shall be carried out as per IS standards and system requirement.

Steam line shall be designed to meet the requirement of IBR and necessary approval for the same shall be obtained by the Tenderer.

Steam shall be made available by the Purchaser at the takeover point (TOP). Tenderer shall make further connections from the TOP to the respective equipment complete with piping, valves, supports, insulation, required instrumentation & controls, electrics as applicable, etc.

Any change in flow parameters with respect to those available at the TOP & required to meet the consumption of individual consumers shall be in the scope of the Tenderer.

4.5 INSTRUMENT AIR

Instrument Air required for ZLD system shall be made available by the Purchaser at the takeover point at a pressure of 6-7 kg/cm2(g). Tenderer shall make further connections from the TOP along with isolation valve to the respective equipment complete with piping, valves, supports, insulation, required instrumentation & controls, electrics as applicable, etc.

Any change in flow parameters with respect to those available at the TOP & required to meet the consumption of individual consumers shall be in the scope of the Tenderer.

For Instrument Air, branch pipe of size DN 25 mm shall be laid on the overhead pipe trestle from the takeover point upto the proposed ZLD plant premises. Pipe shall be laid on overhead trestle from the takeover point.

4.6 DESIGN CRITERIA

Design criteria for the following units are as indicated below:

4.6.1 Backwash Water

Backwashing of Filters shall be through pumps (1 W + 1S). One no. backwash water sump of minimum capacity required for two backwashes shall be provided. The sump shall be provided with low, low-low and high level switches. 2 Nos. blowers (1W+1S) shall be provided for filter backwashing.

4.6.2 Cartridge filter

No. of units	:	8 Nos. (6 for RO trains) and 1 each for cleaning of RO & UF blocks.
Design flow capacity	:	75 m3/hr (nominal) for each RO train feed water and suitable Capacity for cleaning of RO block.
Filtration capacity	:	3 micron
Material of construction	:	Carbon steel, internally lined with hyplon.
Filter cartridge	:	Removable polypropylene material element.
Fittings	:	Frontal piping with control valves, instruments etc.

4.6.3 High Pressure pumps

High pressure pump selection shall be made based on the most optimum pump curve with the highest possible efficiency. The throttling of the high pressure pump pressure at the RO inlet shall be minimized to avoid loss of energy and the operating pressures shall be selected in such a fashion that consumption of power is kept at the minimum while an optimum balance is maintained between the power and membrane replacement costs.

Specification of pumps

No. of pump sets	:	Total 3 Nos. (2 working and 1 standby) for two trains
Design capacity	:	75 m3/hr
Design head	:	Sufficient to maintain design output at 28 deg.C upto 15 years life cycle of R.O. element.
Type	:	Multistage Horizontal centrifugal, (preferably of ring section casing, diffuser type)

Preferred material of construction:

Suction casing	:	CF8M
Discharge casing	:	CF8M
Intermediate casing	:	CF8M
Impeller	:	CF8M
Diffuser	:	CF8M
Main shaft	:	SS 316
Shaft sleeve	:	SS 316

4.6.4 RO Trains (Blocks)

A total of 2 R.O. trains (2W) shall be installed with 50% capacity each to meet together, the required through-put even after 25 years of operation. Each train shall be equipped with its own semi-automatic, automatic valves, piping work, flushing and cleaning Connections, Instrumentation and control console. Each train shall consist of 50 % capacity of total flow. Combined flow through the 2 trains shall be 150 m3/hr. Each R.O. train shall be an integrated assembly of high strength fibre glass reinforced epoxy thermally cured pressure tubes housing the R.O. membrane element s, feed, product and concentrate piping, all mounted on a high-strength steel structure. Pressure tubes shall be arranged in a series/ parallel array to achieve the desired water recovery.

In addition, the successful Tenderer shall furnish the following during detail engineering:

Catridge Filter

Sl. No.	Parameters	To be furnished by Tenderer
1.	Quantity	
2.	Vessel dimension - Dia, mm - Height, mm	
3.	Design flow (each filter), m3/h	
4.	Material of construction - Body - Cartridge	
5.	Particle removal size	

RO Block

Sl. No.	Parameters	To be furnished by Tenderer
1.	No. of RO Blocks	

2.	No. of tubes per block and array	
3.	Manufacturer's name	
4.	Pressure tube	
a)	Material	
b)	Nominal pressure rating	
c)	Minimum no. of membrane element per tube	
d)	End closure type	
e)	End cap type	
f)	Feed and concentrate piping material	
g)	Product connection	
h)	Support system	
i)	Vessel hold down clamp	
5.	Membrane element	
A.	Membrane Material & type	
B.	Outer wrap	
C.	Application data	
	- Max. applied pressure	
	- Max. feed flow to element	
	- Max. operating temperature	
	- Feed water pH range	
	- Max. feed water turbidity	
	- Max. feed water silting index	
	- Max. concentrate flow	
6.	Whether membrane graphs as per TS submitted (YES/ NO)	

The following applications data of the membrane shall be furnished during detail engineering:

a) Maximum applied pressure
b) Maximum feed flow to element
c) Maximum operating temperature
d) Feed water pH range
e) Maximum feed water turbidity
f) Maximum feed water silting index
g) Maximum concentrates flow

In addition, the successful Tenderer shall furnish the following membrane graphs during detail engineering showing

(a) Relationship between feed pressure and productivity and salt passage correction factor.
(b) Relationship between feed concentration productivity and salt correction factor.

(c) Relationship between feed temperature and productivity
(d) Relationship between feed temperature and salt passage correction factor.
(e) Relationship between recovery and productivity and salt passage correction factor.
(f) Relationship between operating time and productivity and salt passage correction factor.
(g) Relationship between flow and pressure drop across the element.
(h) Element initial capacity under standard rated conditions

4.7 AIR-CONDITIONING & VENTILATION SYSTEM

Scope of work

Air conditioning and Ventilation systems shall be of energy efficient and low operating cost. The scope of work of the turnkey supplier of air conditioning and ventilation systems for ZLD Plant comprising of waste water pre-treatment plant with RO system and Crystallizer system with Mechanical vapour Recompression forced circulation crystallizers and accessories shall include the design, engineering, manufacture / procurement, inspection, shop painting, supply F.O.R. Successful Tenderer 's site stores, transportation of materials from above Successful Tenderer 's site stores to erection site, storage, erection, painting, testing, commissioning and performance guarantee of Air Conditioning and Ventilation Systems.

4.7.1 AIR CONDITIONING SYSTEM

Split air conditioners with high wall mounted indoor unit and complete with all accessories shall be installed for Control rooms, PLC room, Server room, Computer rooms, VFD rooms, office rooms etc for cooling load less than 5TR to maintain DBT of 23±2 C

4.7.2 VENTILATION SYSTEM

Tube axial/propeller type exhaust ventilation to maintain maximum 3°C rise above ambient temperature considering a minimum of 20 Air Changes shall be considered for the following areas:

- RO Plant building
- Dewatering plant building
- Pump house
- Transformer rooms,
- Store rooms, pantry rooms, toilets, etc
- Cable cellar & Rooms housing PCC, MCCs, PDBs, MLDBs etc

Tube axial exhaust ventilation (Bifurcated type in flame proof/explosion proof construction) to maintain maximum 3°C rise above ambient temperature considering a minimum of 20 Air Changes shall be considered for the following areas:

- Chemical house
- RO plant (Fumes generating areas in the building layout) etc.

Natural ventilation for building / shops shall be provided

Air Conditioning Systems (Outside Design conditions):

SEASON	TEMP. deg.C (DBT)	TEMP. deg.C (WBT)	RH (%)
SUMMER	35.6	25.6	45
MONSOON	27.8	25.6	82
WINTER	14.4	12.2	78

Ventilation Systems (Outside Design conditions):

SEASON	TEMP. deg.C (DBT)	TEMP. deg.C (WBT)	RH (%)
SUMMER	35.6	25.6	45
MONSOON	27.8	25.6	82
WINTER	14.4	12.2	78

4.8 HOISTING AND HANDLING FACILITY

General

For the technical specification (mechanical and electrical) of Cranes & Hoists Design criteria shall be referred. The Bidder shall provide all handling and hoisting equipment to meet the process & maintenance requirement. However the following shall be noted.

1. Capacity of cranes/ hoists shall be 1.2 times the single largest weight to be handled in the Building/Installation.

2. The lifting height of all the cranes/ hoists shall be suitable to approach all the equipment to be maintained, whether on ground or in pit (as applicable).

3. The hook approaches of the cranes/ hoists shall be minimum and suitable to approach all the equipment planned in the building/ installation.

4. The hoisting speed shall be 10m/min, cross travel speed 20m/min and LT speed 40m/min for the cranes.

5. Cranes shall be pendant operated. The pendant shall be fixed with the girder. The height of pendant shall be 1000mm from operating floor.

6. Cranes shall be provided with a C- type maintenance platform at one of the gable ends, with approach through a staircase from ground. Cat ladders shall not be acceptable. Minimum 800mm walkway shall be maintained on either side of crane girder.

7. Any additional cranes/ hoists required during detail engineering for the ease of maintenance of the plant & equipment shall be envisaged by the Bidder.

8. Tentative technical parameters of the crane are indicated along with the equipment. However, the same shall be finalized during detail engineering.

(Indicative minimum list of Handling and hoisting equipment)

SL. NO.	Description	Qty.	Location
1.	2.0T Capacity Electric Hoist	(2 nos.)	Chemical House
2.	Suitable handling Facilities	--	CMB transfer pumps, Clarified water pumps Zero Liquid Discharge plant, RO Plant Building Sludge handling Plant

4.9 FIRE PROTECTION SYSTEM

Complete fire protection system to be provided for Zero Liquid Discharge Plant.

General

In order to combat any occurrence of fire in various facilities in Zero Liquid Discharge Plant premises, fire protection shall be provided. The system shall be provided in conformity with NFPA, Tariff Advisory Committee's guidelines, BIS and other relevant standard/codes.

Major facilities envisaged are as following:

i/ Microprocessor based intelligent Automatic Fire detection and alarm system
ii/ Fire Hydrant System
iii/ Automatic Medium Velocity Water Spray System (MVWS)
iv/ Passive fire protection
v/ Portable fire extinguishers

Scope of work and services

The scope of work & services to be rendered by the Bidder covers on turnkey basis Design & engineering, supply, handling at site, preparation of erection drawings, fabrication and erection as per approved drawings, site testing, painting, obtaining approvals from TAC/ TAC certified agency, commissioning and fulfilment of guarantee tests of all fire protection systems, sub-systems and integrated systems envisaged for various facilities.

a. Major work comprises of following:

i. Separate headers for both systems viz water spray and hydrant shall be provided with interconnectivity with gate valve and NRV at battery limit.

ii. The TOP of pipe is to be maintained at 1.2m below finished ground level.

iii. Tenderer shall tap water from TOP from the nearest available point and provide fire water for the hydrant system & spray system under the ZLD plant package. The coordinates of TOPs will be finalized at engineering stage.

iv. Tenderer shall leave flanged outlet points with isolation valves in RCC valve pits from respective networks (i.e. one no. from hydrant & one no. from spray) at ZLD plant battery limits. The location shall be finalised during engineering.

v. While crossing beneath the road, all pipes are to be encased in hume pipe of NP4 grade.

b. Microprocessor based intelligent Automatic Fire detection and alarm system

For details, refer to Fire Detection & Alarm system under design criteria of the Specification. Microprocessor based intelligent Automatic Fire detection and alarm system shall also be provided for Automatic Medium Velocity Water spray system.

ZLD plant zone Alarm system shall be placed along with main plant Fire Detection & Alarm System Zone for ease of monitoring.

c. Automatic Medium Velocity Water Spray (MVWS) System

Medium velocity water spray system shall be provided for the protection of cable basements / cable floor / cable cellars/ cable vaults. Spray network shall be provided in ring main concept. The velocity of water in spray network pipe header has to be considered as maximum 3m/sec and accordingly header ring main pipe has to be selected and same matching one number of flange connection is also to be provided.

The system shall be designed as per TAC, BIS guidelines. Dewatering pumps shall be provided to drain out sprayed water from the area /premises, where sprayed water cannot be drained out with normal drainage system.

d. Passive Fire Protection measures

Passive fire protection is an integral part of a complete fire protection system and is essential for prevention of spread of fire through openings in walls or floors. Passive fire protection measures like Fire Retardant Coating/Painting of cables, Fire barrier / Sealing of Cable Openings, Partition and fire door etc., shall be provided.

e. Fire hydrant system

Yard hydrants system shall be provided in this package. Yard hydrants shall be provided at every 45m interval covering all the areas/units. Hoses and other accessories shall be provided as specified elsewhere in the tender document. RRL hose shall confirm to IS-636 Type-B.

f. Portable fire extinguishers.

Different types of portable fire extinguishers and trolley mounted heavy duty fire extinguishers (Mechanical foam, DCP, CO2, water type and fire bucket) shall be deployed in various area of the complex as a measure of first-aid firefighting. Portable fire extinguishers shall cover all the

working/equipment areas, including electrical and cable premises, office buildings etc. Selection, quantity and distribution of the fire extinguishers shall be as per IS: 2190 (latest revision). Bidder will supply spare extinguishers as per IS 2190. However, trolley mounted heavy duty fire extinguishers shall be provided in critical areas such as control rooms/cable basements and main shop floors etc.

Portable and heavy-duty fire extinguishers will conform to IS codes mentioned below and detailed specification provided in the Design criteria. Initial fill of gas and other fire extinguishing media (including quantity required for performance test/commissioning) and demonstration shall be supplied. Gas or other fire extinguishing media discharged during performance test shall be replenished by the Bidder.

All fire extinguishers & fire buckets shall bear ISI mark. The testing parameters of the portable extinguishers shall conform to as mentioned in IS: 15683-2006. The material of construction of Mechanical foam (portable), water type (gas cartridge type) and the caps of the extinguishers (except CO2) shall be of stainless steel only.

g. Piping, valves, sluice gates etc.

h. All civil & structural work

i. All electrics.

j. Controls and instrumentation.

k. Dewatering pumps to drain out the sprayed water from MVWS.

l. Shop and site painting for all equipments, pipes etc.

m. Erection, testing, commissioning, PG test and Warranty for the complete fire protection system.

n. All the requirements of TAC for complete fire protection systems shall be incorporated by the Bidder in their scope irrespective of whether the details are described in specification and/or shown in the drawings or not.

o. Mandatory spares required for regular operation/ maintenance of systems shall be supplied along with the equipment. Apart from the mandatory spares Bidder shall include special tools and tackles and commissioning spares required for various systems.

Miscellaneous materials and services shall include but not limited to the following:

a) All piping integral to and/or between any equipment furnished under this specification, except as otherwise specified.

b) Coupling guards for all exposed shafts and couplings.

c) Foundation bolts, base plates, thrust blocks, duck-foot bends, matching flanges, supporting materials and shims.

d) All necessary instruments, power and control wiring integral to any equipment furnished under this specification. This shall include terminal blocks and integral wiring to these terminal blocks for equipment requiring external connection.

e) Earthling strips of all panels, & other firefighting equipment supplied by the Bidder shall be connected to the nearest earthling ring available at site.

f) Digging of underground trenches, laying of cables, laying of protection slab/bricks over the cable routes, back filling of trench and levelling of earth if required.

g) GI pipes/conduits and other accessories wherever required for laying of cables.

h) Other erection materials like cable supporting structures, channels, brackets, clamps and other hardware materials, as required, for laying of cables.

i) All erection accessories, consumables and miscellaneous materials, though not specifically indicated in this specification, but actually required for completing the job in all respects.

j) All necessary connections for hook-up with other system, if required and as per instruction of the purchaser.

k) Erection, testing and commissioning materials.

l) Initial fill of gas and other fire extinguishing media (including quantity required for PG test) and demonstration.

m) RCC Valve chambers for all isolation valves.

n) Housing for deluge valves.

o) Cylinder battery racks.

p) Obtaining TAC approval certificate for the individual equipment and integrated systems, approval from statutory and local authorities.

q) Hume pipe of NP3 rating/encasing pipe for the underground pipes/cable protection below road/rail.

r) Obtaining approval certificate from TAC/TAC accredited agencies for the individual equipment and integrated systems and also obtaining approval from statutory and local authorities.

All Civil works elaborated in Civil specification.

Civil works pertaining to underground buried pipelines such as excavation, laying, backfilling, compacting, construction of valve chambers, manholes, laying of encasing pipes below roads shall also be in the scope of the Bidder as a part of pipe laying/ Cable laying. In case group of existing or proposed pipes are crossing road, RCC culverts to be provided below the roads and the same are included in the scope of the Bidder. Bidder has to protect the existing services line found in course of laying of pipeline.

All civil works for completeness of fire protection systems which may not have been described but required technically are included in Bidder's scope.

Drawings and Documents

For Approval by purchaser/consultant after placement of order drawings and document shall be submitted as per Drawings/documents to be furnished for review / information by the bidder.

4.10 DESIGN CRITERIA FOR PUMPS

HORIZONTAL & VERTICAL CENTRIFUGAL PUMPS

All the pumps provided in the pump house shall be horizontal centrifugal type with flooded suction. Drainage pumps installed in sump pits shall be horizontal, centrifugal type with priming tank arrangement. In the event of space constraints, the use of vertical centrifugal, non-clog submersible pumps may be permitted. As far as practicable, pumps of reputed indigenous makes shall be preferred. Pump type shall be HSC SSSD type only.

The horizontal pumps shall be mounted on a common base plate with the motor and shall be directly coupled to the motor thorough a flexible coupling without any gear reducer. In case of slurry pumps use of fluid coupling may be permitted.

The pumps (horizontal as well as vertical centrifugal) will be designed, manufactured and tested as per IS:1520-1980, IS:5120-1977 R.A.1991, IS:9137-1978 R.A.1993 or as per international standards acceptable to the Purchaser and will be suitable for the required duty conditions and capacities.

The pumps and their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty at full load.

The centrifugal pumps shall be suitable for a capacity range of 40% to 120% of duty point capacity.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantable without disturbing the suction and delivery pipe connections.

The equipment design shall incorporate provisions for reduction in noise level.

The rotating elements of the pumps shall be checked for critical speed in bending as well as in torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

The direction of rotation shall be clearly marked either by incorporating it on the casing or by separate metal plate arrow securely fitted to the casing.

- The head – Vs – discharge characteristics of the pump shall be continuously rising form the duty point to the shut off point without any zone of instability. The required duty range for a pump shall be on the stable portion of its head capacity

curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge. The power-Vs- discharge characteristics shall be non-overloading type.

- The pump shall be so selected and installed that the available NPSH is not lower than the required NPSH even in the most adverse operating conditions.

- The pump shall be of proven make and design having material of construction which is the best of its kind for the particular application and shall be manufactured using best engineering practices under strict quality control. Each pump shall be tested as per the standards stipulated elsewhere in this document. The test shall include hydrostatic test, static and dynamic balancing tests, performance tests material tests and motor routine tests.

- The pump shaft and bearing shall be adequately sized to take the unbalanced forced due to mal-operation. The pump gland shall ensure proper sealing without excessive tightening of the packing. Proper cooling and flushing arrangement for the gland shall be provided wherever required.

- All moving parts of the pump shall be adequately guarded to prevent any injury to operating personnel.

- Pumps shall be designed and installed keeping in view the easy accessibility of its parts for maintenance. All end suction pumps shall be of back-pull-out design and shall be provided with spacer coupling of adequate length.

- Mechanical seals shall be provided at all pumps envisaged for closed loop circuit.

- Minimum no. of standby pump shall be provided for each group of clear water pumps and drainage pumps as specified in the design criteria for pump house. The group of Pumps for scale water or other abrasive slurries shall be provided with at least two standby units. Special abrasion resistant material shall be used for these pumps and the design shall allow easy replacement of parts subject to wear and tear.

- An isolating valve shall be provided on the suction line of each pump and another isolating valve together with a non-return valve shall be provided at the delivery line of each pump. Pressure gauges shall be provided at the suction and delivery flange of each pump.

- The suction pipeline shall be laid at a constant down ward slope from pump centre line to the suction chamber. Reducers used in the line shall be eccentric type to keep the top of the suction line straight.

- Each pump shall be provided with adequate safety interlocks including overload

and dry running protection.

- Dismantling joints shall be provided on the delivery side of large size pumps to facilitate quick maintenance, wherever required.

- All pumps shall be provided with suitable lifting attachments and each pump installation shall have suitable handling facilities.

- A clear minimum gap of 800 mm shall be maintained between the pump and the adjacent piping, other equipment or structures for proper movement. In case the height of the top most part of the pump from the working floor is more than 1.0 m, the minimum clearance shall be increased to 1000 mm.

- The details of pumps should match with the drive motors throughout the working life of these equipments and to meet operational requirement. High-speed motors of 3000 rpm shall not be used, as for as practicable. Working hour meter shall be provided on control panels to monitor conditions and subsequent ageing / reduced efficiency, etc.

- Vibration readings, etc. of new installation shall be supplied.

- Pumps shall be installed and commissioned as per manufacturer's instructions. A continuous running for 72 hours shall be required before final acceptance is given to the pumping installation.

SHOP TESTING OF PUMPS

- All materials, casting and forging shall be of tested quality.

- Pump casing shall be of robust construction and hydrostatically tested at 200% of the rated pressure or 150 % shut off pressure, whichever is higher. The test pressure shall be maintained for at least 15 minutes.

- The impellers along with any other un machined rotating parts shall be tested for proper balancing in order to avoid undue vibration during operation.

- Performance tests shall be carried on each centrifugal pump. Performance test shall be made to determine the following.

  a) The discharge against a specified head when running at a specified speed under a specific suction head.
  b) The power absorbed by the pump at the shaft (BHP) under the above-specified conditions.
  c) Efficiency of the pump under the above specified conditions.
  d) Variation of required NPSH with discharge.

- The pump accessories like bearings, couplings etc. shall be subject to shop tests as per manufacturer's standards.

- The materials of construction of various components of all equipment and material covered under the scope of his specification shall be certified by the contractor with regard to their compliance to specifications laid down for them under relevant clauses of applicable standards and /or the manufacturing drawings of the contractor duly approved by the purchaser. Formal material test certificates to the effect shall be issued by the contractor.

- All test results and certificates including material test certificates shall be submitted for approval to the purchaser before dispatch of equipment.

The vertical centrifugal pump sets shall be supplied with flange mounted vertical motors, motor stool, base plate, coupling, column pipe, delivery pipe, suction strainer, companion flanges, gaskets, bolts, nuts, washers, etc.

A stainless steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information: -

- Name of Manufacturer
- Model No.
- Purchaser's item no. or tag No.
- Serial number of pump
- Capacity in cubic meters per hour
- Pumping head in meters of liquid column
- Specific gravity of liquid pumped
- Revolutions per minute
- Pump input power, kW
- Motor rating, kW
- Design code IS/IPSS:

MATERIAL OF CONSTRUCTION FOR PUMPS

A) HORIZONTAL PUMPS:

Sl. No	ITEM	MATERIAL
a)	Casing	CI IS: 210 FG260
b)	Impeller	CF8M
c)	Shaft	En8
d)	Shaft sleeve	SS410
e)	Wearing rings	CI FG 220
f)	Shims & packings	Brass IS: 442
g)	Neck ring	CI FG 260
h)	Lantern ring	CI FG 220

i)	Gland	CI FG 220
j)	Bearing end cover	CI FG 220
k)	Bearing Housing	CI FG 220
l)	Coupling Pump & motor	CI FG 260
m)	'O' rings	Nitrile Rubber
n)	Sleeve nuts	SS 410
o)	Cowl nuts	SS410
p)	Base plate	MS Fabricated

B) VERTICAL PUMPS:

Sl.No.	ITEM	MATERIAL
1	IMPELLER	CS ASTM A 216, CF 8M
2	CASING	CAST IRON (IS 210 FG 260)
3	CASING RING	CAST IRON (IS 210 FG 260)
4	SHAFT	EN 8
5	SHAFT SLEEVE	SS – 410
6	GLAND	CAST IRON
7	BASE FRAME	M.S FABRICATED
8	COMPANION FLANGES	M.S
9	COLUMN PIPE	M.S
10	SUCTION STRAINER	M.S GALVANISED

DATA/DOCUMENTS TO BE FURNISHED BY SUCCESSFUL TENDERER

The Successful tenderer shall furnish required sets of the following data/documents/drawings.

a) Drawings/data for approval (Within four weeks after placement of order)

- Predicted Characteristic Curves showing head, shaft power requirement, efficiency and NPSH requirement against capacity

- General arrangement drawing showing overall dimensions, weight including that of base plate

- Sectional drawing showing material of construction for various components indicating grades and standards.

- G.A. drawing for the common base plate.

- Inspection and testing procedure and details of shop tests for various components, sub-assemblies or all the pumps and motors.

- Motor Data Sheet

- Motor dimensional sheet

- All characteristic curves of motor including speed torque curve of the motor

- Terminal box GA drg. with details of cable size suitable for AYY type cable termination.

b) Feed back data/drawings (Within four to six weeks after placement of order)

- Civil design data and drawings showing bolt hole locations, pocket sizes, dynamic and static load, level of top of bolts and grouting thickness below the base plate. The drawing shall indicate the level of base, position of anchor pockets, inserts if any, to be embedded in the concrete and other details enabling the Purchaser to design the civil foundation.

- Firm requirement of cooling and sealing water with max. and min. pressure along with pipe connection size.

- Dimension and weight of largest component and other information regarding hoisting and handling required for maintenance

c) Drawings/documents for information

- Part nos. and description of spare parts.(within eight to ten weeks after placement of order)

- Installation, operation and maintenance manual (to be supplied at the time of despatch of equipment)

- Reproducible for final drawings.

- Final test certificates

- As built drawings

- One set of reproducible and two copies of CD's all' As built drawings' for all equipment shall be submitted along with 10 sets of prints (to be supplied at the time of dispatch of equipment)

4.11 DESIGN CRITERIA FOR WATER BASED FIRE-FIGHTING SYSTEM

FIRE HYDRANT

Landing valve/ yard hydrant shall be as per IS: 5290, Type-A .

The hose cabinet shall be fabricated out of fiber-reinforced plastic (thickness 2.5 mm) of size 750 mm x 600 mm x 250 mm. The top shall have pressed edge slightly projecting outside to prevent water (while cleaning etc.) from entering the cabinet. The cabinet shall be fitted with glass-fronted door. The door shall be provided with a knob and a lock with duplicated key on the body of the door with a glass cover. The glass of the key box shall be easily replicable. Suitable hooks, etc, shall be provided in the cabinet to hold the hose reels etc. mentioned above. Suitable wall mounting bracket shall be provided with the cabinet. The Tenderer shall provide a fully dimensioned general arrangement drawing indicating materials of construction, relevant specifications, etc.

General specification of Hydrants to be provided by the Tenderer is given below. However, the quantities of all the items will be provided by the Tenderer as per requirement and approval of Purchaser/Consultant without any price implication.

SPECIFICATION OF FIRE HYDRANTS AND ACCESSORIES

Sl. No.	IS no.	Description	Quantity
A.	**INTERNAL HYDRANT**		
1.	IS:5290 Type-A(1993)	Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap. **(Stainless Steel)**	As per TAC requirement(to be indicated by the Tenderer)
2.	IS:6392 Table-18 (1971 R.A.1988)	MS matching flange DN 80 (Slip-on type)with bolts, nuts & gaskets for the above hydrants	-do-
3.	Hose cabinet with glass front (for indoor installation, One number Hose box for each landing valve to keep 7.5m long hoses (2 Nos.) branch pipe, nozzle and spanner) consisting of the following:		
a)	IS:636 Type-2 (1988) & IS:903 (1984 R.A.- 1990)	Reinforced rubberised fabric lined flexible canvas hose of 7.5 m length having 63mm dia, each fitted (as per IS:1648:1961) with instantaneous male Coupling at one end and female Coupling at the other end.	-do-

b)	IS:903 (1984 R.A.1990)	One branch pipe **(Stainless Steel)**	-do--
c)	-do-	One 25mm nozzle **(Stainless Steel)**	-do-
d)	-do-	One nozzle spanner **(Stainless Steel)**	-do-
B.	**YARD HYDRANT**		
1.	IS:5290 Type-A (1993)	Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap. **(Stainless Steel)**	-do-
2.	IS:6392 Table-18 (1971 R.A.1988)	MS matching flange DN 80 (Slip-on type)with bolts, nuts & gaskets for the above hydrants	-do-
3.		Hose cabinet with glass front (suitable for outdoor installation, One number Hose box for each landing valve to keep 15 m long hoses (2 Nos.), branch pipe, nozzle and spanner)consisting of the following	
a)	IS:636 Type-2 (1988) & IS:903(1984 R.A.-1990)	Reinforced rubberised fabric lined flexible canvas hose of 15m length having 63mm dia, each fitted (as per IS:1648 -1961) with instantaneous male Coupling at one end and female Coupling at the other end including intermediate coupling for joining 1x15m long hose.	-do-
b)	IS:903 (1984 R.A.1990)	One branch pipe **(Stainless Steel)**	-do-
c)	-do-	One 25mm nozzle **(Stainless Steel)**	-do-
d)	-do-	One nozzle spanner **(Stainless Steel)**	-do-

The details and specification of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. as specified above and as mentioned in other clauses of this specification are applicable for this system also.

4.12 DESIGN CRITERIA FOR PLATE HEAT EXCHANGERS:

EQUIPMENT SPECIFICATION

A) The heat exchanger unit shall consist of gasketed plates supported in frame capable of being opened and closed. The frame provides structural support as well as pressure containment for the gasketed plates and consists of frame plate, pressure plate, guide bar & carrying bars, closing studs/nuts and carrying bar supporting columns. Wherever Plate Heat Exchangers are envisaged, one number Plate Heat Exchanger should be installed in addition to the required number of Plate Heat Exchangers.

B) The frame shall be designed to permit future installation of 30% additional plates.

C) Each plate heat exchanger shall be designed for full pressure in each stream having no pressure on other stream.

D) While designing heat exchange area and number of plates, cleanliness factor on account of fouling shall be considered as 20%.

E) Carbon steel components in contact with fluid system shall have a corrosion allowance of min 3mm. All the threaded hardware items like studs and nuts shall be zinc coated.

F) Minimum thickness of stainless steel plate shall be 0.5 mm.

G) Frame plate in the primary stationary end of the plate heat exchanger. All nozzles shall be located on frame plate.

I) Inspection openings shall be provided on the pressure plates. The openings shall be blanked by providing blind flanges. Ball valves shall be provided on the bottom blind flanges for drain purposes. Handles are to be provided on all the blind flanges.

J) All nozzles on the frame plate and inspection openings on pressure plate shall be provided with stainless steel sheet lining conforming to AISI 316.

K) Pressure plate shall be supported in a roller bearing hanger from the carrying bar. Pressure plate shall move along the carrying bar and shall be guided by the guide bar.

L) The carrying bar shall be welded to the frame plate and carrying bar support column. A stainless steel tee section shall be welded to the carrying bar to provide mounting member for the plates of the plate pack. A smooth surface shall be provided for roller bearing carrying groove for the whole length of the

carrying bar. Carrying bar shall be designed to support 1.5 times the weight of the flooded exchanger along with pressure plate, tie rods, nuts and nozzles.

M) Guide bar shall be welded to the frame plate and carrying bar supporting column. It shall be sheathed in stainless steel on the 3 surfaces coming in contact with the plates and is a guide bar only for the plates.

N) Minimum diameter of tie rod shall be 19 mm.

O) Carbon steel boiler quality plates shall be as per SA 515/516 Grade 60.

P) Plates having thickness of 16 to 50 mm shall be examined ultrasonically as per ASTM A 435.

Q) The heat exchangers shall be designed, manufactured and tested as per ASME code Section VIII, Div. 1 and shall be suitable for the duty conditions and capacities as required.

R) The plate heat exchangers along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty.

S) The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantled without disturbing the inlet and outlet pipe connections.

T) Stainless steel nameplate shall be furnished and securely attached by stainless steel pins at an easily accessible point on each plate heat exchanger. The plate shall be stamped with the following minimum information:-

- Purchaser's item no. or tag in 15 mm high letters.
- Serial number of plates heat exchanger
- Capacity in cubic meters per hour both for primary & secondary sides.
- Temperature ranges for primary & secondary liquids.
- Pressure drop in Primary & Secondary sides
- Design code.

INSPECTION & TESTING

a) The tests to be conducted at shop for various sub-assemblies/assemblies of equipment shall include, but not limited to the following:

- Material test
- Testing during manufacture/fabrication like dye penetration tests on randomly selected plates, high intensity light check for plates
- Dimensional checking

- Hydrostatic tests
- Ultrasonic test for the plates used for frame and pressure plates.

b) All the plate heat exchangers shall be subject to stage inspection by the successful tenderer's own inspecting authority. However, Purchaser's Inspector may visit the works from time to time and who shall have free access to all the places of the manufacturing premises where any part/parts are under manufacturing.

c) The successful tenderer's inspecting authority shall keep a close surveillance in respect of the quality of job for the design dimensions, tolerances, surface finish etc.

a) Before giving call for final inspection, all the documents shall be furnished to the Purchaser. The record of manufacturing details, inspection and tests carried out by the successful tenderer shall be made available to the final Inspecting Authority. However, approval and final inspection at the manufacturing works shall not relieve the successful Tenderer of responsibility of replacing at his cost any defective part/material which may be detected by the purchaser during erection and commissioning or guarantee period.

b) Hydrostatic test shall be carried out at 1.5 times the design pressure maintaining test pressure for a minimum of 60 minutes. Testing shall be done by pressurising each side separately.

c) The final tests shall be conducted in the presence of the Purchaser's representative. Test certificates for different tests shall be made available to the Purchaser. Material test certificates for bought out items shall be obtained from original manufacturer/reputed test house. For all bought out items, test certificates as relevant to the items shall be furnished by the successful Tenderer before the equipment is offered for final inspection.

d) Wherever required, all tests shall be done as per relevant Indian Standards. In the absence of the Indian Standard, the equivalent internationally reputed standards shall be followed.

PAINTING

a) After surface preparation, the plate heat exchanger shall be painted as per the manufacturer’s standard.

4.13 DESIGN CRITERIA FOR VALVES:

Flow control /isolating valves, drain valves, air release valves and Compensators, wherever necessary, shall be provided for the complete pipe network including cross- country pipeline.

All valves shall be suitable for service conditions i.e. quality of fluid, flow temperature and pressure under which they are required to operate.

Unless there is change in flow quantity in the pipeline, the valve size shall be same as the size of pipeline.

Valves shall be provided on pipe network for isolation of pipe section and equipment, control of pressure and flow, venting, draining etc. They shall be suitable located considering ease of operation and maintenance.

All valves shall be provided with hand wheel and position indictor. The face of each hand wheel shall be clearly marked with words “Open” and “Shut” with arrows adjacent to indicate the direction of rotation.

Valves shall be provided with suitable extension spindle and head stock assembly wherever required. In case gears or bevel system are used , these shall be of cast steel or suitable grade cast iron with machine cut teeth.

Constructional features, materials of construction of various components and testing of double-flanged C I non-return/check valves shall conform to IS 5312 : 1984 (1990), Part 1 or IS 5312 : 1986 (1991), Part 2 or BS 5153 : 1974 (1991) or equivalent reputed International Standards like DIN, ANSI/AWWA, API and ISO. Non-return valves shall be of swing check type. For sizes above DN 600, valves shall be designed for multi-disk.

The body end ports shall be circular. The area of the flow way between the body end ports shall not be less than the area of a circle of which the diameter is the nominal bore size of the valve.

The disk shall be either integral with or separate from the hinge and shall have a flat seating face. Where the disk is separate from the hinge, means shall be provided to prevent the disk, hinge pin and retainers becoming detached in service.

Any parts of the valve which can become detached in service, such as hinge pin and disk, hinge pin plugs, hinge pin stuffing boxes and two-piece disks, shall be locked. Hinge pin design shall ensure accurate alignment of the disk and the valve seat.

All non-return valves shall be designed for anti-slam/ dash pot design to reduce surge pressure.

Larger size valves shall be provided with by pass and drain arrangement.

Float operated valve shall be preferably be right angled pattern complete with ball float, level and other accessories.

Butterfly valves shall be of quotable flanged, tight shut of design with angular travel of 90 deg. from open to shut off position.

SPECIFICATIONS FOR VALVES

SPECIFICATION FOR CAST STEEL GATE VALVE. (MANUAL / GEAR OPERATED & MOTORISED)

Sl No.	Description	Material
01	Type	Gate valve with rising spindle & bolted bonnet.
02	Body /Bonnet	ASTM A351 CF8M
03	Body Seat Ring	ASTM A 105 + 13% CR (AISI 410)
04	Wedge	ASTM A351CF8M
05	Stem	AISI 410
06	Gland	AISI 410
07	Gland flange	Carbon steel
08	Stud, Stud Nut, Eye Bolt nut	ASTM 193 Gr.B & 2H
09	Gland Packing	Spiral wound metallic
10	Hand wheel	Carbon steel
11	End Connection	Flanged
12	By Pass Valve	Forged Steel gate valve with seal less pipe.
13	Electrical Actuator	Rotork Make Electrical actuator
14	Manufacturing Standard	API 600/BS 1414
15.	Pressure testing	ASME B 16:34 / API 598
16.	Face to Face Dimension	B 16. 10
17.	Flange Drilling Standard	ANSI B 16.5

18.	Test certificate service	For Physical/chemical analysis & metallurgical tests for body parts, Hydro testing
19	Service	DM / Soft water / Industrial water

SPECIFICATION FOR CAST IRON GATE VALVE (MANUAL/GEAR OPERATED & MOTORISED)

1.	Type	Gate valve with rising spindle & bolted bonnet.
2.	Body	Below 50 mm Bronze. 50mm & above Cast iron as per IS:210-1993,GR.220
3.	Bonnet	Bolted
4.	Spindle	SS as per AISI 410
5.	Wedge	Cast iron as per IS:210-93 GR 220, face ring 13% Cr. Steel
6.	Body seat ring	13% Cr. Steel
7.	End connections	Below 50 mm - Screwed. 50 mm & above - flanged end, to be drilled as per ANSI B.16.5
8.	Pressure rating	PN=1.6 N/mm2
9.	Flange facing	Flat Face
10.	Manufacturing standard	IS:778/IS-780/IS-2906
11.	Bolts & nuts	Black Hexagonal bolt with nut as per ASTMA 307 Gr B.
12.	Gaskets	Compressed Asbestos Fibers to IS-2712-1979 1.5 mm thick
13.	Hand wheel	Malleable CI , ASTMA - Gr 32510
14.	Disc	Solid Wedge
15.	Seat	Body Renewable - ASTM B 164 – B Disc --- do ---
16.	Stem	--- do ---
17.	Packing	Asbestos free
18.	Companion Flanges	ANSI B16.5 Class 150
19.	Hydrostatic testing	Shell test - 350 PSIG ; 25 Bar(g) Seat test - 200 PSIG ; 14 Bar(g) Seat air test - 5.5 bar (g)
20.	Test certificates	For Physical/chemical analysis & metallurgical tests for body parts , Hydro testing
21.	Service	Make up water/drinking water/fire water

SPECIFICATION FOR CAST STEEL NON-RETURN VALVE (SHORT –BODY)

Sl No.	Description	Material
01	Type	Swing check type
02	Body	ASTM A351 CF8M
03	Cover	ASTM A351 CF8M
04	Seat rings	13% Cr. Steel.
05	Hinge	AISI 316
06	Hinge pin	SS to AISI 316
07	Disc ring	13% Cr. Steel
08	Disc	ASTM A351 CF8M
09	Gasket	Spiral wound SS 304 with CA Filler
10	End connections	Flanged end as per ANSI B16.5
11	Pressure testing	BS 5146/API 598
12	Manufacturing Standard	API 600 / BS 1414
13	Bolts & Nuts	A193 B7/A1942H
14	Companion flanges	ANSI B 16.5 class 600
16.	Test certificates	For Physical/chemical analysis & metallurgical tests for body parts, Hydro testing
17.	Service	DM / Soft water / Industrial water

SPECIFICATION FOR CAST IRON NON-RETURN VALVE (SHORT –BODY)

1.	Type	Swing check type
2.	Body	Cast iron as per IS: 210-1993 GR. 220.
3.	Cover	- do -
4.	Seat rings	13% Cr. steel.
5.	Hinge	Cast iron as per IS:210-1993GR.220.
6.	Hinge pin	SS to AISI-410
7.	Disc ring	13% Cr. steel
8.	Disc	C.S.to ASTM A-216, Gr.WCB.
9.	Gasket	CAF gasket as per IS:2712-1979 of thickness 1.5 mm
10.	End connections	Flanged end as per IS:6392
11.	Pressure rating	PN=1.6 N/mm^2
12.	Manufacturing Standard	BS-5153- 1991

13.	Bolts & Nuts	Black Hexagonal type as per IS:1364 Part 1 & 3, 1992 class4.6/4
14.	Companion Flanges	ANSI B 16.5 class 150
15.	Hydro static testing	BS 5153 (1991)
16.	Test certificates	For Physical/chemical analysis & metallurgical tests for body parts , Hydro testing
17.	Service	Industrial water.

SPECIFICATION FOR GLOBE VALVE (CAST STEEL)

Sl No.	Description	Material
01	Type	Globe valve for water supply pipelines
02	Body/ Bonnet	ASTM A351 CF8M
03	Disc	ASTM A351 CF8M
04	Stem	AISI 410
05	Body / Disc seat	AISI 410
06	Seating surface & rings	AISI 410
07	Hand wheel	ASTM A 216 Gr WCB
08	Gland, Gland plate, disc spindle nut	AISI 410
09	Gland Packing	25% Carbon filled PTFE rings
10.	Manufacturing standards	BS 1873/ API 600
11.	Operation	Manually operated hand wheel with open and close direction indication
12	End connection	Screwed upto 40 mm except othewise mentioned. Flanged end for 50mm and above
13	Service	Soft water / Industrial water
14	Pressure Testing	As per BS 6755 Part I/API 598

SPECIFICATION FOR GLOBE VALVE (Gun Metal)

1	Type	Globe valve for water supply pipelines
2	Body & Bonnet	GM to IS : 318-1981,(RA'91)Gr LTB – 2, C.I.
3	Wedge	GM to IS : 318-1981(RA'91) Gr LTB – 2, C.I.
4	Stem	Stainless steel

5	Back seat	GM to IS : 318-1981(RA'91) Gr LTB-2
6	Seating surface & rings	Malleable Cast Iron ASTM A-4 Gr - 32510
7	Hand wheel	Cast Iron to IS:210-1993 Gr. FG-200
8	Gland, Gland plate disc spindle nut	Non ferrous alloy
9	Gland Packing	Asbestos free
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing standard	IS:778-1984 (RA 1990)/IS:781-1984
12	Max. operating temp	65 deg C
13	Operation	Manually operated hand wheel with open and close direction indication.
14	End connection	Screwed upto 40 mm except otherwise mentioned. Flanged ends for 50 mm & above, IS:6392-1971 (RA-1988), table 17
15	Hydro static testing	Shell test = 15 kg/cm2 Seat test = 10 kg/cm2 Back seat test = 10 kg/cm2
16	Special features required	1- Arrow indicating flow direction
		2-Embossed name plate giving details of tag no.,type & size
17	Service	Water

SPECIFICATION FOR BUTTERFLY VALVE

(Manual Butterfly Valve, Gear operated and Electrical actuated Butterfly valve)

Sl No.	Description	Material
01	Body/ Disc/ Retainer ring	ASTM A351 CF8M
02	Shaft	Stainless Steel AISI 410
03	Body Seat	Stainless Steel CF8M
04	Disc Seat	Nitrile Rubber
05	Bearing	BS 1400 LG2
06	Pressure testing	BS 6755 Part I
07	End Connection	Flanged
08	Electrical Actuator	Relevant IS standards
09	Manufacturing Standard	BS 5155 / AWWA C-504
10	Face to Face Dimension	AWWA C 504-94
11	Flange Drilling standard	AWWA C 207

12	Test certificate service	For Physical/chemical analysis & metallurgical tests for body parts, Hydro testing
13.	Service	Soft water / Industrial water

SPECIFICATION FOR BUTTERFLY VALVES (C I) Manual Operation /

Pneumatic Operation/Motor Operated

1	Type	Flanged type Butterfly valve for water supply pipe lines.
2	Body & Cover	CI, IS: 210 FG 260
3	Disc	SS, IS: 3444-1987, Gr 6/ 7
4	Seat, Body/Disc	EPDM/ Neoprene
5	Pin	Stainless Steel, AISI-410
6	Spindle	SS, IS: 6603-72, 15 Cr 16 Ni 2
7	Bolting, internal	SS
8	Bolting, external	Carbon Steel, (HT)
9	End connections	Flanged
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing Standard	IS-13095-1991/AWWA:C-504/ BS:5155/ IPSS-1-06-012 / API 609
12	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
13	Test certificates	Required for material/hydro test
14	Service	Water
15	Max. operating temp	100 Deg ^{0}C
16	Type of operation	Upto DN125- Lever operated Beyond DN125- Gear operated
17	Operation	Manual / Pneumatic(As and where specifically mentioned)
Remarks- All valves above DN600 shall be supplied with SS 304 gaskets with CAF fillers		

SPECIFICATION FOR BALL VALVE / FULL BORE / 2 WAY / 3 WAY CAST STEEL

Sl No.	Description	Material
01	Type	three piece, Reduced bore, floating ball, PTFE seated
02	Body & Connector	ASTM A 351 CF8M
03	Ball	SS , ASTM A 351, Gr. CF 8M
04	Seat	PTFE

05	Stem	AISI 316
06	Body Seal	PTFE
07.	Gland & Stem Packing	35 % Carbon filled PTFE
08	End Connection	Screwed NPT for less than 50mm, flanged for 50mm & above
09	Fasteners	HT, SS 304 only
10	Operation	Lever operated
11	Valve Design	BS 5353/API 599
12	Pressure testing	As per BS 6755 Part I
13	Pressure rating	PN = 1.6 N/mm^2
14.	Face to Face Dimension	ANSI B 16.10
15.	Flange dimension	ANSI B 16.5
16	Max. operating temp	100 Deg ^{0}C
17	Test certificate service	For Physical/chemical analysis & metallurgical tests for body parts, Hydro testing
18	Service	DM / Soft water / Industrial water

SPECIFICATION FOR CI / BRONZE PLUG VALVES

1	Type	DN 65 and above: C.I. Two way, lubricated type, tapered plug : Sizes up-to DN50: Bronze, T port 3 way lubricated type tapered plug
2	Body, Cover & Gland	CI as per IS:210-1993 FG 220
3	Plug	CI as per IS:210-1993 FG 220/ Bronze as per IS:318 LTB-2
4	Fasteners	Black Hexagonal bolt with nut as per IS:1364 Part 1& 3,1992, class 4.6/4
5	Gland Packing	Rubberized Asbestos
6	Gaskets	CAF
7	End connection	Screwed end up-to DN50, NPT/ Flanged end for DN65 & above as per IS: 6392-1971 (RA'88) with matching flanges, table-17.
8	Pressure rating	PN = 1.6 N/mm^2
9	Manufacturing Standard	BS 5353/API 599
10	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
11	Test certificates	Required for material/hydro test
12	Service	Cooling water for Blast furnace stove and stove valves
13	Max. operating temp	50 ^{0}C
14	Gear arrangement	Worm gear of C.S./forged steel

Note: 1. Type of threading for screwed end will be as per IS:554-1999. 2. Plug valve of size DN200 shall be provided with worm gear arrangement t.

SPECIFICATION FOR AIR RELEASE VALVE

Air release valves shall be single large orifice type, with flanged ends. Air release valve shall conform to IS: 14845-2000.

1	Type	Air release valves shall be cast iron, type S1 & S2 upto diameter 50 mm and type DS1 above diameter 50 mm and upto diameter 200 mm IS: 14845-2000.
2	Body	CI FG 210 as per IS:210
3	Body seat ring	Gun metal IS:318 LTB-2
3	Float	Timber core with vulcanite/ rubber coating
4	Disc	Gun metal IS:318 LTB-2
5	Stem	SS, IS: 6603, 04Cr17
6	Disc nut	Gun metal IS:318 LTB-2
7	Bolts/studs, nuts	Carbon steel IS:1367
8	Gland	CI FG 200 as per IS:210
9	Gland packing	Graphite asbestos/ jute/ hemp
10	Air release nipple	Gun metal IS:318 LTB-2
11	Gasket	Compressed asbestos Fiber 3 mm thick
12	Rubber ball	Vulcanite Ebonite
13	End connection	Screwed up-to DN40 and flanged for DN50 & above
14	Pressure rating	PN 1.6 N/mm^2
15	Test pressure	Body Seat : 24 kg/cm2 Test duration : 16 kg/cm2 : 30 minutes

SPECIFICATION FOR BALL FLOAT VALVE

1	Type	Single - beat type with balancing piston
2	Body/Cover/Gland/Piston	Cast iron Gr 200 as per IS 210-1993
3	Seat ring/valve guide	IS 318 Gr 2
4	Pilot valve seat/face cap/spindle	IS 318 Gr 2
5	Links	M.S. cadmium plated
6	Face ring/piston cups	Leather
7	Lever	M.S.
8	Float	Tinned copper
9	Pressure rating	PN = 1 N/mm^2

10	End connections	Flanged end, IS:6392-1971(RA'88) 50 mm and above . Screwed end upto 40 mm . Threading as per IS: 554/BSP Thread.
11	Hydrostatic testing	Body - 15 Kg/cm^2
12	Service	Makeup/Drinking/fire/ service water.

SPECIFICATION OF ACTUATOR FOR MOTORISED VALVE

1	MAKE	ROTORK/AUMA/LIMITORQUE
2	OUTPUTMOTION	ROTARY
3	OPERATION TIME	90 SEC (MAX)
4	SERVICE CONDITION	INLET PR.-8.5 Kg/cm2 (MAX) INLET TEMP.-40 deg.C max. FLUID – WATER
5	ACTUATOR SHALL BE SUPPLIED COMPLETE WITH THE FOLLOWING	
A	DECLUTCHING LEVER FOR MANUAL OPERATION	
B	HANDWHEEL FOR MANUAL OPERATION	
C	POSITION INDICATOR	
D	OPEN/CLOSE LIMIT SWITCHES	
E	TORQUE LIMIT SWITCHES	
F	EACH LIMIT SWITCH SHALL HAVE 2 NO / 2 NC CONTACT SWITCH FOR 10 AMP. AT 240 V	
G	MOTOR TERMINALS AND LIMIT SWITCH CONTACTS SHALL BE WIRED UPTO A TERMINAL BOX TO BE MOUNTED ON THE VALVE ACTUATOR	

MOTOR SPECIFICATIONS

1	TYPE	3 PHASE,4 WIRE, SQUIRREL CAGE, INDUCTION MOTOR
2	SUPPLY CONDITIONS	415 V AC + 10%, 50 C/S + 3% -6%
3	CONTROL VOLTAGE	240 V
4	PROTECTION	IP-65
5	ENCLOSURE	TEFC
6	DUTY CONDITION	S2, 30 MINUTES
7	CLASS OF INSULATION	`F' Temperature rise limited to class-B
8	NO. OF STARTS/Hr ALLOWED	60

9	Design performance	As per IS:325-1996
10	Break down torque	Minimum 2.5 TFL or higher

SPECIFICATION FOR PNEUMATIC ACTUATOR:

a) Pneumatic Actuators shall be of double acting type for on/off operation and shall be directly mounted on the valve. Single acting type shall be considered for fail/safe operation

b) Each pneumatic actuator shall be supplied with

- Single solenoid common for both open &close operation.
- Valve position indicator- Mechanical type.
- Facility for emergency manual operation.
- SS tubing of 3.00 m length along with isolation valve and suitable end connections for connecting it to ½" MS pipe by welding complete with required pneumatic tube fittings for connection to dump valve and ½" MS Pipe.
- Open and close position, proximity switch, 2-wire, universal type AC/DC),PLF, IFM make, wired up-to a junction box.

c) All the above accessories shall be mounted on / connected to the valve.

- Actuator shall be capable of operating the valve when the air pressure is 6 Kg/cm2 and shall be able to operate the valve even when the air pressure drops to 4.5 Kg/cm2.
- Each actuator shall be supplied complete with two or one way solenoid valves of ¼" pipe size. Material of construction for body shall be Brass.
- Solenoids for all solenoid operated valves shall be suitable for 20 to 240V AC/DC power (Universal type).
- The enclosure class of solenoids shall be IP65.
- For termination of cable to the solenoid, proximity switches junction box shall be provided by supplier. Terminals shall be suitable for terminating 2.5 sq. mm copper conductors. 20% spare terminals shall be provided in the junction box.
- Apart from other tests, performance test for pneumatically operated valves

with respective actuators mounted in position to show valves opening and closing and observation of leakage shall be conducted.

SPECIFICATION FOR COMPANION FLANGES

1	Type	Raised face plate flanges, Slip-on, welded, plate fabricated, machined finish.
2	Dimensional Standard	As per IS-6392-1971(RA'88), PN=1.6 /1.0 N/mm2 as per valve rating, Table-17/11, drilled off centre, RF.
3	Material	C.S as per IS-2062 -1992 GR.A.
	Note: Valve flanges and matching flanges shall be drilled as per IS:6392-1971 (RA'1988), table 17 for PN 1.6.	

4.14 DESIGN CRITERIA FOR FILTER

ONLINE AUTOMATIC BACKWASH FILTER - EQUIPMENT SPECIFICATION

Mechanism

The online filter shall be of cylindrical body with wedge wire slot tube element housed in it. For automatic filter, area will be in the ratio of 1:4 where-as for strainer it will be 1:6. The filter should start the self-cleaning process when the pressure differential across the screen reaches a preset value or predetermined lapse of time. Cleaning of the filter elements is to be carried out by the suction scanner with its spiral rotational movement.

The automatic backwash filter shall be of 200 microns or less.

The filter control shall be carried out by purchaser's PLC and MCC system. However, Tenderer shall furnish functional description / Control write-up, PLC Input/Output list to the purchaser.

Flush drain valve and vent shall be provided for each unit of the main filter. The design of the filter shall be suitable for easy maintenance and replacement of the parts and inspection.

Each strainer shall be provided with basket opening area (six times of pipe cross section area or bigger) to ensure high flow volumes at low pressure and a long service life.

Provision shall be made for collection of drainage water from the strainers and shall be suitably connected to the plant area drainage system.

Along with the offer the Tenderer shall furnish details of the basket filter such as make, general arrangement and cross sectional drawings, operating parameters, materials of construction of various components supported by manufacturer's literature and catalogues.

Valves to be supplied as part of the filters shall conform to the following standards. Pressure rating of all valves shall be 16kg/cm2.

VALVE ACTUATOR

All motors shall be suitable for 415V, 3-Phase power supply. Actuators shall be provided with travel Limit switches and Torque switches. These switches shall have IP-55 degree of protection. It shall have 2 NO + 2 NC contacts rated for 10 amps AC

a) Electrically operated built-in change over valves shall be complete with electric motors, necessary gear drive, position limit switches, torque switches and terminal box.

b) Motor shall be squirrel cage induction motor with DOL starter at 415+/- 10% 50Hz +/- 5% having the following:-

i) Class `F' insulation, temperature rise limited to Class `B'.

ii) TEFC enclosure with degree of protection IP55

c) Arrangement shall be provided on the valve for disconnecting power supply, which shall operate when valve is opened manually.

d) All end position limit switches and torque switches for open & close position shall be dust and waterproof.

e) All the limit switch contacts shall be wired in a terminal box (part of actuator) suitable for termination of 14 x 1.5 mm^2 control cable.

The filter shall be designed for following parameters:

- Normal and maximum flow rate
- Minimum Inlet Pressure
- Filtration Degree absolute
- Inlet TSS in mg/l or ppm
- Minimum water used for draining / flushing
- Cleaning Mechanism
- Mechanical Life of screens and housing

Normal and Maximum Flow rate: The maximum flow rate the filter should be able to handle shall be minimum 20% of the normal flow rate.

Minimum Inlet Pressure: The minimum inlet pressure provided for the filter shall be in the range of 1.5 to 2.0 bars. No back wash pumps shall be used for cleaning purpose

Filtration Degree absolute: The filter design shall be based on weave wire screen – 4 layer wherein the filtration degree to be achieved shall be by 2^{nd} layer screen. The minimum useable area of the screen shall be 6:1 or 32% of the proposed screen area. Wedge wire screens can be used as one of the layer.

Inlet TSS in mg / or ppm: Based on the inlet TSS load the filter selection shall be done accordingly with minimum flushing cycles.

Minimum water for flushing: The water used for flushing shall not exceed 1 to 2% of the rated flow and the filter shall always deliver at the outlet of 98% of the rated flow. No standby filters are envisaged for this application.

Cleaning mechanism: The cleaning mechanism shall be of spring loaded suction nozzles to ensure uniform cleaning of the screen. The cleaning mechanism shall be suitable for number of flushing cycles online basis with no downtime and should be activated either by pressure differential or timer whichever is earlier.

Mechanical life of screens / filter housing: The screens shall be in SS316L material for surface water (rivers, lakes etc.) and for sea water the screens shall be of 6MO (254) material grade. Housings shall be in high grade carbon steel with suitable sandblasting and epoxy coating with polyester coating.

The control panel shall be provided with the following control and monitoring.

- Common Selector switch to operate the system in following mode.
- PDS mode.
- PDS & Timer Mode
- Continuous Flushing Mode

The filters shall be having arrangement to do manual flushing with the help of test button on the front of the control panel as well by simulation locally on the filter by closing the small ball valve for 5 sec and re-opening it, thus creating an artificial backflush cycle.

SURFACE PREPARATION AND PAINTING

Blasting with steel balls on the surface to achieve as SA 2.5 quality according to the requirements of the Swedish standard organisation (SIS)

Phosphatization according to the American Federal specification procedure TT-C-490D- Type 1, also included degreasing by immersion of the product in tank containing various chemical solution.

DUPLEX STRAINER - EQUIPMENT SPECIFICATION

Duplex basket filters shall be installed on water pipelines to arrest suspended particles of 1000 microns or bigger size in supply water.

- Strainers/Duplex basket filters shall be of cylindrical MS construction.

- Strainers/Duplex arrangement with built-in valves shall be such that one element will always remain in operation ensuring continuous uninterrupted supply of filtered water from each strainer. It should not be possible to isolate

both the strainers simultaneously due to even inadvertent rotation of hand wheels for movement of valve disc during changeover from one basket to another. The changeover valves shall have manual drive.

- Basket Filter bodies and internals shall be designed to withstand design pressure with normal surges.

- Pressure equalizing connections for both the chambers shall be provided for smooth changeover.
- Two nos. dial type pressure gauges of size 150 mm dia shall be provided suitably mounted at the inlet and outlet mains of each strainer.
- Differential pressure switch with alarm contacts shall be provided for each unit of the main strainer across inlet and outlet for operation at a differential pressure adjustable within 0-1 kg/cm^2.

- Flush drain valve and vent shall be provided for each unit of the main strainer. The design of the strainer shall be suitable for easy maintenance and replacement of the parts and inspection.

- Each strainer shall be provided with basket opening area (six times of pipe cross section area or bigger) to ensure high flow volumes at low pressure and a long service life.

- Provision shall be made for collection of drainage water from the strainers.
- Valves to be supplied shall conform to the following standards. Pressure rating of all valves shall be 16kg/cm^2.

Gate valves	:	IS : 14846-2000 .
Globe valves	:	IS : 778-1984 reaffirmed in 1990.

Y – STRAINERS - EQUIPMENT SPECIFICATION

Y – Strainers of suitable sizes shall be installed at water pipelines to arrest suspended particles are in the scope of the contractor.

- The body of the Strainer will be MS fabricated.
- Element will be SS 304
- Screwed for 50 NB and below Flanged for 65 NB and above
- Mesh size will be 1 mm
- Test pressure will be 15kg/cm^2.

SHOP TESTING

Testing and inspection of equipment and materials shall be carried out at the works of the Contractor or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of

Technical Specifications, approved drawings, authenticated manufacturing drawings and reference Indian/International standards.

Tests to be conducted at the shop for various assemblies/sub-assemblies of equipment shall include, but not be limited to the following:

- Material test.
- Tests during manufacture/fabrication.
- Dimensional checking.
- Hydraulic test at the shop.
- Performance test.
- Any other test as required

SUPPLY OF FOLLOWING DOCUMENTS AT THE TIME OF DELIVERY OF EQUIPMENT.

- All the finally approved GA drawings and cross sectional drawings/documents indicating overall dimension and bill of materials , Specifications / details of each including bought out items of complete assembly and sub assembly of the equipment in required sets together with two copy of good quality polyester reproducible.

4.15 DESIGN CRITERIA FOR PRE TREATMENT PLANT

PRETREATMENT

STILLING CHAMBER & FLASH MIXERS

Stilling chambers shall be designed to provide adequate retention time for optimal functioning of the system.

Flash mixer shall be designed to provide adequate mixing time with the coagulant.

As such suitable piping arrangement on inlet side and outlet side of flash mixers is to be provided along with necessary isolation valves. Pipes leading to clariflocculators, structural ladders, platforms, hand-railings, etc. shall also be provided. Coagulant preparation and dosing system shall also be provided. The outflow Pipes shall be adequately supported.

RCC CLARIFLOCCULATOR

- Clariflocculator complete with all mechanical and electrical accessories shall be designed in such a way that each can handle required quantity of raw water.
- The clariflocculator shall also contain overflow weir, peripheral launder for collection of clarified water, sludge raking arms with MS scrappers and squeezes attached to the bladder, sludge drainage pipeline with telescopic arrangement, sludge chamber alongwith necessary instrumentation and protection system.
- Walkways with handrails shall be provided along the periphery of the clariflocculators and on the moving bridge assembly. The clarifiers shall be connected to the first floor of chemical house by suitable structural / RCC walkway.
- Suitable measures for proper cleaning, flushing of the clariflocculator and its various components shall be provided.
- Suitable platforms, handrails, approach staircases/ ladders etc. shall be provided for the clarifier.
- Tenderer shall fill in the data sheet for the clariflocculator

PRESSURE FILTERS

The pressure filters and the connected equipment shall be designed, manufactured and tested as per relevant IS/IPSS or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated.

Mode of operation of the pressure filters shall be semi-automatic. Initiation of backwashing is by the operator from the Control Panel. Process of the backwashing and bringing the filter to the normal stream to be done automatically. Double flanged butterfly valves with rack and pinion type rotary pneumatic actuators shall be provided for this purpose.

The surface loading shall be decided as per quality requirement of filtered water.

The design, fabrication, inspection and testing of the pressure filter shall conform to IS: 2825- 1969 (RA 1984).

At least 60% of free board shall be left over the filtering media.

The pressure filters shall have air scouring facility prior to back washing.

Back wash cycle for each filter shall be once in every 24 hrs. Over Head Tank with compartments and required capacity having staging height of minimum 15 m shall be provided for back washing of filters. The complete piping from the backwash water tank to all the filters for supplying the back wash water to be provided. Drain and overflow pipelines with valves for all the back wash tanks to be provided.

Suspended solids content in the filtered water shall not exceed 5 ppm.

The piping system and control valves shall be provided in front of the vessel for smooth operation. The same shall include contaminated water inlet, filtered water outlet, back wash inlet, waste water outlet, drain, air scouring and air vent.

Pressure filters shall be provided with access manholes for filling and charging of gravel, sand and for maintenance purposes.

Pressure filters shall be of vertical type and shall be provided with built in legs with proper supports to the concrete.

The filter shall be provided with unfiltered water distributors and header lateral type under-drain collecting system.

Maximum pressure loss across the filters should not be more than 8 mWc.

- The minimum depth of filtering media bed shall be decided on the basis of the filter media offered and shall not be less than 750 mm. Atleast 60% of free board shall be provided over the filtering media bed.

- The pressure filters shall have air scouring facility prior to backwashing for which the Contractor shall provide two air blowers (1W + 1S) complete with accessories and entire piping with valves.

- Backwash cycle for each filter shall be once in every 24 hours. 2 nos. (1W + 1S) backwash water pumps of suitable capacity and head will be provided.

- Necessary piping system and control valves shall be provided for the filter for smooth operation. The same shall include influent water inlet, filtered water outlet, backwash water inlet, waste wash water outlet, air scouring inlet, air vent, drain cock, sampling cocks etc. All valves shall have flanged connections and shall be supplied by the Contractor with matching flanges, nuts, bolts and gaskets.

- Pressure filters shall be provided with access manholes of minimum 500 mm size for enabling the filling and changing of filter media and for maintenance purposes.

- Filters shall be of vertical type and shall be provided with built in legs.

- The filter shall be provided with inlet water distributors and header - lateral type under drain collecting system.

- Sampling points along with valves for inlet and outlet water shall be provided.

- Inspection opening shall be provided to inspect the internals and filtering media.

- The pressure filter vessel shall be internally painted with 3 coats of anti – corrosive paint and shall be coated externally with a protective paint.
- Quality of outlet water shall be such that suspended solids content shall not exceed 5 ppm.

CHEMICAL STORAGE CUM PREPARATION/ DOSING AREA

The Contractor shall design the chemical dosing/ storage system ensuring the following:

- The chemical house shall be of two storied building having minimum two entries. One entry shall be provided with a ramp for truck entry.

- The ground floor shall be used for storage of chemicals and the first floor shall have chemical solution preparation tanks.

- The chemical storage capacity shall be for a minimum of 30 days consumption of chemicals.

- The process of preparation of chemical solution shall be designed so that it is safe to operate.

- Each of the solution tanks shall have a capacity to meet the system requirement.

- One weighing machine shall be provided at the ground floor and weighed amount of chemicals shall be transported to the first floor. A pallet box shall be provided for lifting the chemicals. Six pairs of gloves for handling of chemicals along with measuring jars, dissolving trays etc. shall be provided for safe and proper handling and measurement of the chemicals.

- Metering pumps with SS internals shall be used for dosing the Polymer, Lime and Liquid Poly-electrolyte solutions to the flash mixer.

- Two pumps (one working + one standby) shall be provided each for dosing polymer, lime and Poly-electrolyte.

- Each of the solution preparation tanks and solution handling tanks shall be provided with agitators with electric drive. Material for agitator shaft and paddles shall be stainless steel (AISI 304).

- The solution preparation and holding tanks shall be interchangeable.

- The valves shall be of CIRL Diaphragm valves for polymer & Poly-electrolyte and CS Gate valves for lime.

- No effluents from the chemical house shall be discharged into the storm water drainage system after neutralization. The contractor is to provide suitable facilities to achieve zero discharge of effluents.

- Tenderer shall fill in the data sheet for chemical solution-cum-dosing tank and metering pumps.

SLUDGE PUMPING SYSTEM

- Two sludge pumps shall be provided for the clariflocculators. The capacity and head of the pumps shall be decided based on the sludge characteristics. The sludge pumps shall be of Ni hard, non clog, centrifugal type.

- Sludge pumping system shall be so designed that the pump, pipe network and valves shall be flushed with industrial water after completing the cycle of pumping.

AIR BLOWERS

- Three twin lobe type air blowers (Two working and one reserve) complete with accessories and piping shall be provided by the tenderer for air scouring of the filters. The air blowers shall be of oil free type.

- The air blowers shall be complete with drive motor, D.O.L starter, base plate, coupling, coupling guard, bolts, nuts and gaskets, air filter, etc.

- The capacity and pressure of the air blower shall be decided to suit the requirement of the filters. The drive motor shall be selected with at least 15 % overload margin over the maximum shaft power requirement.

SLUDGE AGITATORS

001 2 Nos. agitator assemblies shall be provided for installation in the open topped slurry storage tanks to ensure the following:

a) To keep the solids in an appropriate degree of suspension

b) To prevent formation of stagnant conditions at any point of the tank

c) To facilitate intermittent batch pumping of the slurry in a predetermined controlled manner without differential accumulation of size fractions within the tank.

002 The slurry storage tanks will be of RCC construction will be constructed by the Tenderer having required storage capacity. The tank will receive the underflow sludge discharged from the clarifier on a continuous basis and shall also receive the waste wash water and rinse water discharged from the Filter on a batch-basis during the back washing period.

003 The selection of the correct agitator mechanism shall be based on selection of the appropriate propeller diameter and rotational speed to ensure that sufficient axial force is developed to maintain the solids in suspension in the storage tank to suit the aforesaid tank dimensions and the slurry characteristics.

004 The agitator shall be of axial flow, single MIL (minimum induced loss) propeller type designed for the requisite duty conditions. The propeller shall be specifically designed to minimise the induced losses that are generated by the vortex sheets created by the pressure differentials in the liquid near the propeller trailing edges.

005 Each agitator assembly shall consist of a super structure which shall be mounted on the open topped slurry storage tank and shall support the gear box, motor, V-belt drive, shaft, propeller, etc. The super structure shall be fitted with necessary walkways and handrails also.

006 Each agitator shall consist of the following major components: -

a) **Propeller:** - Keeping in view the height: area ratio of the tank and the anticipated percentage value of solids in the slurry, only one propeller will be used which shall be located at the bottom of the shaft. The propeller blades shall be made from steel and bolted to the flange(s) of the agitator shaft. The propeller assembly shall be balanced within limits, which shall be dictated by the weight and the proposed operating speed. Tenderer shall recommend whether the propeller blades are to be covered with any abrasion resistant rubber.

b) **Propeller shaft:** - The propeller shaft shall be constructed from carbon steel and shall be provided with flanges welded to it at the top, bottom and intermediate positions (as required). The dimensions of the shaft shall be so selected that the running speed does not exceed 50% of the critical speed.

c) **Drive:** - Gear reducer drive shall be provided to suit to the exact duty requirements for the agitator. Medium sized propellers may be driven by gear boxes with vertical input shaft and vertically mounted motors and larger units will be driven by gear boxes with horizontal shaft and horizontally mounted motors. The gear box will be of multi stage, helical gear variety and the complete gear and shaft assembly shall be housed in a high grade cast iron housing. The gear box shall be driven by a standard 4 pole motor via V-belts and pulleys fitted with tapered bush. The output shaft shall be fitted with a cast steel half coupling to match the propeller shaft.

SLUDGE HANDLING SYSTEM

As part of the water treatment plant, a sludge handling system shall be provided like centrifuge or filter press as per the system requirement complying to IS standards.

The sludge dewatering plant shall be capable of producing filter cake of low moisture consistently. Suitable mode of filter cake discharge shall be provided under the sludge handling plant so that the filter cakes can be conveyed by trucks for final disposal.

The dewatering station shall be PLC controlled and operated from a control room located in the chemical house.

4.16 DESIGN CRITERIA FOR ELECTRIC HOIST

ELECTRIC HOIST

The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of Electric hoist of various capacity.

TECHNICAL SPECIFICATION

a) The hoist shall be designed in accordance with IS:3938-1983.

b) For outdoor hoists, motors, brakes & other equipment shall be covered to suit to outdoor operations.

c) All trailing cables shall be clamped with PVC or non-metallic clamps.

d) Defects in the materials like fractures, cracks, blowholes, or laminations are not allowed.

e) No cast iron parts shall be used except for electrical equipments and no wood or combustible material shall be used unless specifically mentioned otherwise.

f) All working parts requiring replacements or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

g) All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washer.

h) All parts of the hoist shall be thoroughly cleaned of all loose mill scales, rust or foreign matter & then painted as specified. All parts inaccessible after assembly shall be painted before assembly & assembled while paint is still wet.

i) All parts except motors, resistors, gears, thrustors, solenoids, etc. shall be de-rusted manually & painted as follows:

Mechanical details

1. **Wheel & drive**

The electric hoist shall run on two pairs of wheels, a pair of which shall be driven by flange mounted motor through reduction gear. The wheels shall be of cast steel/forged steel, single flanged with taper / parallel treads to suit to monorail. The

wheels shall be mounted on anti-friction bearings & shall be easily removable for repair & replacement. The wheel diameter shall be selected such that skidding does not take place even under unloaded condition.

2. Hoist mechanism

The hoist mechanism shall consist of a bottom block fitted with a standard forged swivel hook of the specified capacity, supported on 2 or 4 falls of wire rope. However, non-spinning type of wire rope shall be used for 2 falls rope arrangement. The wire rope shall be wound on a grooved drum which shall be sufficiently long to accommodate in one layer the length of rope requisite for the specified lift & in addition not fewer than two turns at each anchored end & one spare groove at the opposite end. The hoist drum shall be motor driven.

3. Gearing

Straight & helical spur gearing shall be used for all motions. Worm & bevel gears shall not be used with specific permission from purchaser. Preferably all first reduction gears shall have single helical teeth. All gears shall be hardened & tempered alloy or carbon steel with machine out teeth. Surface hardening of teeth is not acceptable. All gears shall be enclosed in oil filled gear box except when not possible.

4. Motors/ Couplings

For Hoists above 5T, the motor (Foot mounted B3 type) shall be connected to its gear drive by a flexible coupling. Flange mounted motors (B5) may be used for Hoists of capacity upto 5T and also for traverse drive of hoists.

5. Lubrication

All gears & bearings shall be lubricated either by splash lubrication or by grease. If possible, all the lubricating points shall be grouped together in easily accessible positions.

6. Bearings

Ball & roller antifriction bearings of reputed make shall only be used, with minimum bearing life as per IS: 3938.

7. Brakes

D.C. Electromagnetic brake / DC disc brakes shall be used for Hoist motion. For LT, CT and slew motions (in case of Jib cranes), DC disc brakes shall be used.

8. The Electric hoists shall be inspected as per IS: 3938 - 1983 and as specified in GCC.

DATA (ELECTRIC HOIST)

01 General

1. Item number :
2. Location :
3. Capacity :
4. Duty classification :
5. Total weight of hoist :
6. Make :

02 Hoist

Speeds with safe working load :
Lifting height :
a) Above floor level :
b) Below floor level :

Wire ropes
a) Type of construction :
b) Size :
c) Number of falls :
d) Factor of safety :

Rope drum :
a) Materials :
b) Diameter :
Drives
a) Type & material of gear box :
b) Gear & pinion :
c) Material & hardness :

Motors
a) Type & number :
b) Kw rating :
c) Synchronous speed :
d) Class of insulation :
e) Pull out torque :
f) Frame size :

Brakes :
a) Type :
b) Size :
c) Torque rating :
_ Type & details of limit switches :

_ Type of couplings :
_ Type of bearings :

Lifting hook
a) Type :
b) Material :
_ Type & details of control :

03 Trolley
_ Speed with safe working load :
Wheels
a) Numbers :
b) Diameter :
c) Material & hardness :
d) Max. wheel load :
e) Wheel base :

Drive
a) Type & material of gear box :
b) Gears & pinions :
c) Material & hardness :
d) Kw rating :
e) Synchronous speed :
f) Class of insulation :
g) Pull out torque :
i) Frame size :

Brakes
a) Type :
b) Size :
c) Torque rating :

Type & details of limit switches :
Type of coupling :
Type of bearings :
Type & details of controls :

04 Clearance diagram indicating the basic : dimensions
05 Type & lubrication provided :
06 Type & size of cables :
07 Location & control details of hoist : block power feeding arrangement

4.17 DESIGN CRITERIA FOR HAND OPERATED CRANE

HAND OPERATED CRANE

The **scope of work** of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of Hand Operated Crane of various capacity.

Technical Specification of Manual Hoist with Traveling Trolley

The bridge shall consist of main girder which shall be of steel section and with an auxiliary structure where necessary. Girder shall be sufficiently strong and rigid to withstand the most severe combination of loads that may develop under different working conditions.

The bridge shall not deflect more than 1/900 of span with safe working load on the trolley, with trolley stationed at mid span and excluding deflection due to dead load. There shall be no permanent set when the crane is loaded with 1.25 times the safe working load.

The bridge girder shall be connected to the end carriages by large gusset plates. The bridge girder shall be attached to the end carriages by turned fitted bolts.

Match marks shall be provided on each girder to facilitate erection and squaring of the bridge.

End carriages made of twin channels construction shall be amply strong to resist all stresses likely to be imposed on them under severe condition, including collision with other cranes or stops. The end carriage shall be of sufficient width and this length shall be such that no other part of the crane is damaged in collision. The end carriage shall be provided with substantial safety devices to prevent the crane from falling more than 25 mm in the event of breakage of a track wheel on axle. These safety devices shall not interfere with the removal of wheels. Jacking pad device shall be provided on end carriage and this shall not in any case interfere with the replacement of track wheels, but shall be located as near to the wheels as possible.

DATA

1. Equipment No. :
2. Capacity :
3. Quantity :
4. Height of Lift :
5. Travel distance
6. Class of Duty :
7. Make :
8. Minm . Radius of Curvature of Track beam size: :
9. Max. Trctive effort (Kgs)
   - Hoist :
   - Cross Travel
   - Long Travel :
10. Movement in 'm' corresponding to operating chain movement of 30m.
    - Hoist :
    - Travel

4.18 DESIGN CRITERIA FOR MANUAL HOIST

MANUAL HOIST

The **scope of work** of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of manual hoist with traveling trolley of various capacity.

Technical Specification of Manual Hoist with Traveling Trolley

- Ball and roller anti frictional bearing only shall be used.
- Swiveling type standard shank hook mounted on grease lubricated anti-friction thrust bearing shall be used.
- The Chain Pulley Block shall conform to class-I duty as per IS: 3832-1986.
- Load chain & operating chain shall be of calibrated type.
- Pulley used for the operating mechanism shall have suitable guards to prevent the operating chain from coming out.
- All the open gearing shall have suitable cover.

DATA SHEET

1. Equipment No. :
2. Capacity :
3. Quantity :
4. Height of Lift :
5. Class of Duty :
6. Make :
7. Minm . Radius of Curvature of Track beam size: :
8. Max. Trctive effort (Kgs)
   - Hoist :
   - Travel :
9. Movement in 'm' corresponding to operating chain movement of 30m.
   - Hoist :
   - Travel

4.19 DATA SHEETS

4.19.1 DATA SHEET FOR PUMPS

A. HORIZONTAL CENTRIFUGAL PUMP SETS

(To be furnished by the Tenderer separately for each group of pumps)

Sl. No	DESCRIPTION	Data to be filled in by Tenderer
1	Type of pump	
2	Make and model of pump	
3	Pump operating characteristics a) Rated capacity of each pump m3/h	
	b) Total dynamic head (TDH) at rated capacity mWC	
	c) Shut off head mWC	
	d) Speed rpm	
	e) Pump efficiency at rated conditions %	
	f) Pump shaft power at rated capacity kW	
	g) Required NPSH mWC	
	h) Type of gland sealing	
	i) Mode of connecting pump to motor	
	j) Direction of rotation	
	k) Impeller diameter (min, rated, max)	
	l) Type of end connection - Suction flange bore - Discharge flange bore - Drilling standard for flanges	
	m)Setting depth(In case of vertical pumps)	
4	a) Type of shaft seal	
	b) In case of external water seal(required water pressure)	
5	Bearings	
	a) Type	
	b) Make	
	c) Quantity provided	
	d) Type of lubrication required	

6	Couplings	
	a) Type	
	b) Make	
	c) Coupling guard provided or not	
7	Base plate with holding down bolts and nuts provided or not	
8	Companion flanges at suction and delivery of pump included or not	
9	Weight	
	a)Pump	
	b)Base plate/motor stool	
	c) Accessories	
10	Materials of Construction of pump components (Indicate the applicable IS/BS/ASTM standard and grade)	
	a) Impeller	
	b) Casing	
	c) Casing ring	
	d) Impeller ring	
	e) Shaft	
	f) Shaft sleeve	
	g) Gland	
	h) Base frame	
	i) Companion flanges	
	j) Bearing	
	k) Suction strainer	
11	Drawings enclosed	
	a) GA drawing	
	b) Catalogue	
	c) Predicted performance curves	
	d) Speed vs torque curve for pump considering open valve operation	
	e) Speed vs torque curve for motor	

B MOTOR FOR HORIZONTAL PUMPSET

Sl No.	DESCRIPTION	Data to be filled in by Tenderer
1.	Application standard	
2.	Rated power supply	
3.	Voltage variation	
4.	Frequency variation	
5.	Combined variation	
6.	Ambient temp	
7.	Relative humidity	
8.	Rated kW	
9.	Derating factor for rating at 50^0C over standard continuous motor rating at 40^0C	
10.	Method of starting	
11.	Max. permissible winding temp by resistance method	
12.	Starting current	
13.	Starting torque	
14.	Pull out torque	
15.	Motor overload and over speed capabilities	
16.	Motor frame size selection	
17.	Bearing	
18.	Degree of protection	
19.	Terminal box	
20.	Accessories	
21.	Application	
22.	Make	
23.	Quantity	
24.	RATED kW at 50^0C	
25.	Rated speed	
26.	Rated kW at 40^0C S1 duty (kW)	
27.	Motor Frame size selected	
28.	Full load current	
29.	Starting current	
30.	Motor no-load current	
31.	Ist /Ir	
32.	Tst/Tr	
33.	Mounting	
34.	Duty cycle	
35.	Overload capacity	
36.	Class of insulation	
37.	Max winding temperature by resistance method	
38.	Direction of rotation	
39.	Rated voltage & voltage/frequency variation	

40.	Operation at 80% rated voltage for 5 minutes	
41.	No. of starts/hr (equally spread) permissible	
42.	No. of cycles/hr (equally) spread permissible	
43.	Motor starting torque	
44.	Locked rotor torque	
45.	Pull up torque	
46.	Pull out torque	
47.	Degree of protection of motor enclosure	
48.	Degree of protection of terminal box enclosure	
49.	Motor type & ref. Standard	
50.	Power factor at no load and full load	
51.	Efficiency at no load and full load	
52.	Design ambient temperature and relative humidity	
53.	Double compression Brass Cable glands (Qty & size) as part of motor supply	
54.	Space heater	
55.	Double shaft extension	
56.	RTD's / BTD's	
57.	Weight of motor	
58.	Power terminals	
59.	Control terminals	
60.	No. / Cable (AYRY OR AYFY type) size considered for termination	
61.	Stator resistance and inductance per phase	
62.	Size of Terminal box	
63.	Motor GA drg. for the frame selected (To be submitted for each type of motor)	
64.	Motor speed torque characteristic (to be submitted for each type of motor)	
65.	Motor performance characteristic curves (to be submitted for each type of motor)	
66.	Shear motor overload data/other to be furnished based on details given by	

B. VERTICAL CENTRIFUGAL PUMPS
(To be furnished by the Tenderer separately for each group of pumps)

Sl. No	DESCRIPTION	Data to be filled in by Tenderer
1	Type of pump	
2	Make and model of pump	
3	Quantity	
4	Pump operating characteristics a) Capacity of each pump(Rated,Min. and Max.) m^3/h	
	b) Total dynamic head (TDH) at rated capacity and Shutt off Head mWC	
	c) Speed rpm	
	d) Pump efficiency at rated conditions %	
	e) Pump shaft power at rated capacity kW	
	f) Required NPSH mWC	
	g) Type of gland sealing	
	h) Mode of connecting pump to motor	
	i) Direction of rotation	
	j) Impeller diameter (min, rated, max)	
	k) Type of end connection - Suction flange bore - Discharge flange bore - Drilling standard for flanges	
5	a) Type of shaft seal	
	b) In case of external water seal(required water pressure)	
6	Bearings	
	a) Type	
	b) Make	
	c) Quantity provided	
	d) Type of lubrication required	
7	Couplings	
	a) Type	
	b) Make	
	c) Coupling guard provided or not	

8	Base plate with holding down bolts and nuts provided or not	
9	Companion flanges at suction and delivery of pump included or not	
10	Weight	
	a)Pump	
	b)Base plate/motor stool	
	c) Accessories	
11	Materials of Construction of pump components (Indicate the applicable IS/BS/ASTM standard and grade)	
	a) Impeller	
	b) Casing	
	c) Casing ring	
	d) Impeller ring	
	e) Shaft	
	f) Shaft sleeve	
	g) Gland	
	h) Base frame	
	i) Companion flanges	
	j) Column pipe	
	k) Suction strainer	
12	Drawings enclosed	
	a) GA drawing	
	b) Catalogue	
	c) Predicted performance curves	
	d) Speed vs torque curve for pump considering open valve operation	
	e) Speed vs torque curve for motor	

D MOTOR FOR VERTICAL PUMPSET

S.No	DESCRIPTION	Data to be filled in by Tenderer
1.	Type	
2.	Make	
3.	Rated kW at 50 ^{0} C s1 duty	
4.	Rated kW at 40 ^{0} C S1 duty	
5.	Rated voltage & system condition	
6.	Frame size	
7.	Class of insulation	
8.	Rated speed & direction of rotation	
9.	Rated current	
10.	Starting current	
11.	Operation at 80% rated voltage for 5 minutes	
12.	Operation at 150% rated current for 2 minutes	
13.	No. of starts/hr (equaly spread) permissible, from cold condition.	
14.	No of starts in quick succession. a) From Cold Conditions b) From Hot Conditions	
15.	Locked rotor withstand time at 110% rated voltage	
16.	Locked rotor torque	
17.	Pull up torque	
18.	Break down torque	
19.	Max. permissible GD^2 of load	
20.	Nema Classification for speed-torque characteristics	
21.	Max. winding temperature by resistance method	
22.	Type of construction	
23.	Whether casing feet is integral with the frame	
24.	Degree of protection of enclosure	
25.	Material of stator frame	
26.	Number and size of aluminium cables that can be terminated	
27.	Earthing system provided inside Terminal box	
28.	Detail of thermal protection	
29.	Weight in Kg.	

4.19.2 DATA SHEET FOR PLATE HEAT EXCHANGER

S. No.	Description	Unit	Data to be filled in by Tenderer	
1	General			
1.1	No. of Plate heat exchangers	Nos.		
1.2	Manufacturer			
1.3	Model No. / Type		Plate type	
1.4	Whether single or double pass		Single	
2	Design			
2.1	Design Pressure	Bar(g)		
2.2	Design Temperature	^{0} C		
2.3	Heat Load	Kcal/h		
2.4	LMTD(Corrected)	^{0} C		
3	Guaranteed performance for each heat exchanger		Primary Soft Water)	Secondary side(Industrial water)
3.1	Flow rate	M^3/h		
3.2	Inlet Temperature	^{0} C		
3.3	Outlet temperature	^{0} C		
	a) In fouled conditions			
	b) In clean conditions			
3.4	Total Pressure drop across heat exchanger from inlet to outlet	Bar(g)		
	a) For design flow			
	b) For 110% of design flow rate			
4	Heat transfer and fluid flow data		Primary Side(Hot fluid)	Secondary side(Cold Fluid
4.1	Film heat transfer coefficient	Kcal/ hr/M^2/0 C		
4.2	Fouling factor	M^2/hr ^{0}C / Kcal		
4.3	Overall fouling	M^2/hr ^{0}C / Kcal		
4.4	Overall heat transfer coefficient	Kcal/ hr/M^2/ ^{0}C		
	a) In fouled conditions			
	b) In clean conditions			
4.5	Total Effective heat transfer area per heat exchanger	M^2		
4.6	Average velocity	m/s		

	a) Through ports			
	b)Through plate channels			
4.7	Pressure drop in ports	Bar(g)		
	a) In clean conditions			
	b) In fouled conditions			
4.8	Pressure drop in channels	Bar(g)		
	a) In clean conditions			
	b) In fouled conditions			
4.9	Maximum differential pressure between hot and cold fluids in plate channels(Operating)	Bar(g)		
5	Heat transfer Plates			
5.1	Area of each plate	m^2		
5.2	Dimension(Width x height)	mm x mm		
5.3	Thickness	mm		
5.4	Material and chemical composition		AISI 316	
5.5	Number of plates per heat exchanger	Nos		
5.6	Maximum number of plates that can be accommodated in the heat exchanger frame	Nos		
5.7	Type of corrugation		Herringbone	
5.8	Maximum plate pack length	mm		
	a) as per 5.5 above			
	b) As per 5.6 above			
5.9	Average spacing between two plates	mm		
5.10	Number of contact points for each plate	Nos		
5.11	Hold up volume of each passage	M3		
5.12	Port Size(Diameter)	mm		
6	Plate Gaskets			
6.1	Type		Glued	
6.2	Material and chemical composition		Nitrile Rubber	
6.3	Thickness of gasket	mm	5	
6.4	Hardness of gasket		72 + 5 deg.	
6.5	Expected life of gasket	Years	5	
7	Carrying bar			
7.1	Type of construction		Stdd. I section beam	
7.2	Number per heat exchanger	Nos		

7.3	Size			
7.4	Material		CSIS:2062 with SS Cladding	
8	Guide bar			
8.1	Type of construction		Stdd. I section beam	
8.2	Number per heat exchanger	Nos		
8.3	Size			
8.4	Material		CS IS 2062	
9	Frame plate			
9.1	Type of construction		Fabricated - profile cut	
9.2	Material		CS IS:2062	
10	Pressure plate			
10.1	Type of construction		Fabricated - profile cut	
10.2	Material		CS IS:2062	
11	Supporting columns			
11.1	Type of construction		Stdd. I section beam	
11.2	Material		CS IS:2062 GR B	
12	Clamping / Gasket compression arrangement			
12.1	Type of arrangement		Tie rod type	
12.2	Bolt size and material		ASTM 193 B7	
12.3	Nuts size and material		ASTM 194 2H	
13	Inlet and outlet nozzles		Primary fluid)	Secondary side(Cold Fluid
13.1	Size	mm		
13.2	Rating		150 Class	150 Class
13.3	Facing and drilling standard		Weld RF	ANSI B 16.5
13.4	Flange material		ASTM 105	
13.5	Are all nozzles counter flanges, bolts, nuts and gaskets etc. included in the offer		Yes(Studded End Connections)	
14	Cleaning frequency of the heat exchanger for assumed fouling factor	months		
15	Is backwash necessary		NO	

16	Are all auxiliaries and accessories included in the offer		YES / NO
17	Local temperature indicators		
17.1	Manufacture & Type		
17.2	Number per heat exchanger	Nos	
17.3	Dial size	mm	
17.4	Range		
17.5	Accuracy		
17.6	Material of construction		
18	Local Pressure gauges		
18.1	Manufacturer & Type		
18.2	Number per heat exchanger	Nos	
18.3	Dial size	mm	
18.4	Range		
18.5	Accuracy		
18.6	Material of construction		
19	Differential pressure gauges		
19.1	Manufacturer & Type		
19.2	Number per heat exchanger	Nos	
19.3	Dial size	mm	
19.4	Range		
19.5	Accuracy		
19.6	Material of construction		
20	Relief other valves (if applicable)		
20.1	Location		
20.2	Type and size		
20.3	End details		
20.4	Materials		
	a) Body		
	b) Trim		
20.5	Pressure rating		
20.6	Number per heat exchanger	Nos	
20.7	Manufacturer		
21	Are all counter flanges, bolts, nuts and gaskets etc. for all terminal points included in the offer		Yes(Studded end connections)
22	Are all heat exchangers supplied with necessary foundation plates, anchor, bolts, sleeves, inserts, lifting lugs etc., as specified		Yes
23	Shot tests & Inspection		

23.1	Whether all tests and inspections as detailed in specification / quality plan will be carried out		All standard tests will be carried out
23.2	Hydrostatic test		
	a) Test Pressure	bar(g)	15
	b) Test duration	min.	20
23.3	Are all plates checked for cracks and other defects by penetration method? If not, what percentage is checked		10 % Dye penetrant test
23.4	Whether hardness test will be conducted for plate gaskets		Test reports of sub vendors will be provided
24	Details of painting		
24.1	Exterior surface		YES
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
24.2	Interior surface		
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
25	Weight of each heat exchanger	Kg	
	a) Empty		
	b) Flooded		
26	Overall Dimensions		
	Length x breadth x height	mm x mm x mm	
27	Withdrawal space		min. 1 m from all sides
28	Other information (If any)		

4.19.3 DATA SHEET FOR STORAGE TANKS

Sl. No.	Description	Filtered water	Reject water	Chemicals	Acid	Alkali	Any other
1.	Nos. offered						
2.	Chemical to be stored						
3.	Type of tank						
4.	Nominal capacity, m^3						
5.	Diameter, mm						

6.	Height/ length, mm						
7.	Material of construction						
8.	Internal surface protection						
9.	Thk.of shell & dished ends, mm						

4.19.4 DATA SHEET FOR MEASURING TANKS

Sl. No.	Description	Acid measuring tanks		
1.	Nos. offered			
2.	Chemical to be stored			
3.	Nominal Capacity, litres			
4.	Diameter, mm			
5.	Depth, mm			
6.	Material of construction			
7.	Internal surface protection			
8.	Agitator - kw (estimated) - rpm			

Sl. No.	Description	Alkali measuring tanks		
1.	Nos. offered			
2.	Chemical to be stored			
3.	Nominal Capacity, litres			
4.	Diameter, mm			
5.	Depth, mm			
6.	Material of construction			
7.	Internal surface protection			
8.	Agitator - kw (estimated) - rpm			

4.19.5 DATA SHEET FOR DOSING PUMPS, (IF PROVIDED)

Sl. No.	Description	Acid dosing pumps	Alkali dosing pumps
1.	Nos. offered		
2.	Type		
3.	Capacity, m^3/h		
4.	Discharge head, mLC		
5.	Material of construction Casing Impeller Motor – hp, - rpm		

mLC - Meter of liquid column.

4.19.6 DATA SHEET FOR BLOWERS

Sl. No.	Description	For filter (If reqd.)		
1.	Nos offered			
2.	Make			
3.	Capacity, m^3/min			
4.	Total head, mWC			
5.	Rpm of blower			
6.	kW of motor			
7.	Rpm of motor			
8.	Type of coupling			
9.	Size of suction/ discharge, mm			
10.	Make of motor			
11.	Material of construction			
12.	Total weight, kg			

4.19.7 DATA SHEET FOR PUMPSETS

Sl. No.	Description				
1.	Nos offered				
2.	Make				
3.	Size of suction/ discharge, mm				
4.	Capacity, m^3/h				
5.	Total head, mWC				
6.	Speed, rpm				
7.	Efficiency at duty point				
8.	Power requirement				

	at duty point				
9.	Material of construction				
10.	Details of stuffing box/ mech seal				
11.	Type of coupling				
12.	Whether coupling guard provided or not				
13.	Base plate material				
14.	Motor make				
15.	Speed, rpm				
16.	Rated output, kW				
17.	Starting torque				
18.	Pull out torque				
19.	Frame size				
20.	Degree of protection				
21.	Type of enclosure				
22.	Class of insulation				
23.	Total weight, kg				

Sl. No.	**Description**	**Acid transfer pumps**	**Alkali transfer pumps**	**Effluent transfer pumps**
1.	Nos offered			
2.	Make			
3.	Size of suction/ discharge, mm			
4.	Capacity, m^3/h			
5.	Total head, mWC			
6.	Speed, rpm			
7.	Efficiency at duty point			
8.	Power requirement at duty point			
9.	Material of construction			
10.	Details of stuffing box/ mech. seal			
11.	Type of coupling			
12.	Whether coupling guard provided or not			
13.	Base plate material			
14.	Motor make			

15.	Speed, rpm			
16.	Rated output, kW			
17.	Starting torque			
18.	Pull out torque			
19.	Frame size			
20.	Degree of protection			
21.	Type of enclosure			
22.	Class of insulation			
23.	Total weight, kg			

4.19.8 DATA SHEET FOR AUTOMATIC BACKWASH FILTER

Sl. No.	Description	Parameters
1.	Flow, m3/hr	
2.	Inlet Pressure, Kg/cm2	
3.	Line Size	
4.	Sieve Size, micron	
5.	Operation	Automatic backwash Self cleaning Filter
6.	Degree of filtration	200 microns
7.	Qty.	

4.19.9 DATA SHEETS FOR VARIOUS EQUIPMENT OF TREATMENT PLANT:

A DATA SHEET FOR FLASH MIXER:

- Nos. offered :
- Design flow rate :
- Detention time :
- Size of flash mixing tank :
- Material of construction of tank :
- Type and details of mixer mechanism :
- Material of construction of mixer :
- Ratio of impeller diameter to tank diameter :
- Rotational speed of impeller:
- Velocity gradient:
- Details of drive:
- Rated kW of motor:
- Motor rpm:

B DATA SHEET FOR HRSCC

- Design Flow (m^3/h):
- Assumed underflow losses:

- Design Inflow (m^3/h):
  of influent raw water (ppm):
- Maxm. suspended solid content
  of effluent clarified water (ppm):
- Sedimentation velocity:
- Retention time

a) Flash mixer zone (minutes):
b) Flocculator zone (minutes):
c) Clarifier zone (minutes):

- Design Sedimentation Area (m^2) :
- Quantity of media required (m^2) :
- Required plan area of each
  clarifier (m^2) :
- Surface loading rate (SLR)

a) Normal ($m^3/m^2/h$) :
b) Maximum ($m^3/m^2/h$) :

- Surface area of each clarifier(m^2) :
- Overall dimension of each clarifier

a) Dia (m) :
b) Height (m) :

- Sludge Zone Volume :
- Sludge bleed off system : Intermittent/Continuous
- Sludge consistency :
- Sludge retention time (min) :
- Weight of assembly :
- GA drawing submitted :

C CHEMICAL SOLUTION PREPARATION-CUM- DOSING TANKS

Nos. offered :
Chemical to be handled:
Nominal capacity :
Dimensions of tank:
Material of construction & thickness:
Interior surface protection:
Mixer/Stirrer Mechanism

i) Number:
ii) Manufacturer:
iii) Speed (rpm):
Material of construction of
i) Propeller/agitator:
ii) Shaft:
iii) Fixing bracket:
Drive details :
Rated kW of drive

NOTE : SEPARATE DATA SHEET SHALL BE FURNISHED FOR EACH TYPE OF THE ABOVE TANKS.

D DATA SHEET FOR METERING PUMPS

Nos. offered :
Type, make :
Capacity (lph) :
Discharge head :
Material of construction of
i) Casing :
ii) Impeller :
- Drive details :
- RPM :
- Rated kW of motor :

(Note : Separate data sheets shall be furnished for each type of the above pumps)

E DATA SHEET FOR PRESSURE FILTER

Type :
Nos. offered :
Design flow rate
i) Normal (m^3/h) :
ii) Maximum (m^3/h) :
iii) Back wash :
iv) Rinse :

Quality of influent water :
i) Total suspended solids (ppm) :
ii) pH :

Guaranteed effluent quality
i) Total suspended solids (ppm) :
ii) Micron size :
iii) pH :

Filtration rate ($m^3/h^2/h$) :
Vessel dimensions
i) Shell diameter (mm) :
ii) Straight length (mm):
iii) Overall length (mm) :

Plate specification and thickness
i) Shell :
ii) Dished end :

Vessel design code :
Design pressure (Kg/cm^2) :
Test pressure (Kg/cm^2) :

Filtration area :
Filter media
i) Type :
ii) Effective size (mm) :
iii) Volume per filter(m^3) :
iv) Life of filtering media :

Media depth (mm) :
Free board (mm) :
Type & MOC of inlet distributor :
Type & MOC of under drain collection system :
Back-wash cycle period :
Guaranteed output between
two successive backwash (m^3) :
Duration of air scour (minutes) :
Specific consumption of scour air ($m^3/h^2/h$) :
Pressure of backwash water (mWC) :

Quantity of backwash water
a) Flow rate (m^3/h) :
b) Total consumption (m^3) :

Quality of backwash water :
Time required for backwash (minutes) :
Time required for rinse (minutes) :
Arrangement of disposal of waste wash water :
Empty weight of filter (kg) :
Flooded weight of filter (kg):

Details of dosing system required for
i) When influent water is received from inclined plate clarifier :
ii) When influent water is received directly from the raw water reservoir :

F SLUDGE AGITATOR DATA SHEET

Nos. offered :
Type and make :
Design considerations
i) Slurry viscosity (CP) :
ii) Max. solid size (mm) :
iii) Max. dry solids sp. gravity :
iv) Max. liquor sp. gravity :
v) Max. solids content (by weight):

No. of propellers :
Propeller diameter :
No. of blades :

Tip speed
Power (kW) at tip speed :
Weight (kg) :
Details of agitator features :
Details of drive system :

Material of construction for
i) Propeller blades :
ii) Propeller shaft :
iii) Gear box housing :
iv) Output shaft:
v) Bearing (upper/lower) :
vi) Bearing housing :

Details of gear reducer :
Details of V-belt drive :
Details of electric motor :
i) Rated kW of motor :
ii) RPM of motor :

Details of super structure :
Weight of super structure :
Details of tank fittings :

G MATERIAL OF CONSTRUCTION

A. GATE VALVE/GLOBE VALVE/BUTTERFLY/BALL (AS APPLICABLE)

B. NON-RETURN VALVE

1.	Body	
2.	Bonnet	
3.	Yoke	
4.	Wedge/Disc	
5.	Spindle	
6.	Seat ring	
7	Yoke Sleeve	
8	Hand Wheel/Chain wheel	
9	Gland Bush	
10	Gland Packing	
11	Gland Flange	
12	Body Bonnet Gasket	
13	Bonnet Bush	
14	Bonnet Stud	
15	Bonnet Stud Nut	
16	Hand Wheel Nut	
17	Lifting Lugs	
18	Companion Flanges	
19	Gasket for Companion Flanges	
20	Fasteners for Companion Flanges	
21	Type of Wedge for Gate Valve	

1.	Body	
2.	Cover	
3.	Hinge	
4.	Hinge Pin	
5.	Hinge Pin Spacer	
6.	Disc	
7.	Seat ring	
8.	Disc Nut	
9.	Disc Washer	
10.	Cotter Pin	
11.	Cover Stud	
12.	Cover Stud Nut	

13.	Gasket for Cover	
14.	Companion Flanges	
15.	Gasket for Companion Flanges	
16.	Fasteners for Companion Flanges	

Testing

1. List & type of tests

2. Testing Standard to be followed

   a. Brief description
   b. Allowable leak rates for pneumatic & hydraulic tests.

3. Wt. of assembled valve.

4.20 LIST OF MAKES

Sl. No.	Item Description	Manufacturers
1.	Filter Press	Panama, Andritz, FL Smith, PURAB Industries, YOTANA, DIEMME
2.	Twin lobe / Centrifugal Blower	Kay International, Patel Blowers, Usha, Turbomax, Siemens, KPT, Swam, Triveni, Manik Lal, Batliboi, Everest.
3.	Agitator / Mixer	Triveni, Remi, Standard Engineers, Ceecons, EIMCO-KCP, Delkor
4.	R O High Pressure Pump	Kirloskar Brothers, Mather & Platt (WILO), KSB, GRUNDFOS.
5.	Evaporators	Chem Process System , Mazda Limited , Unitop , Raj Process & Equipment Pvt Ltd. , Praj Industries, GE, SSP, ALFA LAVAL
6.	ATFD (Automatic Thin film dryer)	Unitop , Raj Process & Equipment Pvt Ltd. , Praj Industries, SSP
7.	HRSCC / UHRSCC	Thermax , Ion Exchange,VA Tech, GEA Energy Systems, Triveni, EIMCO-KCP, HDO.
8.	Centrifuge Machine	Alfa Laval , Humbolt, West Falia, Penwalt, Hiller, FERRUM.
9.	CS Globe Valves	L&T Valves, KSB, Steam & Mining, WeirBDK, KBL, Virgo
10.	Knife Gate Valves	Jash Engineering, Orbinox, Weir BDK, Vass.
11.	PP / CPVC / UPVC Valves	Oriplast, Finolex, George Fischer, Astral
12.	Rotary Pneumatic Actuators	AL Saunders, Xomox, EL-O-Matic, Virgo, L&T, Flocon, Precision Processing Equipt. Co., Rotex, Schradder

Valves (Manual/Auto-on/off/ Control)

1.	Reverse osmosis membrane	Dow , Hydranautics, Koch, GE, CSM
2.	UF Membrane	Dow , Hydranautics, Koch,GE , CSM
3.	Horizontal Centrifugal pumps	KSB , KBL India, M&P India, Flowserve , Sulzer , Grundfos ,ITT , Danfoss, Nanfang, Kishor ,Andritz Zigong, AKAY, Johnson, CRI, Microfinish, JEC
4.	RO HP Pumps	KSB, Flowserve pumps , Sulzer, PEI/ERI ,Duchting, Lowara, M&P, Grundfos , KBL, ITT , Andritz, Danfoss ,Nanfang ,Zigong
5.	Screw pumps/ sludge pumps	Roto pumps, Rotomac ,Johnson pumps, Tushaco
6.	Submersible pumps	KSB India, Grundfos, Matter & Platt ,Kishor , Xylem
7.	Vertical Turbine Pumps	KSB Global, Torishima
8.	Dosing system (solenoid driven)	Grundfos, Heidelberg, Prominent, Milton Roy, Swellore, OBL , Pulsa feeder, Idos Edos, VK Pumps, Seko Pulsation dampener, calibration column, PRV, accessories As per dosing pump manufactures standards
9.	Dosing system (Motor driven)	Grundfos, Heidelberg, Prominent, Milton Roy, OBL Seko , Shapotools, Swellore Pulsation dampener, calibration column, PRV, accessories As per dosing pump manufactures standards
10.	Air blowers	Kay International, Everest blowers, Swam pneumatics, Usha blowers, TMVT
11.	Cartridge filter & cartridges	Geofluid India, Brother Filtration Aquatech , Gopani , Pratham , S.S. Microtech
12.	Pressure vessels & tanks	Jasmino, S.V.Fabricators ,Pinnacle Equipments, Anup Engineers, Fab-tech Pressure Vessels, J.P.Skytek, Essar India, Syscon Engineers India
13.	HDPE/PVC/GRP/FRP Pipes	Astral,George Fischer,CPP ,Sunrise ,

1.	Butterfly valves	Bray Global, GM India, Intervalve , 2L Engineers India, Belgaum Aqua valves, Expert, Deltech,Del Valve,Advance
2.	Diaphragm valves Crane Global / India	Procon, BDK, 2L Engineers, Belgaum Aqua valve, Floway, Expert India, Intervalve India
3.	Gate / Globe / Check valves Weir BDK India	Intervalve,2L Engineers, Belgaum Aqua valves, Expert, Arem, Virgo, Advance valves, Flow serve, Audco Microfinish,
4.	PP / PVC valves	Astral, George Fischer, Ludwig Prahar, Prince Asahi, Sanking
5.	Control valves	Fisher, Xomox Masoneilan, MIL Controls, Dembla, Crane, Severn, Glucon, Tyco, Elomatic, Samson Belimo, Flowserve
6.	Ball valves	BDK India,2L Engineers ,Belgaum Aqua valves, GM , Del Valve ,Microfinish, Gemini, Arem
7.	Plug valves	Dip-Flon Engineering & Co. PTFE India, Polyvalent, Xian valves, BDK ,2L Engineers, Belgaum Aqua valves,Xomox, Xian valves
8.	Rubber liners	Western Rubber, Shriram Rubbertech
9.	Pipes /Flanges/Fittings	Jindal Pipe, Tata Pipe, Gujrat infra Pipes, Jai Ambe, M.S. fittings
10.	Centrifuge	Alpha Laval, Humbolt, Safetech, Ferum, Huada, Pennwalt, Rotofilt, GEA westfalia
11.	Top entry mixer/Clarifier mechanism	Aquatech India,Fiber & Fiber India,Kankan engineers, Maruti Industries, Indofab, EKCP (Emico KCP)
12.	Mechanical vapour compressor	Pillar, Howden / Flaktwoods, Dresser Roots
13.	Crystallizer Recirculation pump	Flow Serve US, Egger Germany, Andritez Europe
Note: The above mentioned are preferred Makes, However vendor approval shall be obtained from KPCL before finalizing the Make from the above list.		

SECTION 5.0

ELECTRICAL SYSTEM

The scope of Contractor shall include Engineering design, manufacture / procure, Quality assurance, inspection, supply including transportation to site, storage at site, transportation from place of storage to erection site, installation, testing, commissioning and handing over in fully operable condition satisfactory to Purchaser of all electrical equipment required for the ZLD for YCCPP, besides obtaining all statutory clearances etc. All expenses incurred, along with payment of necessary fees, for obtaining such clearances shall be borne by the contractor

Two nos. of 630A spare feeders in 6.6kv switchgear, one transformer feeder and one motor feeder in section A &B will be provided to the bidder for his further establishing the required switchgear for ZLD system. All necessary modification like upgradation of breakers, down comers, relays & related protection components wiring etc to suit the ZLD system are in bidder scope. The laying of cable from breaker onwards, cable termination (both ends), etc., is also under the scope of the bidder.

STR fault level checks shall be carried out to ensure that the ZLD load on any of these buses shall not affect unit performance. Further the feeders shall be taken to ZLD buses.

For distribution locally, for the ZLD system, Power supply is envisaged at two levels viz., 6.6 kV & 415 V, to provide Power for all the drives and equipment. For ZLD system of each unit, one 6.6kV Switchboard, with two incomers and bus coupler shall be provided by the bidder

5.1 6.6kV SWITCHGEARS

6.6kV switchgears shall meet the following minimum requirements:

a) Incomers from all the switchgear shall be provided with Draw out Type Line PT in separate draw out cubicle.

b) Each bus section of the 6.6 kV HT switchgear shall be provided with Draw out type Bus PT.

c) In each bus section of the 6.6kV switchgear, at least one spare feeder each shall be provided for highest and lowest rating motors and one spare feeder for largest rating Service transformer.

5.1.1 Design Criteria:

a) Short Circuit Ratings

The short circuit and short time ratings of HV switchgear including, circuit breakers, earth switch, bus bars etc. shall not be less than the values mentioned in Electrical single line diagram. The short circuit & short time levels shall be calculated by considering short circuit current contribution from transformer / HV switch boards plus short circuit contribution by the motors running on the bus.

A margin of 5% over the above S.C current thus calculated shall be applied and rounded off to the next higher standard ratings and this value shall be adopted for the breakers and switchgears. The momentary current ratings shall be 2.5 times this value. The bidder has to submit the necessary calculations during detailed engineering, Asymmetrical S.C current breaking capacity of the breaker shall consider the higher time constant for decay of current in the vicinity of power generating stations and the breaker offered shall be suitable for this duty.

b) Continuous Current Ratings

The continuous current rating of the feeders shall be based on the nameplate current rating of the connected equipment with 10% margin rounded off to the next higher rating.

5.1.2 Codes and standards

The equipment, materials and service shall conform to the latest applicable provision of the following standards:

IS : 722	AC electricity meters
IS : 996	Single phase small AC and universal electrical motors.
IS : 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories
IS : 13947	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS : 2544	Porcelain post insulators for systems with nominal voltages greater than 1000V
IS : 2705	Current transformers.
IS : 3156	Voltage Transformers
IS : 3231	Electrical relays for power system protection
IS : 3427	Metal enclosed switchgear and control gear
IS : 5082	Specification for wrought aluminium and aluminium alloy bars, rods, tubes and selections for electrical purposes.
IS : 6005	Code of practice for phosphating of iron and steel.
IS : 8686	Specification for static protective relays.
IS : 9046	AC contactors for voltages above 1000 volts and upto and including 11000V.
IS : 9224	Low voltage fuses
IS : 9385	HV fuses
IS :9431	Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 volts upto and including 300 kV
IS : 9921	AC dis-connectors (isolators) and earthing, switches for voltages above 1000V
IS : 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS : 13118	Specification for high voltage AC circuit breakers.
IEC-60099 part4	Metal oxide surge arrestor without gap for AC system
IEC-62271	HV Switchgear and Control gear
IEC-60099-1	Non-linear resistor type gapped arrestor for AC systems
CIGRE WG 13.02 Chapter-3	Recommendation for substitute test for switching over voltage test

5.1.3 Technical Parameters

i) The switchgear shall be indoor, metal clad, draw out type. 6.6kV switchgear shall be provided with Vacuum Circuit Breakers only. The operating mechanism of the circuit breakers shall be of the stored energy type DC motor operated charging springs.

ii) The circuit breaker, contactor and switchgear assemblies shall have the following technical parameters :

a)	**System parameters**	
1)	Nominal System voltage	6.6kV
2)	Highest System voltage	7.2kV
3)	Rated Frequency	50 Hz
4)	Number of phases	Three
5)	System neutral earthing	Earthed through resistance to limit fault current to 300A or High resistance grounding through artificial earthing transformer and earthing resistor
6)	One minute power frequency withstand voltage- for Type tests for Routine tests	 20KV 20KV
7)	1.2/50 microsecond Impulse withstand voltage	60 kV(peak)
8)	Maximum system fault level including initial motor contribution	40 kA for 1 second
9)	Dynamic withstand rating	100 kA (peak)
10)	IAC Rating	40kA, 1sec
11)	Control supply voltage - Trip and closing coils - Spring charging motor - Space heaters	---- 220V DC ---- ------220V DC --- --(240V AC can be accepted for off-site areas) – --- 240V AC ----
12)	Ambient temperature	50^0 C
b)	**Busbars**	
1)	Continuous current rating at50^0C ambient:	as per system requirements
2)	Temperature rise	- 40^0C for plain joints - 55^0C for silver plated joints
c)	**Constructional requirements**	

1)	Colour finish - exterior and interior	as mentioned elsewhere
2)	Cable entry - Power cables - Control cables	 Bottom Bottom
3)	Bus duct entry	Top
4)	Earthing conductor	Galvanised steel strip
5)	Service Continuity of swgrs (as per IEC 62271-200)	LSC2B-PM
d)	**Circuit breakers**	
1)	Short current - AC component - DC component	 40 kA As per IS 13118 or IEC 62271
2)	Short circuit making current	100 kA (peak)
3)	Operating Duty	B – 3min – MB – 3min – MB
4)	Total break time	Not more than 4 cycles
5)	Total make time	Not more than 5 cycles
6)	Operating Mechanism	Motor wound spring charged stored energy type as per IEC 62271
e)	**Relays**	
1)	One minute power frequency	2.0 kV (rms)
f)	**Meters**	
1)	Accuracy class for energy accounting and audit meters on incomer of each 6.6kV switchgear - on all, 6.6kV motor other meters	 0.2S 0.2S 1.0
2)	One minute power frequency	2.0 kV (rms)
g)	**Current Transformer**	
1	Class of Insulation	Class E or better
2	Rated output of each	Adequate for the relays and devices connected, but not less than fifteen (15) VA.
3	**Accuracy class for energy accounting and audit meters** - on incomer of each 6.6kV switchgear - on all 6.6kV motor other meters **Protection core**	0.2S 0.2S PS 5P20

	-differential and core balance CTs -other protection CTs			
4	Minimum primary earth fault current to be detected by core balance CT	3 A		
h)	**Voltage Transformers**			
1	Rated voltage factor	1.2 continuous for all VTs and 1.9 for 30 sec for star connected VTs		
2	Measurement	0.2 S		
3	Protection	3P		
3	VA burden	Adequate for application		
i)	**Fuses**			
1	Voltage class		6.6KV	
2	Rupturing capacity	Adequate for 100KA (peak)		
3	Rated current	As per applicable		
j)	**Surge arrestors**		6.6KV	
1	Nominal discharge current (8x20 micro-sec)		500A	
2	Maximum system voltage		7.2KV	
3	Maximum standard impulse spark over voltage (peak)	25 KV (without any positive tolerance)		
4	Residual voltage at nominal discharge current		12KV	
5	Temporary over voltage capability (rms) a) For 10,000 seconds b) For 5 seconds		7.2KV 8.6KV	
6	Installation	Inside the switchgear panel		

l)	**Transducers**	
1)	**Current transducers**	
	a) Input	0-1 A (CT secondary)
	b) Rated frequency	50 Hz
	c) Output	4-20 mA (2 Nos. decoupled)
	d) Accuracy	0.5%
2)	**Voltage transducers**	
	a) Input	110V, 50 Hz (from VT secondary)
	b) Output	4-20 mA (2 Nos. de-coupled)
	c) Accuracy	0.5%
3)	**VAR transducers**	
	a) Input	3 phase, 3-wire 1 A (CT secondary)
		110 V (VT secondary)
	b) Rated frequency	50 Hz
	c) Output	4-20 mA (2 nos. de-coupled)
	d) Accuracy	0.5%
4)	**Watt transducers**	
	a) Input	3 phase, 3-wire 1A (CT secondary)
		110V (VT secondary)
	b) Rated frequency	50 Hz
	c) Output	4-20 mA (2 nos. decoupled)
	d) Accuracy	0.5%
5)	**Frequency transducers**	
	a) Input	110V (VT secondary)
	b) Rated frequency	50 Hz
	c) Range	45 to 55 Hz
	d) Output	4-20 mA (2 nos. decoupled)
	e) Accuracy	0.5%

5.1.4 **Metering**

Ammeters with Ammeter selector switch to be provided on incomers, Bus coupler and outgoing feeders. Voltmeters with voltage selector switch for each bus section to be provided on bus coupler. On incomer panels of HT switchgear, energy meters (0.2s accuracy class) shall be provided. Transducers shall be provided to transfer the data of current / voltage / power to DCS .

The energy meters shall be provided as per the Central Electricity Authority (Installation and Operation of Meters) Regulations,2006 and its amendments. However, the following energy accounting and audit meters shall be provided in general :

- On each incoming feeder of 6.6kV buses.
- On all 6.6kV motor feeders.

Energy accounting and audit meters shall be of accuracy class of 0.2S. The accuracy class of CTs and VTs shall not be inferior to that of associated meters. In case, numerical relays having built-in features of energy measurement of requisite accuracy are provided in switchgear, separate energy meter is not necessary.

5.1.5 **General Technical Requirements**

i) **Switchgear panel**

a) Each 6.6kV switchboard shall have two sections each of 100% capacity and connected through a 'Normally Open' bus-coupler. These two sections shall be fed from two independent sources to be arranged by the bidder. All 6.6 kV buses shall have facility for auto/manual live changeover facility.

b) Switchgear cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to Draw out position. Forced cooling for HV breakers and HV switchgear is not acceptable.

c) Fault occurring within an individual compartment shall be contained within the compartment itself and except for bus fault shall not cause shutdown of the switchboard other than the cubicle itself.

d) Dummy panel/ adapter chamber shall be supplied complete with bus bars, clamps and other accessories for terminating external bus duct or cable connections. Switchgear cubicles shall be suitable for top entry of busduct and bottom entry of cables. Dummy panels/ adapter chamber/bus trucking panel shall be of full cubicle with closed roof and rear door similar to enclosures for active cubicles.

e) Single phase VTs on the incoming breaker panels shall be provided for checking the voltage on both of the sections while paralleling. The Automatic Reserve Closure (ARC) facility shall be provided on bus-coupler breaker such that it will close automatically in case of failure of any one incomer.

f) The 'Synchronizing Check' relay with necessary ancillary equipment shall be provided for manual bus transfer with and without voltage interruption. The type, make etc. of the relay/scheme shall be subjected to prior approval of the purchaser.

g) All necessary instruments, such as ammeter, voltmeter with selector switch, etc. in incomer breaker panels shall be provided.

h) The switchgear shall have a single front, single tier, fully compartmentalized, metal clad construction complying with clause No. 3.102 of IEC-62271-200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main bus bars and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets except in bus bar compartments where insulated barriers shall be provided to segregate adjacent panels. Each cubicle shall have a front hinged door with latches and a removable back cover. All covers and door shall be provided with neoprene gaskets.

i) The circuit breakers and bus VTs shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position.

j) The trucks shall have distinct Service, Test and Isolated positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturer's where the truck front serves as the compartment cover may also be considered, provided the breaker/ contactor compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position.

k) The switchgear assembly shall be dust, moisture, rodent and vermin proof with the truck in any position Service, Test and Isolated or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.

l) The VT/ relay compartments shall have degree of protection not less than IP:52 in accordance with IS/IEC 60947. However, remaining compartments can have a degree of protection of IP: 4X. No louvers/opening shall be provided on the top of the panel. All other louvers if provided, shall have very fine brass or GI mesh screen.

Tight fitting gourmet/gaskets are to be provided at all openings in relay compartment.

m) Enclosure shall be constructed with rolled steel sections and cold rolled steel sheets of at least 2.0 mm thickness, Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for nonmagnetic material it shall be 3.0 mm.

n) The switchgear shall be cooled by natural air flow and forced cooling shall not be accepted.

o) Total height of the switchgear panels shall not exceed 2600 mm. The height of switches, push buttons and other hand operated devices shall not exceed 1800 mm and shall not be less than 700 mm.

p) Safety shutters complying with IEC-62271-200 shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the truck is moved to TEST and ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck.

q) The switchgears shall have the facility of extension on both sides.

r) The Switchgear shall have an Internal Arc Classification of IAC FLR 40KA, 1 sec. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. To demonstrate that the pressure relief device operates satisfactorily the Contractor shall submit the type test report in line with IEC 62271-200 Annex - A. Wherever louvers are provided, the construction of louvers shall be such that the IAC requirements are satisfied. Further, viewing glass windows shall have the same strength as that of enclosure against internal Arc.

s) All internal wiring shall be carried out with 1100 V grade, single core, 2.5 sq. mm. stranded copper wires having minimum of seven strands per conductor and colour coded, PVC insulation. CT circuits shall be wired with 2.5 sq. mm. wires which otherwise are similar to the above. Extra flexible wires shall be used for wiring between fixed

and moving parts such as hinged doors. Ring type lugs shall be used for CT/PT circuits. No plug in type connectors shall be acceptable in meters, relays & switches. Screw type connectors shall be provided. Bidder shall be fully responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

t) Rubber mat suitable for 11kV grade as per IS 15652-2006 shall be provided in front and rear of the switchgear.

ii) Circuit breaker

a) The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism. Surge arrestor shall be provided for each motor/ transformer feeder.

b) Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features.

c) Plug and socket isolating Contacts for main power circuit shall be silver plated, of self-aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self-aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.

d) Mechanical Safety Interlock shall be provided to prevent Circuit Breaker being racked in or out when the breaker is closed.

e) Each breaker shall be provided with Two (2) nos. of Trip Coils, Auxiliary switch, with 6 NO + 6NC contacts, mounted on the draw out portion of the switchgear. Position/cell switch with 4 NO + 2NC contacts, one each for TEST and SERVICE position. Auxiliary switch with 4 NO + 4 NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding lever from the breaker in SERVICE position.

f) Latch type relay with sufficient relay numbers of 6NO & 6NC contacts for meeting the functional requirement of the bus transfer scheme and the same shall be initiated by auxiliary contacts (1NO+ 1 NC) mounted on the moving portion. 2 NO+2NC contacts shall be made available for future use of owner after satisfying the functional

requirements. Alternatively, electrically reset latching relay, EE type VAJC11 or equal may be used for the purpose.

g) Bidder shall fully co-ordinate overload and short circuit tripping of breaker with upstream and downstream breakers. Various equipments shall meet requirement of Type-II class of coordination as per IEC.

h) Circuit breakers shall be suitable for switching transformers and motors at any load. It shall be capable of being used for frequent direct on line starting of squirrel cage induction motors.

i) Over voltage factor arising out of such switching operations shall not exceed 2.5 times the peak value of rated phase to neutral voltage at motor terminals. This shall be established by conducting over voltage test as per IEC draft document on substitute circuit at an approved laboratory such as CPRI (Central Power Research Institute, Bhopal) or KEEMA-Holland or CESI-Italy.

iii) **Protection**

The protective Numerical relays shall be provided for protection of all the three phases of feeders. Adequate electrical protections with auxiliary relays and timers as required shall be provided for all the equipment which shall include but not limited to following.

a. **The 6.6 kV Incoming (Main & Bus Coupler) and Outgoing supply feeders :**

i) Three Phase Over current (50/51).
ii) Bus No-volt/Under voltage with time delay.
iii) Lockout (86)
iv) Earth fault protection (50N/51N)
v) Synchronizing check (25)

b. **The 6.6kV motor feeders :**

i) Instantaneous over current relay (50)
ii) Thermal overload relay (49).
iii) Locked rotor protection (50LR)
iv) Protection relay for Unbalance current (46)
v) Earth fault protection (50N)
vi) Under voltage (27M) with VT fuse failure
vii) Motor start monitoring & Restart inhibit feature
viii) Number of starts limitation (66)
ix) Differential Protection-High Impedance(87M) for Motors of rating ≥ 2MW

c. **6.6kV/433V auxiliary service transformers feeders** :

i) Instantaneous Over current for short circuit protection (50)
ii) Back-up Instantaneous Over current for short circuit protection (51)
iii) Transformer in-built protection for incipient fault.
iv) Earth fault protections (50N)
v) Zero sequence protection/REF on LV side (neutral CT to be provided in case of solid grounding)
vi) Stand by earth fault protection (51N) for TRF LV neutral resistively grounded
vii) Transformer Differential protection-Low impedance (87T) for Transformer rating ≥ 5 MVA

iv) **Relays**

a) The protective relays shall be numerical type. All relays, auxiliary relays and devices shall be of reputed make and types proven for the application and shall be subject to purchaser approval. The relays and timers shall have appropriate setting ranges, accuracy, resetting ratio, transient over-reach and other characteristics to provide required sensitivity to the satisfaction of the owner.

b) Relays shall be suitable for efficient and reliable operation of the protection scheme. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when relay is de-energized, shall be employed in the circuits.

c) Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and downstream breakers/ fuses/MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.

d) Relays shall be flush mounted on the front with connections at the rear. Provision shall be made for easy isolation of trip circuits for testing and maintenance.

e) Relays shall be provided with self-reset contacts except the trip, lockout relays and interlocking (contact multiplication) relays which shall be manual reset type

f) Auxiliary relays shall be provided in the trip circuits of protections located outside the board, such as Buchholz relay, temperature indicators, fire protection, etc.

g) Suitable measures shall be provided to ensure that transients present in CT and VT connections due to extraneous sources in 400kV system do not cause damage to static circuit.

h) Only DC/ DC converters shall be provided in the solid state devices/ relays wherever necessary to provide a stable auxiliary supply for relay operation

i) All relays shall have hand-reset flags or other means for ready visual indication of their operation and also of the faulty phase.

vi) **Surge arrestor**

The surge arrestors shall be provided for all motor/ transformer feeders and shall be metal oxide, gapped or gap less type generally in accordance with IEC 60099-1 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for non-effectively earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.

vii) **Control and Interlocks**

a) The circuit breaker shall be wired up for local & remote operation. The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The control switch located on the switchgear would normally be used only for testing of circuit breaker≠ in isolated position, and for tripping it in an emergency.

b) The circuit-breaker shall have three distinct positions as follows:
'Service' - Both power and control contacts connected.
'Test' - Power contacts isolated, control contacts connected.
'Isolated' - Both power and control contacts isolated.

c) 'Red', 'Green' and 'white' indication lamps shall be provided on the panel to indicate breaker 'Close', 'Open' and 'Auto-Trip' position. In addition to above, mechanical indicator shall be provided which shall be clearly visible to the operator standing in front of the panel.

d) Suitable indication to show the circuit-breaker 'service' and 'Test' positions shall be provided.

e) Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

f) Six (6) normally open (NO) and six (6) normally closed (NC) auxiliary contacts shall be provided in Incomer, Bus coupler and tie feeders for future use. For all other breakers/ contactor modules four (4) NO and four (4) NC contacts shall be provided. The above contacts shall be wired out to the terminal blocks. Contact multiplication, if necessary to meet the above contact requirement, shall be done through electrical reset latch relay.

viii) **Bus bars and Insulators**

a) All bus bar and jumper connections shall be of high conductivity aluminum alloy. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Bus bar cross-section shall be uniform throughout the length of switchgear. Bus bars and other high voltage connection shall be sufficiently corona free at maximum working voltage. All bus bars shall be colour coded. .All horizontal & vertical bus bars shall have high voltage sleeving. Bus insulator shall be epoxy resin cast, non-hygroscopic, flame-retardant, track resistant type with high creepage surface. Bimetallic connectors shall be furnished for connections between dissimilar metals.

b) The temperature rise of the horizontal and vertical bus bars when carrying the rated current shall be in no case exceed 55^0C for silver plated joints and 40^0C for all other type of joints. The temperature rise at the switchgear terminals intended for external cable termination shall not exceed 40^0C. Further the switchgear parts handled by the operator shall not exceed a rise of 50^0C. The temperature rise of the accessible parts/ external enclosure expected to be touched in normal operation shall not exceed 20^0C.

c) Successful bidder shall furnish calculations establishing adequacy of busbar sizes for the specified continuous and short time current ratings.

ix) **Earthing and earthing devices**

a) A galvanised steel or copper earthing bus shall be provided at the bottom and shall extend throughout the length of each switchgear. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.

b) The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.

c) All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.

d) The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. Service, Test and Isolated as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

e) All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of suitable size.

f) VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

g) Separate earthing trucks shall be provided for maintenance work. These trucks shall be suitable for earthing the switchgear bus bars as well as outgoing / incoming cables or bus ducts. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual and audible annunciation to warn the operator against earthing of live connections. Two numbers of earthing trucks for feeders and two numbers for bus shall be provided for each 6.6kV switchgear.

As an alternative to separate earthing trucks, built-in earthing facilities for the bus bars and outgoing / incoming connections, in case such facilities are available in their standard proven switchgear design shall also be acceptable. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.

h) Interlocks shall be provided to prevent :

- Closing of the earthing switch if the associated circuit breaker truck is in Service position.

- Insertion of the breaker truck to Service position if earthing switch is in closed position.

- Closing of the earth switch on a live connection. Three (3) nos. voltage capacitive dividers shall be provided on each phase of the section intended for earthing and three (3) nos. "RED" neon lamps/ LEDs connected to these on the panel front for visual indication.

- Energising an earthed Section: Complete details of arrangement offered shall be included in the bid, describing the safety features and interlocks.

i) The earthing device (truck/ switch) shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO+4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.

j) All hinged doors shall be earthed through flexible earthing braid.

x) **Painting**

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C " as specified in IS : 6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, Electrostatic Powder Painting shall be used. Finishing paint shade for complete panels excluding end covers shall be 631 of IS 5 for extreme end covers of all switchgears. The paint thickness shall not be less than 50 microns.

xi) **Instrument transformers (CT's and VT's)**

a) All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure. The class of insulation shall be E or better.

b) Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable. Separate set of current transformer shall be provided for differential protection of the feeder.

c) Core balance CTs (CBCT) shall be provided on outgoing motor and transformer feeders having CT ratio 50/1A. These CBCTs shall be mounted inside the switchgear panel. The CBCT and earth fault relays shall be properly co-ordinated to ensure proper operation and entire range of earth fault current and also to Prevent inadvertent operation due to motor starting current, transformer switching inrush current and short circuit current.

d) All voltage transformers shall have suitable HRC current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in Isolated position.

e) CTs shall be of bar/wound primary design capable of carrying the rated primary current for a period of one minute with secondary winding open circuited.

f) In case of smaller rated CT (say 200 A & below) at expected fault level CT saturation may result in non-operation of instantaneous short circuit protection. In such cases separate protection CT core with high ratio shall be selected to avoid saturation at high fault current.

g) Accuracy class of the Current Transformers shall be:-
- Class PS for differential relaying & REF Scheme.
- Class 5P20 for other relaying.
- Measurement, Energy, Audit & Accounting (MEAA) as per CEA regulations and ISF ≤ 2 for performance/ precision metering

xii) **Instruments and Meters**

a) Indicating instruments and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm^2 size with 240 deg. scales. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

b) Ammeters on motor feeders shall have a compressed scale at the upper current region to cover the motor starting current without graduation from one to six times the rated CT secondary current. These shall be suitable to withstand the above current of motors which can last up to 30 seconds (under stalled condition) without any damage or loss of accuracy.

c) Watt-hour meters shall preferably be 3-phase two (2) element type suitable for measurement of unbalanced loads in three phase three wire system.

d) Watt-hour meters shall preferably be provided in draw out cases with built-in testing facilities. Alternatively, they may have test blocks to facilitate testing of meters without disturbing CT and VT secondary connections. Watthour meters shall have reverse running stops. They shall have six digit register indicating primary circuit energy in MWH with at least count on 0.1 MWH.

e) Suitable self-powered transducers as per IS:12784 Part-I for feeding signals to panel mounted electrical meters (ammeters, voltmeters, VAR meters and wattmeters etc.) and DCCMIS shall be provided. Transducers shall be tested as per IEC – 600298 or impulse test etc. and short circuit withstand capability as per ANSI C 37.90a, 1989. Transducers shall be provided with two decoupled 4-20mA output signals, one for meter and one for DDCMIS. Current limiting features shall be provided for all the transducers.

f) Necessary hardware shall be provided in the switchgear panel like coupling relays (24VDC with maximum burden of 2.5VA), auxiliary relays in addition to current/ bus-voltage transducers (4-20 mA, dual output) etc. to effect interlocks, exchange information/ status and exercise control from remote.

xiii) **Control and Selector switches**

a) Control and selector switches shall be of heavy duty, rotary type with escutcheon plates clearly marked to show the positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

b) On-Off control switches shall have three positions and shall be spring return to 'Neutral' from close and trip positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall have Pistol Grip handles. Lost motion feature shall be provided wherever required.

c) Selector switch shall have two stay put positions as per the module requirements indicated elsewhere. They shall have two contacts for each of the positions and shall have black Spade handle.

d) Ammeter and Voltmeter selector switches shall have four stay-put positions with adequate number of contacts for three phase system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondary.

e) The minimum contact rating of the switches shall be as follows:

	220 V DC	**240 V AC**
Make and carry continuously	5A	10A
Make and carry for 0.5 secs.	30A	30A
Break resistive load	3A	7A
Inductive load with L/R 40 ms	2A	7A

xiv) **Indicating lamps**

a) Indicating lamps shall be of the panel mounting, LED type and low watt consumption preferably built in the lamp assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

b) Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

Red Closed
Green Open
White Auto Trip
Blue For all healthy conditions (e.g. control supply, spring charged, and lock out relay coil healthy)
Amber For all alarm conditions (e.g. pressure low, over load) also for Service and Test positions indications

xv) **Control supply and Space heater supply**

a) Each switchboard shall be provided with two (2) Nos. of 220 V DC feeders for the control supply.

b) Under voltage relay to monitor each of the control supply shall be provided.

c) All DC circuits shall be fused on both poles. Single phase AC circuits shall have fuses on line and link on neutral.

xvi) **Space heater**

a) Each switchgear panel shall be equipped with thermostatically controlled space heater(s), suitably located in breaker/contactor and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240 V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel.

b) For motor space heater supply, one breaker / contactor normally closed (NC) auxiliary contact of each motor feeder shall be wired out in series of switch fuse up to terminals block in the respective panels of switch boards. The motor space heater supply shall be taken from Panel space heater supply given to switch board.

c) A 240V single phase 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp.

xvii) **Terminal blocks**

a) Terminal blocks shall be 650 Volts grade, 10 Amps rated, one piece moulded complete with insulating barriers. clip on type terminals, washers, nuts and identification strips.

b) Terminal blocks for CT and VT secondary leads shall be provided with links to facilitate testing, isolation star/delta formation and earthing. Terminal blocks for CT secondary shall have the short circuiting facility.

c) At least 10% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available in each panel.

xviii) **Power cable termination**

a) Cable termination compartment shall receive stranded Aluminum conductor, XLPE insulated, shielded, armoured/ unarmoured, PVC jacketed, single core/ three core unearthed/ earthed grade power cable(s).

b) A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnections of cables.

c) Cable termination compartment shall be complete with power terminals, power lugs and associated hardware and removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material.

xix) **Name plates and Labels**

a) Each switchgear shall have a name plate for its identification. All enclosure mounted equipment shall be provided with individual engraved name plates for clear equipment identification. All panels shall be identified on front as well as backside by large engraved name plates giving the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame and not on the rear removable cover.

b) Name plate shall be of non-rusting metal or 3-ply lacmoid with white engraved letterings, on black background. Letter size shall be of at least 10mm height.

5.1.6 **Spare feeders**

Spare feeders shall be as detailed under cl.5.1 C).

5.1.7 **Make of Components**

The bidder shall indicate the proposed makes of various bought out components such as relays, CT's, VT's, control transformers, load breaker switch, fuse, contactor, push button. Space heater, instruments etc. in the technical bidding schedule. However, this shall not be bindings on the purchaser, final make shall be approved by the purchaser/ consultant during detailed engineering to satisfy the specification requirement.

5.1.8 **Tests:** List of all the tests on the equipments shall be indicated in Quality Approved plan and is not limited to the following tests.

a) Type Tests:

Reports of all type tests shall be submitted before dispatch for approval. In case type test report on similar equipment (conducted within 10 years as on the date of bid opening) is not available, these tests shall be carried out. The bidder shall clearly indicate in his tender whether he would be furnishing the type tests reports or he shall be conducting the tests along with the additional cost for such tests, if any. The purchaser reserves the right either to waive the type tests or get these type tests conducted.

A. Circuit Breaker and panels:

i) Short circuit duty test on circuit breaker, mounted inside the panel all test duties 1 thru 5 as per IEC 60056.

ii) Short time current rating withstand test on circuit breaker mounted inside panel. (40 kA for 1 sec for 6.6 kV)

iii) Power frequency voltage withstand test on breaker and panel.

iv) Lightning impulse withstand test on breaker and panel.

v) Temperature rise test on breaker and panel together. Temperature rise test shall be done on a section of switchgear assembly that involves bus coupler panels and adjacent breaker panels on both the sides.

vi) Temperature rise measuring points shall include but not limited to the following:-

- Incoming/outgoing terminal for bus coupler circuit breaker
- Main bus tap offs for bus coupler circuit breaker.

vii) Switching over –voltage test on motor substitute circuit as per IEC draft on each rating of breaker used for motor switching duty.

viii) Measurement of resistance of main circuit.

ix) Mechanical endurance test of breaker as per IEC 60056.

x) Degree of enclosure protection test for IP-42.

B. Surge Arrestor:

i) Standard lightning impulse voltage spark over test.
ii) Front of Wave spark over Test
iii) Power frequency spark over and temporary over voltage test.
iv) Residual voltage test
v) Operating duty test
vi) Current impulse withstand test (Long duration & high current impulse).
vii) Pressure relief test.

C. Current Transformers: temperature rise test, impulse voltage test & short time current rating test Certificates shall be furnished by bidder.

b) Routine tests and acceptance tests:

All routine tests as per relevant standards shall be conducted on the assembly and the various components. The successful bidder shall submit

five (5) copies of certified test reports on all routine tests before dispatch for approval.

The purchaser reserves the right to witness all the tests. The tenderer shall give at least three weeks clear notice prior to conducting these tests to enable the purchaser and/or his representative to be present to witness the test.

(A) Checks & routine tests on panels:- The routine tests/checks shall include but not limited to the following:

- Dimensions checks; workmanship/finish of panels' verification of degree of protection limited to first digit of IP-42 at random on few panels.
- Verification of rating; make, bill of material check.
- Verification of operation of mechanical interlock' shutters; racking devices on all panels.
- Verification of wiring and schematic operation of control circuit including operation of relay.
- Five closing /opening operations of CBs at max/rated/min. permissible voltages; recording of opening/closing time of CBs; resistive measurement of closing /tripping coils, millivolt drop test on circuit breakers. Recorded values shall form a part of test reports.
- Checking of continuity of earthing circuit on all panels; Polarity check of CTs
- Power frequency voltage withstand test on all panels.
- Power frequency voltage withstand test on AC/DC control & auxiliary
- Secondary current injection test for relay operation
- Inter changeability feature of CBs; PT modules.
- Insulation resistance test.
- Primary current and voltage shall be applied to all instrument transformers.

(B) Tests on CTs and PTs:

For each switchboard one CT of each rating shall be subjected to following routine tests in the presence of owner's representative:-

- Verification of terminal marking & polarity.
- High voltage power frequency test on primary windings.
- High voltage power frequency test on secondary windings.
- Over voltage inter turn test
- Determination of ratio/phase angle error/composite error at rated ALF current according to requirements of appropriate accuracy class.

- Exciting current & magnetizing characteristic for special protection class CTs.
- Partial discharge test.

Copies of routine test reports of balance current transformers shall be furnished by bidder for owner's approval.

10% of the PTs of each rating shall be subjected to routine tests as below in the presence of owner's representative: -

- Ratio & phase angle error measurement.
- Verification of polarity markings of primary & secondary windings
- High voltage tests on primary & secondary windings
- Induced over voltage test
- Partial discharge test.

Routine test reports for all PTs shall be furnished for owner's approval.

c) Site Tests : The following minimum site tests shall be conducted as per the approved procedure to be submitted during detailed engineering:
   - Visual inspection
   - Insulation Test
   - Calibration of relays & Instruments
   - Function / interlock test
   - Ratio and polarity for CTs and VTs
   - Breaker closing and tripping time
   - Anti-pumping operation
   - HV test on completely installed switchboard

The successful bidder shall submit five (5) copies of certified test reports on all site tests for records.

5.1.9 **Drawings and data**

The bidders shall furnish the following drawings and data with the bid.

a) Single line diagram and Bill of Material for every 6.6kV (as applicable) switchboard including points of control.

b) Single line diagram and schematic (interconnection) drawing of 6.6kV (as applicable) switchboards and 415V switchboard / MCCs/ distribution boards.

c) Layout drawings for the above equipment.

5.2 Auxiliary Service Transformer

5.2.1 Design Criteria:

- 2x100% transformers for each LT board shall be considered.
- 10% spare margin shall be considered while calculating the total load on the L.T. board.
- Additional starting & running of one largest stand by motor with driver equipment shall also be considered when single transformer is feeding the switchgear. The motor terminal voltage during above operations shall be within specified limits.
- All anticipated future loads in or around the load centers shall be taken into consideration while finalizing size of L.T. Transformers.
- The transformer shall be capable of continuous operation at specified rating under the following conditions :
  a) Voltage variation -- +/- 10%
  b) Frequency variation -- +/- 5%
  b) Combined voltage & Frequency variation(absolute sum)--10%
- The transformer shall be capable of withstanding the short circuit stresses due to a terminal fault on any one winding with full voltage maintained on the other winding for minimum period of two (2) seconds. Necessary calculation confirming thermal ability shall be submitted with bid.
- Current density for H.V and L.V windings of all transformers should not exceed 2.8 A/Sq.mm.
- The maximum flux density in any part of core and yoke at rated KVA, Voltage and frequency shall be such that under 10% continuous over voltage condition it does not exceed 1.9 Tesla at any Tap.
- HV line terminals shall be brought out through 12 KV class epoxy cast bushings with a minimum creepage distance of 31 mm per kV and LV line and neutral terminals through 1.1 KV epoxy bushings.
- Epoxy moulded Neutral CTs (2 Nos.) of required ratings for REF and Backup earth fault protection shall be provided.

5.2.2 CODES AND STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted.

IS 2026(Part–I) Power transformers- General
IS 2026(Part–II) Power Transformers- Temperature rise
IS 2026(Part–III) Insulation levels and dielectric tests
IS 2026(Part–IV) Terminal markings, tappings and connection
IS 2026(Part–V) Transformer/Reactor bushings- Minimum external clearance in air
IS-11171 Dry Type transformers
IS 12063 Degree of protection provided by enclosures
IEC-60076-11 Power transformer dry type transformers
IS 2029 - Bushing for Power Transformers

5.2.3 : Technical Parameters: 6.6/0.433kV-LT OIL TYPE TRANSFORMERS

i) The 415V distribution system shall have solidly earthed neutral. 415V Auxiliary supply for catering to various auxiliaries shall be obtained from 6.6/ 0.433kV Delta/ Star Transformers which in turn shall be fed from 6.6kV switchgear respectively. The 415V distribution system shall be designed with 2x100% rating transformers. The capacity of the transformers shall not exceed 2000kVA. In case the total 415V load for a system works out to be more then 2000kVA, the bidder shall design the 415V supply system with 3x50% rating transformer. These transformers shall have the following technical features and the capacity of each shall be either 500kVA, 630kVA, 1000kVA, 1600kVA or 2000kVA, and they shall be of the same make and type for interchangeability.

ii) All auxiliary transformers shall be dry type (indoor)/ oil filled (outdoor) as per site requirement and considerations.

iii) Rating

1.	Vector Group	--	Dyn11
2.	Tap Changing	--	Off load externally hand operated
3.	Tappings	--	± 2½ % and ± 5% on HV side
4.	Impulse test Voltage	--	60kV peak on HV
5.	Power Freq. Test voltage	--	20kV rms on 6.6kV, 3kV rms on LV
6.	Type of transformers	--	Oil Type Transformer
7.	Type of cooling	--	ONAN
8.	Impedance	--	The impedance of the transformers shall be in the range of the values in relevant standards. Impedance shall be chosen to limit the voltage drop on415V system to the prescribed limits in the relevant standards as

			well as to limit the parameters of the 415V system to the following values:			
			System fault level		50KA rms	
			Breaking capacity		50KA rms	
			Making capacity		- 105 KA p	
			Normal system voltage		- 415 V	
			Highest system voltage		476 V	
			Voltage variation		- ±10 %	
			Frequency		- 50 Hz	
			Frequency variation		- ± 5 %	
9.	Terminal connections of 6.6kV (as applicable)/ 0.433kV LT Transformers	--	Terminal connections of these transformers on 6.6kV side will be through 6.6 kV(UE) (as applicable) XLPE Aluminium cables. Terminal connections on LV (0.433kV) side shall be through non-segregated phase bus duct/ Cable. Crimping lugs and compression glands Shall be used for cable connections.			
10.	CT details and Bushing details		Specified in the design criteria.			

5.2.4 General Requirements :

a. For Dry type transformer of encapsulated design HV and LV coils shall be separately encapsulated under vacuum in cast resin compound. In case of design involving coils impregnated in Silicone varnish, the entire winding block shall be vacuum impregnated with polyester material without using any mould such that transformer can be installed in a high humid atmosphere.

b. The supplier shall connect tank / body frame and HV neutral terminal to the earth mat. The HV neutral terminal shall be connected at two different points of earth mat.

c. The transformer shall be housed in enclosure fabricated from sheet steel of minimum 2 mm thick. Base frame for moving the transformer shall be min. 4mm thick and shall be provided with bi-directional rollers. Core shall be constructed from high grade, cold rolled, non- ageing, low loss, high permeability, grain oriented, silicon steel laminations of 0.014 inch thickness.

d. Each coil shall be high quality fibre glass insulated reinforced with epoxy resin, continuous smooth, high grade, electrolytic copper conductor, without sharp corners or bends and shall be adequately transposed to minimize eddy current losses and equalize current and temperature distribution. Insulation of windings and other live parts should be adequate to sustain 110% of rated operating voltage continuously.

e. Transformer shall operate without injurious heating, at rated MVA at any voltage within 110% of rated voltage of that particular tap.

f. Transformers shall be capable of delivering the rated current, at a voltage equals to 115% of rated voltage without exceeding rated temperature rise.

g. Transformer shall operate below the knee of the saturation curve at 110% voltage to preclude ferro-resonance and non-linear oscillations.

h. Transformers and accessories shall be designed for fault levels indicated in 6.6 kV and 415V switchgear specifications. Dynamic ability and thermal ability to withstand the short circuit force shall be demonstrated by tests / calculations.

i. Each transformer shall be provided with one set of bi-directional rollers with locking facility for rolling the transformer parallel to either centreline.

j. Noise level shall not be more than the values specified as per NEMA TR-1.

k. Epoxy moulded Neutral CTs (2 Nos.) of required ratings for REF and Backup earth fault protection shall be provided.

l. Core grounding arrangement shall be subject to the Purchaser's approval. It shall be located at the top for easy access from inspection hole and shall drain off any electrostatic potential that may build up. A ground bus rated to carry the maximum fault current shall run all along the transformer enclosure.

m. Temperature Indicator :

A winding temperature with necessary current transformer, heating coil and RTDs (placed in windings) shall be mounted locally so as to be readable at a standing height from ground level. The WTI shall be provided with necessary contacts for alarm and trip.
A warning plate indicating "Switch shall be operated only when the Transformer is de-energised" shall be fitted on the off circuit tap changer.

n. Terminal Arrangement :
The primary and secondary of the transformer shall be suitable for cables/ Bus duct. The cable box shall be self-supporting, weather proof to suit out

door service. It shall be designed for sufficient phase to phase and ground clearance.

It shall be furnished complete with removable gland plate of non-magnetic material. The terminals for bus duct connections shall be located in this box.

o. Marshalling Box :

Stainless steel vermin proof, well ventilated and weather proof marshalling box with water-tight hinged and padlocked door of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have slopping roof. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55.Cubicle illumination lamp with door switch and space heater with thermostat and ON/OFF switch shall be provided. 1 no. 5 Amp. socket switch shall be provided inside the cubicle.

p. FITTINGS AND ACCESSORIES: Each transformer shall be equipped with fittings and accessories, as listed below:-

- Handling and lifting lugs for both enclosure and core-coil assembly.
- Jacking pad for core-coil assembly.
- Flat type bi-directional roller with locking arrangement for core-coil assembly.
- Inspection cover for cable end box.
- Door handle operated safety limit switch with 1NO + 1NC contact.
- Grounding accessories/ Bus
- Rating, diagram and terminal marking plate.
- Off circuit links in the primary for voltage variation

Note: All indication, alarm, trip contact provided shall be rated 0.5 A at 220 V DC and 5 A at 240 V A.C.

5.2.5 Spares: One set of spares for each rating of transformers shall be provided.

5.2.6 Make of Transformers and components: The bidder shall indicate the proposed makes of various bought out components in the technical bidding schedule. However, this shall not be bindings on the purchaser, final make shall be approved by the purchaser/ consultant during detailed engineering to satisfy the specification requirement.

5.2.7 Tests:

a. Routine Tests and Acceptance test (As per IS):

During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IS/IEC and its different parts.

Following tests shall be performed on each transformer:

- Ratio test at each tap
- Magnetic balance test for three (3) phase transformers
- Check test for polarity, vector relationship and terminal markings
- Calibration of temperature indicators.
- No load 50 Hertz excitation current referred to the HV winding at 90 percent, 100 percent and 110 percent of rated voltage.
- Measurement of no load and load losses at rated load current and calculation of the load loss at 75 degrees Centigrade.
- Impedance voltage at all taps especially principal and extreme taps between windings at rated current and 75 degrees Centigrade temperature.
- Resistance of windings at all tappings, cold at test bed temperature and calculation for corresponding values at seventy five (75) degrees Centigrade.
- Insulation resistance between windings and windings to earth at test bed temperature.
- Induced over voltage withstand test on HV and LV windings
- Separate source voltage withstand test
- Determination of efficiency at full, three fourth (3/4) and half (1/2) loads at unity and 0.8 power factor lagging
- Calculations of regulation at unity and 0.8 power factor lagging
- After assembly, each core shall be pressure tested for one minute at 2kV (r.m.s.) A.C. between all bolts, side plates, structural steel works and the core.
- The wiring for auxiliary power and control circuitry shall be subjected to withstand one minute power frequency test with 2 kV (r.m.s.) to earth.

b. Type Tests

- Manufacturer shall have to submit type test certificate on same type of equipment. Otherwise manufacturer shall have to do the type test as per relevant IS / IEC without any extra cost implication.
- However, in spite of availability of valid type test certificate following minimum tests shall have to be performed on one transformer (selected by Purchaser) of each rating and type in presence of Purchaser / Purchaser's representative as per IS/IEC Standards:-
- Impulse test.
- Heat run (Temperature rise) Test.

c. Site Tests

All the tests as per relevant standards shall be conducted at site prior to commissioning and during commissioning.

5.2.8 DRAWINGS/ DATA AND MANUALS

Following minimum drawings/ data and Manuals to be submitted for approval General Arrangement Drawing:-

- Dimensioned general arrangement drawing showing enclosure, core coil assembly, terminal arrangement, marshalling box and various fittings.
- Transport/shipping dimensions with weights, wheel base detail etc.
- Foundation plan & loading.
- Bus duct/cable termination arrangement.
- Control schematics and wiring diagrams.
- Test reports and QAP
- Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- Instruction manuals on Transformer and its various fittings, the manual shall clearly indicate method of installation, checkups and tests to be carried out before commissioning of the equipment.
- The drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted.

5.3 415V SWITCHGEARS AND NON-SEGREGATED PHASE BUS DUCT, DC BOARDS

All 415V switchgears (i.e. Power control centers (PCCs), Motor control centres (MCCs)), 415V non-segregated phase bus duct, and DC Boards for ZLD system shall be provided.

5.3.1 Codes and standards

The equipment, materials and service shall conform to the following standards :-

IS : 5	Colours for ready-mixed paints and enamels.	
IS: 694	PVC insulated cables for working voltages upto and including1100V	
IS : 722	AC Electricity Meters	
IS : 1248	Electrical Indicating instruments	
IS : 13947 Pt.	Degree of protection provided by enclosures for	low voltage
1	Switchgear and Control gear	
IS : 13947Part -	AC Circuit Breakers	
2 / IEC-60947		
IS : 2551	Danger Notice Plates	
IS : 2629	Hot dip galvanising	
IS : 2705	Current Transformers	
IS : 13947Pt	Contactors and motors starter for voltages not exceeding 1000 V	
4,Sec-1 (IEC-	AC or 1200 V DC	
60947)		

IS : 3043	Code of practice for earthing	
IS : 3072	Code of practice for installation and maintenance of	Switchgear
IS : 3156	Voltage Transformers	
IS : 3202	Code of practice for climate proofing of electrical equipment	
IS : 3231	Electrical relays for power system protection	
IS : 13947	Air-Break Switches, air break disconnectors, air Break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.	
IS : 13947 Pt. - I IEC –60947	General Requirements for Switchgear and Control gear for voltages <1000 V	
IS : 5082	Wrought Aluminium and Aluminium alloys for electrical purposes.	
IS : 6005	Code of practice of phosphating of iron and steel	
IS:13947 Pt.-5 Sec.1, IEC-60947	LV switchgear and Control gear Control current devices and switching element	
IS : 8623 (3 parts) / IEC-60439	Specification for factory built assemblies of Switchgear and Control gear for voltages up to and including 1000V AC and 1200V DC	
IS : 8686	Static Relays	
IS : 13703 / IEC-60269	HRC Cartridge fuses	
IS : 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear	
IS : 11171	Specification for dry type transformers	
IS : 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals	
IS : 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC	
IS:8084 Updated upto:1992	Interconnecting bus bars for A.C. voltage above 1kV up to and including 36kV.	
ANSI C37:20	Switchgear Assemblies including Metal enclosed Bus.	

5.3.2 **Technical parameters**

i) The switchgears shall be indoor, metal clad having following features :

Circuit Breakers	Air break, three pole, spring charged, horizontal draw out type, suitable for electrical operation	
Switchgear	Fully draw out type,	single front
MCC/ VDDC	Fully draw out type,	single front
ACDB/ DCDB	Fixed type, single front	

Note: In case of space constraint, double front switchgear can be accepted and shall be decided by the utility as per site conditions.

ii) System parameters

1)	Nominal system voltage	415VAC	220V DC
2)	Highest system voltage	456V	240V DC
3)	Voltage variation	± 10%	185 – 240V DC
4)	Rated frequency	50 Hz	--
5)	Frequency variation	(+) 3 to (-) 5%	--
6)	System earthing	solidly grounded	Unearthed
7)	Maximum system fault level	50kA for 1 seconds	20kA for 1 second

5.3.3 **Metering**

The energy meters shall be provided as per the Central Electricity Authority (Installation and Operation of Meters) Regulations,2006 and its amendments.

However, the energy accounting and audit meters shall be provided on LV side of each incoming transformer feeder of 415V buses.

Energy accounting and audit meters shall be of accuracy class of 0.2S. The accuracy class of CTs and VTs shall not be inferior to that of associated meters. In case, numerical relays having built-in features of energy measurement of requisite accuracy are provided in switchgear, separate energy meter is not necessary.

5.3.4 **General technical particulars**

a) Auto/manual changeover facility shall be provided in PCC and MCCs.

b) Temperature rise - The temperature rise of the horizontal and vertical bus bars and main bus link including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55^0C with silver plated joints and 40^0C with all other types of joints over an ambient of 50^0C.

c) **Breakers**

i) Breakers shall have anti-pumping feature.

ii) The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays.

iii) Breakers shall have inherent fault making and breaking capacities. They shall have shunt trip coils. In case releases are offered, the same shall have contact for energization of lockout relay. All breakers shall have built in interlocks for equipment and personnel safety.

iv) Paralleling of two supplies shall be avoided by interlocking except for switchgear where auto-changeover is provided. Breaker contact multiplication, if required, shall be through latch relay.

v) Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.

vi) Provision of mechanical closing of breaker only in 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. The circuit breaker rack in and rack out from Service to Test, Test to Isolated position or vice-versa shall be possible only in the door closed condition. It shall not be possible to open the ACB panel door in breaker closed condition.

vii) Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means.

viii) Supervision relay shall be provided for trip coil monitoring.

ix) Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.

d) **Switches, Contactors, MCCB and Fuses**

i) Incomers for MCCs and DBs rated up to 400A shall be MCCB. Above 400A, breaker shall be provided.

ii) Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be of utilisation category AC-3 for ordinary and AC-4 for reversing starters. DC contactor shall be of DC-3 utilisation category.

iii) Fuses shall be HRC type with operation indicator. Isolating switches shall be of AC 23A category when used in motor circuit, and AC 22A category for other applications. Fuse switch combination shall be provided wherever possible.

iv) Isolating switches and MCCBs shall have door interlocks and padlocking facility.

e) **Panels**

i) All switchgears, MCCs, DBs, panels, modules, local starters and push buttons shall have prominent engraved identification plates.

ii) Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet steel of 1.6mm thickness and shall be of DOP IP55. Push buttons shall be of latch type with mushroom knobs.

iii) Where breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of modules per switchboard shall be supplied for use when carriage is withdrawn.

iv) All non-current carrying metal work of boards/panels shall be effectively bonded to earth bus of galavanised steel, extending throughout the switchboard/ MCC/ DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.

v) Suitable trolley arrangement shall be provided for breaker/starter modules. One trolley per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.

vi) The incoming connection to transformer of more than 1000KVA and inter-connecting sections between switchboards shall preferably be of bus ducts. The bus duct enclosure shall be made of minimum 3mm thick aluminium alloy. The section of the bus duct should have adequate strength to withstand internal and external forces resulting from the various operating conditions. Aluminium sheet hood shall be provided for outdoor bus duct enclosure joints to provide additional protection against water ingress. The bus duct top shall be sloped to prevent retention of water. The bus duct shall have DOP of IP55.

vii) It should be possible to carryout maintenance on a feeder with adjacent feeders alive. A full-height vertical cable alley of adequate width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with bus bar compartment. Cable terminations located in cable alley shall be designed to meet the Form 4b as per IEC 61439 for safety purpose. Necessary grommets shall be provided at the cable entry of individual modules.

viii) All draw-out modules shall be provided with “Closed door operation” feature wherein movement of the module from “Isolated” position to “Service” position & vice-versa and power ON / OFF operation of the module shall be possible only with the module door closed condition.

ix) The switchboards shall comply with the internal arc fault containment tests of 50 kA for 0.3s.as per IEC/TR 61641.

x) Local control station shall be provided for all LT motors.
IP protection for local control station conform to IP54 for indoor and IP55 for outdoor.

f) **Interface with PLC:** All necessary Co-ordination between the switchgear manufacturer and DCS/PLC Supplier for protocol / mapping, procedures, interface and testing is included in the scope of services. The on / Off commend shall be executed through the inter posing relays provided in the respective switchgear cubicles. The hard wired Dos shall be hooked up to these interposing relays.

Software for the same shall be supplied and suitably interfaced with PLC. It shall be possible to configure a device either individually or over a communication network. For this purpose, provision for connecting a laptop should be available at Numerical Relays.

Minimum of 2 Nos. laptop shall be provided along with PCCs / MCCs with all accessories, fully loaded software for Uploading / Downloading the switchgear data. In order to achieve minimum response time, the device shall be capable of transmitting data at a speed, suitable for operation with high speed bus systems.

g) **Relays and Meters**

i) All breaker feeders shall have Numerical relays. All relays, auxiliary relays and devices shall be of reputed make and types proven for the application and shall be subject to purchaser approval. The relays and timers shall have appropriate setting ranges, accuracy, resetting ratio, transient over-reach and other characteristics to provide required sensitivity to the satisfaction of the owner.

ii) Relays shall be suitable for efficient and reliable operation of the protection scheme. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when relay is de-energized, shall be employed in the circuits.

iii) Relays shall be flush mounted on the front with connections at the rear. Provision shall be made for easy isolation of trip circuits for testing and maintenance.

iv) For trip circuit supervision, separate relay shall be provided.

v) Relays shall be provided with self reset contacts except the trip, lockout relays and interlocking (contact multiplication) relays which shall be manual reset type.

vi) Auxiliary relays shall be provided in the trip circuits of protections located outside the board, such as Buchholz relay, temperature indicators, fire protection, etc.

vii) Suitable measures shall be provided to ensure that transients present in CT and VT connections due to extraneous sources in 400kV system do not cause damage to static circuit.

viii) Only DC/ DC converters shall be provided in the solid state devices/ relays wherever necessary to provide a stable auxiliary supply for relay operation.

ix) All relays shall have hand-reset flags or other means for ready visual indication of their operation and also of the faulty phase.

x) Control circuits shall operate at suitable voltage of 110V AC or 220V DC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2 x 100% per section. However, the breakers shall operate on 220V DC. The auxiliary bus bars for control supply shall be segregated from main bus bars. The control supplies shall be monitored.

xi) Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and downstream breakers/ fuses/MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.

xii) All relays and timers shall operate on available DC supply and not have any inbuilt batteries. They shall be provided with hand-reset operation indicator (flags) or LEDs with push buttons for resetting.

xii) All meters/ instrument shall be flush mounted on front panel, at least 96 mm^2 size with 240^0 linear scales and accuracy class of 1.0.

xiii) All motors of 30kW and above shall have an ammeter. Bus-section shall have bus VT, voltmeter with selector switch, and other relay and timers required for protection. Adequate control and selector switches, push buttons and indicating lamps shall be provided. Thermostatically controlled space heaters with switches shall be provided to prevent condensation.

xiv) All motors are required to have an emergency stop push button near the motor.

xv) In case of remote controlled breaker panels, following shall be provided. Each feeder shall have local/ remote selector switch. Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/ remote selector switch is in local position. Tripping from remote shall be either breaker in service position or selector switch being in remote position.

xvi) Suitable self-powered transducers as per IS:12784 Part-I for feeding signals to panel mounted electrical meters (ammeters, voltmeters, VAR meters and watt meters etc.) and DCCMIS shall be provided.
Transducers shall be tested as per IEC-600298 or impulse test etc. and short circuit withstand capability as per ANSI C 37.90a, 1989.
Transducers shall be provided with two decoupled 4-20mA output signals, one for electrical meter and one for DDCMIS/ PLC. Current limiting features shall be provided for all the transducers.

xvii) Transducers

a) Current transducers

Input	0-1 A (CT secondary)
Rated frequency	50 Hz
Output	4-20 mA (2 Nos. decoupled) for meter/ DDCMIS
Accuracy	0.5%

b) Bus voltage transducers

Input	110V, 50 Hz (from VT secondary)
Output	4-20 mA (2 Nos. de-coupled)
Accuracy	0.5%

xviii) Necessary hardware shall be provided in the switchgear panel like coupling relays (24VDC with maximum burden of 2.5VA), auxiliary relays in addition to current/ bus-voltage transducers (4-20 mA, dual output) etc. to effect interlocks, exchange information/ status and exercise control from remote.

All switchgears will be controlled from PLC in control room, for all switchgears Auto/manual changeover facility shall be provided for incomers and bus-couplers.

5.3.5 **Protection:** The following minimum protection shall be provided. Bidder shall provide complete protection envisaged as per relevant standards.

a) **Incomer to 415V Switch boards :**

i. Instantaneous/IDMT over current protection (50/51)
ii. Sync Check (25)
iii. Restricted earth fault protection for Transformer LV winding (64R).
iv. Lockout (86), Hand Reset type.
v. Circuit Breaker Failure Protection.

b) **415 V Bus coupler:**

i. Instantaneous over current protection (50)
ii. Sync Check (25)
iii. Lockout (86), Hand Reset type.
iv. Circuit Breaker Failure Protection.

c) **415V Out going feeders from PCC and Incomer to MCCs:**

i. Over current protection (50)
ii. Lockout (86),Hand Reset type.
iii. Circuit Breaker Failure Protection.

d) **415 Volts motor feeders:**

1) Contactor controlled motor feeders (Motors below 110kW)
   a) Instantaneous short circuit protection on all phases through HRC cartridge type fuses rated for 80kA rms (prospective breaking capacity at 415V).
   b) Thermal overload protection
   c) Single phasing protection for motors protected by fuses

2) Breaker controlled motors feeders (motors rated 110kW &above)
   a) Instantaneous/IDMT short circuit protection (50/51)
   b) Thermal Overload protection (49)
   c) Over load alarm (49A)
   d) Earth fault protection (50N)
   e) Under voltage protection (27M)
   f) Lockout (86),Hand Reset type.
   g) Circuit Breaker Failure Protection.

5.3.6 **Design and constructional features**

a) All 415V switchgears, AC and DC distribution boards (DBs) etc. shall have following features :

i) Shall be of metal enclosed, indoor, floor mounted and free standing type.

ii) All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2mm.

iii) Frame shall be enclosed in cold rolled sheet steel of thickness not less than 2mm (CR). Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Removable gland plates of thickness

3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels.

iv) For motors of rating 90kW & above, remote controlled electrical circuit breakers, and for smaller motors, switch-fuse contactor feeders shall be provided. The other Outgoing feeders of rating 100A and above up to 400A shall have MCCBs and below 100A shall be Switch-fuse Units(SFU).

v) Duty involves direct-on-line starting of large induction motors up to 200 KW and also under certain emergency conditions automatic transfer of loads from one source of supply to other. Motor starting current varies from 6 to 8 times full load current with maximum of 3 starts per hour.

vi) Busbars for PCCs being fed from service transformers shall be sized based on the maximum rated LV winding current of the transformer rounded off to the next higher standard rating. Busbars of MCCs/DBs shall be sized to carry continuously the running load connected to it with a 10% margin. In cubicle ratings of incomer and bus section breakers/MCCBs shall be identical to the associated busbar rating.

vii) The switchboards/ MCC/ DBs of 1600A and above rating shall be of DOP IP42 and of IP52 for less than 1600A rating.

viii) All 415V switchgears, MCC's, AC and DC distribution boards etc. shall be painted by powder coating process. Paint shade for complete panels excluding end covers shall be 631 of IS5 for extreme end covers of all boards.

ix) The control circuitry of all modules in respective PCC/MCC shall be suitable for interfacing with plant DCS for remote monitoring switching and control.

x) Minimum air clearance in air between phases and phase-earth shall be 25 mm for bus bars and cable terminations. For all other components, the Clearances shall be at least 10mm. Wherever above is not possible except for horizontal and vertical bus bars, insulation shall be provided by anti-tracking, sleeving or barriers. However, for horizontal and vertical bus bars, clearances specified above shall be maintained even when bus bars are insulated/ sleeved. In case of DCDBs/ fuse boards, the bus bar system shall be insulated or physically segregated with barriers to prevent interpole short circuit.

xi) All current and voltage transformers as required for metering and protection specified shall be completely encapsulated, cast resin

insulated type. Incomers from transformers shall have CTs for transformer Restricted Earth Fault (REF) protection. All current and voltage transformers as required for metering and protection specified shall be completely encapsulated cast resin insulated type. Incomers from transformers shall have CTs for transformer restricted earth fault protection. The voltage transformers shall be mounted in separate compartments of the switchgears. The accuracy shall be as follows:

	CTs	PTs
Protection	5P20	3P
Metering	1.0	1.0
REF	PS	

b) Indicating lamps shall be cluster LED type.
c) Two common control transformer of ratio 415/110V and adequate rating one for each section of MCC in each Motor Control MCC for the purpose of control supply to all starters in that MCC
d) Control voltage for breaker is 220V DC
e) Ammeter shall be provided for motors 30KW and above.
f) Power receptacles: 3 Ph, 4 wire, 63 A power receptacles/ welding receptacles with switch shall be provided at building wherever required. The numbers will be finalised during detailed engineering.
g) The receptacles shall be industrial heavy duty type & shall have suitable interlock facility for safety. The receptacle shall confirm to IS 1293 and switch to IS 4064

5.3.7 **Spare feeders -** 20% spare feeders with at least one of each rating shall be provided in each switchgear.
In each bus section Bus VT module,240V-1ph space heating,240V 1ph essential supply module, DC supply alarm module for incomers and bus-coupler fault.

5.3.8 **415V Non-segregated phase bus-duct**

i) The section of three phase and neutral metal enclosed non segregated phase bus duct shall be rectangular. The design of the bus duct enclosures shall be of sturdy construction such that it will withstand the internal or external forces resulting from the various operating conditions.

ii) The entire bus duct shall be designed for dust, vermin and weather proof construction. A suitable aluminium sheet flange-protection hood shall be provided to cover all outdoor bus duct enclosure joints to facilitate additional protection against rain water ingress. All horizontal runs of bus duct shall have a suitable sloped enclosure top to prevent retention

of water for both indoor and out-door portion of bus ducts. Bus duct enclosure shall have a degree of protection of IP-55.

iii) The inside of the bus enclosure may be treated with black paint to enable efficient heat dissipation. The matt paint used shall be suitable for temperature experienced during continuous loading of the bus conductor.

iv) Enclosures shall be provided with flanged ends with drilling dimensions to suit the flanges at the switchgear and transformer terminals.

v) The synthetic/ neoprene gaskets shall be provided so as to satisfy the operating conditions imposed by temperature, weathering, durability etc. Flange gaskets shall be provided at the equipment terminal connections.

vi) Necessary earthing arrangement as applicable shall be provided with clamps to receive station earthing bus. This shall be a GI strip of adequate size, continuously running along the bus duct and shall be earthed at both ends. Bus duct enclosures shall be bolted type.

vii) The material of the conductor shall be aluminium. The bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings.

viii) All steel structures required for bus duct support shall be hot dip galvanised.

ix) **Technical Data**

a) Type	Non-Segregated
b) 1 minute power frequency withstand voltage	2.5 kV
c) Maximum short circuit withstand current	50kA for 1 second
d) Momentary dynamic current withstand	105kA (Peak)

5.3.9 Tests

(a) ROUTINE TEST and Acceptance test

- A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, location and connection of terminal etc.
- Manual and electrical operation of circuit breakers / relay shall be checked under the worst condition of the auxiliary voltage.
- Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuit.

- Insulation resistance of the main and auxiliary circuits shall be checked before and after high voltage withstand test.
- Operation checks shall be carried out for every control function / interlocks as per the schematic diagrams by manually simulating fault condition and operation of the control switches / relay etc.
- Relay shall be tested with secondary injection test equipment.
- Primary injection test to check winding of current transformers, ammeter, ammeter selector switch and correction of wiring connection between them.
- For equipment bought from other sub suppliers, certified test report of tests carried out at the manufacturer's works shall be submitted. Normally all the routine test specified in the relevant standards shall be conducted by the sub-supplier at his works.
- Interchangeability of similar modules shall be checked on random basis. This may be done on one module of each size.

(b) TYPE TEST

- The type test certificate of similar rating of switchgear performed shall be submitted.
- In case the Bidder is not able to submit report of the type test(s) conducted or in the case of type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests in the presence of the Purchaser without cost implication and submit the reports for approval.

5.3. 10 **DRAWINGS, DATA AND MANUALS**

Following drawings/ data and Manuals to be submitted for approval.

i) Outline dimensional drawing showing general arrangement, space requirements and bus duct / cable entry points.
ii) Cross-section with parts list
iii) Foundation plan with loading.
iv) Board-wise single line diagrams
v) Control schematics
vi) Wiring diagrams
vii) Consolidated Bill of Material
viii) Relay setting calculation
ix) Test Certificates and QAP
x) Bus bar sizing
xi) CT/VT sizing
xii) Technical leaflets

The Bidder shall also submit all instruction manuals clearly indicating the installation method, check-up and tests that are to be carried out before commissioning the equipment.

5.4 HT AND LT MOTORS

All the HT and LT motors as required for FGD Plant shall be provided.

i. All motors upto200kW rating shall be 3 phase, 415V squirrel cage Induction motors.
ii. Motors of rating above 200kW shall be rated for 6.6kV.
iii. All motors of rating 30kW and above shall be provided with single phase 240V space heaters.

5.4.1 Codes and Standards

All the motors shall conform to the following standards :

IS/ IEC:60034	Three phase induction motors
IS/ IEC:60034	Single phase AC motors
IS/ IEC:60034	Crane duty motors
IS:4722	DC motors
IS12615, IEC 60034-30	Energy Efficient Motor

5.4.2 General Requirements

i) All the motors shall be suitable for an ambient temperature of 50^0C and relative humidity of 95%. The motors shall be suitable for operation in a highly polluted environment

ii) Voltage and Frequency variations: All motors shall be suitable for following variations

Frequency variation	(+) 3% and (-)5%
Voltage variation	a. (±) 6% for 6.6kV b. (±) 10% for 415 V
Combined variation of voltage and frequency	10% (absolute sum)

iii) The voltage level for motors shall be as follows

1) Upto 200 kW	415V
2) Above 200 kW	6.6kV

iv) Fault level

1) 6.6kV	40kA for 1 second
2) 415V	50kA for 1 second
3) 220V DC	20kA for 1 second

v) System grounding

1	6.6kV	Earthed through resistance to limit the current to 300A or high Resistance grounding through

		Neutral grounding Resistor (NGR)
2	415V	Solidly grounded
3	220V DC	Ungrounded

vi) Paint shade shall be 631 of IS 5.

vii) Degree of protection

1)	Indoor motors	IP 55
2)	Outdoor motors	IP 55
3)	Cable box – indoor area	IP 55
4)	Cable box – outdoor area	IP 55

5.4.3 Type

i) AC Motors:

- Squirrel cage induction motor suitable for direct-on-line starting. Further, continuous duty LT motors up to 200 kW Output rating (at 50^0C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30.

- Crane duty motors shall be slip ring/ squirrel cage with VVVF type induction.

5.4.4 Rating

i) Continuously rated (S1). However, crane motors shall be rated for S4 duty i.e. 40% cyclic duration factor.

ii) Maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment unless otherwise specified, under entire operating range including voltage and frequency variations.

iii) Motors starting shall be as per IEC-60034 (part12)

5.4.5 Temperature Rise

Air cooled motors	70 C by resistance method for both class 130(B) and155(F) insulation
Water cooled motors	80 C over inlet cooling water temperature, by resistance method for both class 130(B) and 155(F) insulation

5.4.6 Operational Requirements

i. Starting Capability

a) Low Voltage Starting:
Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80)percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

b) Cold Motor Starting:
Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

c) Hot Motor Starting:
Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.
Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

d) Break-away Starting Current:
Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

- Motors above 200kW upto 1000 KW …… 600% subject to IS Tolerance of plus 20%
- Motors (above 1000 KW upto 3000 KW) ……. 600%. Subject to 20% IS tolerance.
- Motors above 3000 KW……..450%. Not subject to any positive tolerance.

ii. Starting Time

a) For motors with starting time up to 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.

b) For motors with starting time more than 20secs. and up to 45secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

c) For motors with starting time more than 45secs. at minimum permissible voltage during starting, the locked rotor withstand time

under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

d) Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

iii. Torque Requirements

a) Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

b) Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

iv. Starting voltage requirement

a) All motors (except mill motors):
80% of rated voltage for motors up to 4000 kW
75% of rated voltage for motors above 4000 Kw

b) For mill motors
85% of rated voltage for motors above 1000 kW
90% of rated voltage for motors below 1000 Kw

5.4.7 **Design and constructional features**

i) HV motors shall have full load efficiency of 90% minimum and rated full load power factor of 0.8 minimum. The required power factor shall be achieved without using external capacitor.

ii) Suitable single phase space heaters shall be provided on motors rated 30kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters and RTDs shall be provided.

iii) All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type. However, motors rated 3000 kW or above can be closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However, VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor.

iv) For hazardous location such as fuel oil facilities area, the enclosure of motors shall have flame proof construction conforming to IS:2148 as detailed below:

1	Fuel oil area	Group – IIB
2	Hydrogen generation plant area	Group – IIC (or Group-I Div-II as per NEC) or (Class-1 Group-B,Div-II as per NEMA/ IEC60034

v) Winding and Insulation

1	Type	Non-hygroscopic, oil resistant, flame resistant
2	Starting duty	Two hot starts in succession, with motor initially at normal running temperature
3	6.6kV, kV AC motors	Class 155(F) : with winding temperature rise limited to class 130(B). The winding insulation process shall be total Vacuum Pressure Impregnated i.e. resin pour method. They shall withstand 1.2/50microsec. Impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034-Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation
4	415V AC and 220V DC motors	Class 130 (B) or Better

vi) Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

vii) Motors with CACA or CACW enclosure shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

viii) Noise level and vibration shall be limited within the limits prescribed in IS: 12065 and IS/IEC 60034-14 respectively.

ix) In , 6.6kV motors, at least four numbers simplex/ two numbers duplex platinum resistance type temperature detectors shall be provided for each phase of stator winding. Each bearing shall preferably be provided with dial type thermometer with adjustable alarm contact and two numbers duplex platinum resistance type temperature detector Motor body shall have two earthing points on opposite sides.

x) 6.6 kV motors shall be offered with Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover and trifurcating sleeves. SIC termination kit shall be suitable for fault level of 25 kA for 0.17 seconds.

6.6 kV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided.

xi) All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

xii) The motors shall be suitable for bus transfer schemes provided on the 6.6kV, 415V systems without any injurious effect on its life.

xiii) Motors rated 2000kW and above shall be provided with neutral current transformers of PS class on each phase in a separate neutral terminal box for differential protection.

xiv) D.C. Motor provided for emergency service shall be shunt / compound wound type. Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

xv) The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) :

(a) From 50KW & up to 110KW : 11.0

(b) From 110 KW & up to 200 KW : 9.0
(c) Above 200 KW & up to 1000KW : 10.0
(d) From 1001KW & up to 4000KW : 9.0
(e) Above 4000KW : 6 to 6.5

5.4.8 VARIABLE FREQUENCY DRIVES (VFD)

VVVF converters may be provided for drives having requirement of speed control or any other equipment where process requirement calls for variable speed application and specifically asked for in different clauses of the TS.

For all Pumps, Fans (variable torque application), rating of VFDs shall be provided with safety margin of 115% the rating of respective motor full load current (name plate current). For all crane, hoist etc. rating of VFDs shall be provided with safety margin of 150% the rating of respective motor full load current (name plate current). All VFDs rating shall be selected from heavy duty rating. Further, de-rating on account of ambient temperature of 50 deg.C shall be done while calculating the continuous current rating of VFDs.

Each VFD (except VFDs on cranes/hoists) shall be connected to Level-1 Automation for remote monitoring purposes. However, control/start/stop/alarm/annunciation/interlock/set point/feedback etc. shall be done using DCS-RIO through DI/DO/AI/AO.

Inverter grade motor shall be provided for motors driven through VVVF. For VVVF application motors, insulation shall be class 'H' with temperature rise limited to class 'B'.

5.4.9 Tests

a) Routine tests:

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Purchaser's representative, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

b) Type tests

The following type tests shall be conducted on each type and rating of HT motor:

i. No load saturation and loss curves up to approximately 115% of rated voltage

ii. Measurement of noise at no load.

iii. Momentary excess torque test (subject to test bed constraint).

iv. Full load test (subject to test bed constraint)

v. Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED:

The following type test reports shall be submitted for each type and rating of HT motor:

a) Degree of protection test for the enclosure followed by IR, HV and no load run test.
b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15
d) Surge-withstand test on inter-turn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.

5.5 HT/LT POWER AND CONTROL CABLES

All 6.6kV and 415V power cables, control cables and DC cables required to connect auxiliaries shall be supplied.

5.5.1 Codes and standards

All cables to be supplied shall conform to the latest revisions of IS or any other international standards acceptable to purchaser. Some of the Indian Standards/ IEC considered relevant to the cables are given below:

IS:1554(Part-I)	PVC insulated (heavy duty) electric cables for working voltage up
	to and including 1100 V.
IS:1554 (Part-II)	PVC insulated (heavy duty) electric cables for working voltage from3.3kV up to and including 11kV.
IS:7098 (Part-III)	XLPE insulated PVC sheathed cables for working voltages from3.3 kV up to and including 33kV.
IS:3961	Recommended current ratings for cables.
IS:8130	Conductors for insulated electric cables and flexible cords.
IS:5831	PVC insulation and sheath of electric cables.
IS:2982	Copper conductor in insulated cables and cords.
IS:3975	Mild steel wires, strips and tapes for armouring cables
IS:5609	Specification for low frequency wires and cables with PVC insulation and PVC Sheath.
IS:6380	Spec. of elastomeric insulation of sheath of electric cables.
IS:434(I and II)	Specification for rubber insulation cables
IEC:540	The methods for insulations and sheaths of electric cables and cords (elastomeric and thermoplastic compounds).
IEC:230	Impulse tests on cables and their accessories
IEC:60	High voltage test techniques.
IEC:287	Calculations of the continuous current rating of cables(100% load factor).
IEC:288	Nominal cross-sectional area and composition of conductor of insulated cables.
IEC:502	Extruded solid dielectric insulated power cables for rated voltages from 1.00 kV up to 30 kV.
NEMA-WC-5	Thermoplastic insulated wires and cables for transmission and distribution of electrical energy.
IEEE:383	Standard for type test for class IE electric cables, filled splices and connections for nuclear power generation stations
IEC: 332-1	Test on electric cables under fire conditions.
ASTM-D-2843	Standard test method for density of smoke from burning/decomposition of plastics
ASTM-D-2863	Test for determination of Oxygen Index.
IEC-754-I	Test method for acid gas generation.
IEC-331	Fire resisting characteristics of electric cables
SVENSK	Standard SS- 4241475 Class F3
BICC	Hand Book For cables in fire regarding temperature index-

	chapter-6

5.5.2 Design criteria

i) The cable shall be suitable for installation in a tropical monsoon area having a hot humid climate. The reference ambient temperature to be considered for the purpose of this specification is 50^0C.

ii) The derating factor for the various conditions of installation including the following shall be considered while choosing the conductor size and calculations shall be submitted for purchaser's approval:
   a) Maximum ambient air temperature.
   b) Maximum ground temperature
   c) Depth of laying wherever applicable
   d) Grouping of cables

iii) The allowable voltage drop at terminal of the connected equipment shall be maximum 2.5 % at full load while choosing the conductor size and calculations shall be submitted for purchaser's approval. In case of squirrel cage induction motors, the cable size shall be so chosen that the motor terminal voltage does not fall below 85% of the rated voltage, at the time of starting.

iv) The maximum continuous conductor temperature and the maximum allowable conductor temperature during short circuit are to be taken as 70^oC and 160^oC respectively in case of PVC insulated cables and 90^oCand 250^oCrespectively in case of XLPE insulated cables.

v) The minimum size of all 6.6KV(UE) grade power cables and 415V power cables connected to circuit breakers shall be chosen taking into account the following factors:

   a) Fault level due to system contribution.
   b) Fault contribution of running motors.
   c) Expected time up to which motor contribution persists.
   d) Maximum time for fault clearance (i.e. operating time of the back-up protection relays plus the time of operation of the circuit breakers).
   e) Full load current of the circuit.

vi) The cables shall be capable of continuous satisfactory operation under a power supply system frequency variation of (±) 5%, voltage variation of (±)10% and combined frequency and voltage variation of 10% (absolute sum).

vii) The cables shall in general comply with the requirements of the latest revision of IS:7098 (Part-II) for the (UE), 6.6kV grade, XLPE insulated cables, IS:7098 (Part-I) for LT XLPE insulated and IS:1554 (Part-I) for the LT PVC power and control cables or the relevant IEC International Standard unless otherwise specified in this specification. The design, manufacture, installation, testing and performance of the cables, shall comply with the latest revisions of IS/ IEC/

NEMA/ ASTM Standard and the most stringent conditions specified in these specification shall be applicable.

5.5.3 General technical requirements

i) Type of cable

The cable shall be multi-core/ single core (XLPE), PVC and any polymeric/ elastomeric insulation type as specified.

ii) Conductor

The cable conductor shall be made from standard copper/ Aluminum to form compact conductor having a resistance within the limits specified.

All the cables of size 25mm^2 and above shall have sector shaped conductors. The minimum no. of strands in conductor shall be 7 (seven) except as otherwise specified. Power cables shall be of stranded aluminum conductor with a minimum size 6mm^2 and the control cables shall be stranded copper (electrolytic) conductor with a minimum size of 2.5 mm^2.

iii) Conductor Shield

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation, the semi-conducting polymer shall be cross-linked for XLPE cables.

iv) Insulation

The insulation of the cable shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give a very smooth interface between semi conducting screen and insulati0on. The insulation of the cables shall be of high standard quality. The minimum volume resistivity of the PVC insulation of all the PVC insulated cables shall be 1x10^{14} ohm-cm at 27^{o}C and 1x10^{11} ohm-cm at 70^{o}C.

v) Insulation shield

In XLPE cables to confine electrical field to the insulation, a non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion/process. The XLPE cable insulation shield shall be strippable. Metallic screening as given in this specification for the various power and control and special cables shall be provided.

vi) Sheath

The sheath shall be suitable to withstand the site conditions and the desired temperature. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality free from all defects. PVC sheath shall be extruded.

vii) Armour

Hard drawn aluminum wire armouring/ galvanized steel tape/ wire armouring shall be used for single core and multi-core cable respectively.

The hard drawn aluminium wire for armour shall be of H4 grade, as per IS-8130 (having tensile strength above 150 N/mm^2) The diameter of the aluminium wire shall be as per the table for the dimensions of the galvanized steel wire armour given in the relevant standard.

viii) Serving/ outer sheath

Extruded PVC serving as per IS: 5831 or as specified otherwise shall be applied over the armouring with suitable additives to prevent attach by rodent and termites. All serving must be given anti-termite treatment.

5.5.4 **Constructional requirements**

i) Cable shall have suitable filters laid up with the conductors to provide a substantially circular cross section before the sheath is applied. Fillers shall be suitable for the operating temperature of the cable and compatible with the insulating material. All materials shall be new, unused and of finest quality. Workmanship shall be neat, clean and of highest grade.

a) 6.6kV system power cables - The cable shall be 6.6kV/6.6kV (unearthed) grade, heavy duty, stranded aluminium conductor, XLPE insulated, provided with conductor screening and insulation screening, galvanized steel wire/strip armoured, flame retardant low smoke (FRLS) extruded PVC of type ST2 outer sheathed.

d) 415V system power cables - The cable shall be 1.1kV, grade, heavy duty, stranded aluminium conductor, PVC Type-A Insulated galvanized steel wire/strip armoured, flame retardant low smoke (FRLS) extruded PVC type ST1 outer sheathed. XLPE insulated cables shall also be acceptable.

e) Control cables - The cable shall be 1.1kV grade, heavy duty, stranded copper conductor, PVC Type-A insulated, galvanized steel wire/ strip armoured, flame retardent low smoke (FRLS) extruded PVC of Type-ST1 outer sheathed.

ii) Special properties - All the above cables shall be conforming to the relevant Indian/ IEC standard in general, with the following special properties:

a) Oxygen Index of the outer sheath shall not be less than 29, when tested as per ASTM-D-2863.

b) Temperature Index of the outer sheath shall not be less than 250^{o}C, when tested as per ASTM-D-2863.

c) Halogen acid contents in outer sheath shall not be more than 20%, when tested as per IEC-60754.

d) The maximum smoke density in percent light absorption should not exceed 60% in case of PVC compound and 20% in case of fire survival cables, when tested as per ASTM-D-2843.

e) Swedish chimney test as per SS-4241475 class F3 and ladder test for flammability as per IEEE-383.

iii) Fire survival cables - The cable shall be of copper conductor and comply with IEC-60331 in addition to the above requirement. Also the halogen acid contents in outer sheath shall not be more than 2% when tested and per IEC-60754 and the smoke density in percent light absorption shall not exceed 20% when tested as per ASTM-D- 2843.

5.5.5 **Identification of cores**

The insulated cores of HT and LT power cables shall be identified by coloured code. Cable identification shall be provided by embossing on every meter on the outer sheath the following:

- KPCL
- Manufacturer's name or trademark
- Voltage grade
- Year of manufacture
- Type of insulation and sheath, e.g. XLPE FRLS.
- Type of improved fire performance, e.g. FR/FR-LS/FS
- No. of core and size of cables.
- Reference Standard
- ISI Mark.
- Sequential length marking at an interval of 1m throughout the length of the cable.

The control cables shall have identification by means if indelible printing of numbers of its cores at intervals not more than 75 mm. At least 20% cores shall be kept as spares in the multi-core control cables.

5.5.6 **Arrangement of cables**

As far as feasible, separate cables shall be provided for circuits of different plant and auxiliaries, for circuits of different voltages, and for circuit used separately. Power,

control and instrumentation circuit shall invariably be taken through different routes, which shall not be laid together on the same cable trays.

5.5.7 **Drums**

Drum lengths of the cables shall be so chosen that straight through joints are eliminated. However, the drum lengths shall not be less than the following lengths:

i)	6.6 kV grade power cables:	500 M
ii)	1.1 kV grade power / Fire survival cables etc.	
	a) Including and above 400 mm^2 size:	400 M
	b) Below 400mm^2 size:	500 M
iii)	1.1 kV grade control and instrumentation cables:	1000M

Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage.

Cable shall be wound and packed on drums in such a manner that it shall be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose.

A label shall be securely attached to each end of the reel indicating the details mentioned below. A tag containing the same information shall be attached to the leading end of the cable inside. Drum numbers are to be indicated on cable drums.

The cable drums should carry the following details in printed form (non-returnable):-

- KPCL & Manufacturer's name or trade make
- Type of cable & voltage grade
- Year of manufacture
- Type of insulation / sheath e.g. XLPE / FRLS.
- No. of core and size of cables
- Cable code
- Length of cable on drum
- ISI Mark
- Direction of rotation, by arrow
- Approx. gross mass.
- IS/IEC number

5.5.8 Tests

a. Tests During Manufacture:-

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to purchaser's representative during inspection / testing.

b. Type Tests:-
Cables shall be type tested quality. For each type and rating of cables, reports on all type tests as per relevant standards shall be submitted.

These reports shall be for the tests conducted on the similar type of cables proposed to be supplied under this contract. If type test certificate are not available or in the case of type test report(s) are not found to be meeting the specification requirements, the same shall be conducted in the presence of the purchaser free of cost.

c. Special Tests on PVC 'FR-LS' Material
All the sizes of XLPE power cables of the 'FRLS' PVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LS' type 'PVC' to meet these special tests:-

- Oxygen/Temperature Index test on sheath material:-
  This test shall be carried out as per American National Std. A STM-D-2863/77.The minimum oxygen index shall be 29 at room temperature. For determination of the temperature index, the oxygen index test shall be carried out at different temperature up to 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temperature index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.
- Acid gas emission test on sheath material:-
  This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.
- Smoke density test on sheath material:-
  This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.
- Flammability test on finished cable sample:-
  This test shall be carried out as per the following method:
  Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.
  IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by purchaser.
  IEC Std: 332-1.–The cable should meet the requirement of all the above standards.

d. Routine Tests:
The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985.

- High Voltage Test
- Conductor Resistance Test
- Partial discharge test (for screened cables) – on full drum length.

e. Acceptance Test:
The following test shall be carried out as Acceptance Test in the presence of KPCL Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's /supplier's cost.

- High Voltage Test
- Conductor Resistance Test
- Tensile / wrapping test.
- Partial discharge test (In screened cables).
- Insulation Resistance/Volume resistivity test
- Measurement of thickness of insulation and sheath and other dimensions.
- Tensile strength & elongation at break for insulation & sheath.
- Hot set test on XLPE insulation
- Flammability test as per Swedish standard SS:424-15-75 Class-F-
- 3 (Swedish Chimney test)/IS:10810
- Acid gas generation test as per IEC-754-1/IS:10810.
- Smoke density test as per ASTM-D-2843/1977/IS:10810
- Oxygen index test as per ASTM-D 2863/1977/IS:10810
- Temp. index test as per ASTM-2863/77/IS:10810
- Test for rodent and termite repulsion property

f. Site Tests

The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the manufacturers.

- Check for physical damage
- Check for insulation resistance before and after termination/jointing.
- HV cables shall be pressure tested (test voltage as per IS: 7098) before commissioning.
- Check of continuity of all cores of the cables.
- Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.
- Check for correct polarity and phasing of cable connections.

- Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
- Check for provision of correct cable tags, core ferrules, and tightness of connections.

5.5.9 DRAWINGS, DATA AND MANUALS TO BE FURNISHED FOR APPROVAL:

i) Cable datasheets
ii) Cable sizing
iii) QAPs & Test Reports
iv) Relevant catalogues

5.6 INSTALLATION OF CABLES, EARTHING SYSTEM AND LIGHTNING PROTECTION SYSTEM

1. The cable trays, and accessories, supports, conduits, cable glands, lugs, ferrules, tags, clamps and other accessories for installation of cables in cable galleries, trenches etc. for auxiliaries; earthing system network/ earth mat including interconnections; and lightning protection of service buildings and other tall structures shall be provided.

2. The supply, laying and termination of bidder's cables shall include installation of cable facilities viz. cable trays and conduits, supports, trays, lugs, terminals, tags, clamps etc. as required.

3. All cables shall be run in GI cable trays / rigid GI conduits as far as possible. The bidder has the option to make use of existing cable facilities to the extent feasible without causing any damage/disruption.

4. The bidder shall carefully examine the possibility of making use of the existing cable facilities before preparing his offer with a view to correctly estimate the quantity of cable trays/conduits that would have to be supplied and installed by him.

5.6.1 Codes and standards

All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead
	transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet and strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables up
	to and including 33 KV rating
IS:1367	Technical supply conditions for threaded Steel fasteners. (Hot

	dip
Part-13	galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear
	and control gear
IS:2309	Code of Practice for the protection of building and allied structures
	against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron and steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for earthing
IS:3063	Fasteners single coil rectangular section spring washers.
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal arc welding of carbon and carbon manganese steels-recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from6.6kV up to and including 33kV performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial and commercial power systems
DIN 46267	Non tension proof compression joints for Aluminium conductors.
(Part-II)	
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.

5.6.2 **Design and Constructional Features**

i) Inter Plant Cabling - Interplant cabling for main routes shall be laid along overhead trestles/duct banks/buried cables. However, from tap-offs, same can be through shallow trenches/ support taken from nearest building/ structure. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route.

ii) Cable entry - Cable entry from outdoor underground/ cable routes to the buildings, if any, shall be above the finished floor level of the building.

iii) Trenches - PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

iv) No sub-zero level cable vault/ trenches shall be provided below control building/ switchgear rooms.

5.6.3 Equipment Description

i) Cable trays, fittings and accessories

a) Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, GI strap, hook etc.) as required. Cable tray shall be ladder type for power and control cables and perforated for instrumentation cables.

b) Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

c) Cable trays shall have standard width of 150 mm, 300 mm and 600 mm and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm .

ii) Support system for cable trays

a) Cable tray support system shall be pre-fabricated.

b) Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : i) C1: having provision of supporting cable trays on one side and ii) C2: having provision of supporting cable trays on both sides. The support system shall be as follows :

- Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

- The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanized.

- The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to

form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer and aluminium paint shall be applied.

- All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.

- The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheet conforming to IS.

- Cantilever arms of 300 mm, 450mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

iii) **Pipes, Fittings and accessories**

a) Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

b) GI Pipes shall be of medium duty as per IS:1239.

c) Duct banks shall be high density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

iv) **Junction boxes**

a) Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/ synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanized as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation

b) Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece moulding. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex

type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Terminal block shall be suitable for terminating 2 wires of 2.5mm^2 on both sides arranged to facilitate easy termination

v) Terminations and straight through joints

a) Termination and jointing kits for 6.6kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, tapex type or heat shrinkable type. 6.6kV grade joints and terminations shall be type tested as per IS:13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ ESI specification. The kit shall be complete with the aluminium solderless crimping type cable lugs and ferrule as per DIN standard.

b) Straight through joint and termination shall be capable of withstanding the fault level for 6.6 kV system.

c) 1.1KV grade straight through joints shall be of proven design.

vi) **Cable glands**

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful bidder.

vii) **Cable lugs/ ferrules**

Cable lugs for power cables shall be Aluminium solderless crimping type conforming to IS:8309 suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper conforming to IS:8309. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

viii) **Trefoil clamps**

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

ix) **Cable clamps and straps**

The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/ straps shall be used. The clamps/ straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

x) **Receptacles**

Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/ column/ structure, glandplate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminiun. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/ copper wire of adequate size. The Terminal blocks shall be of 1100V grade.

xi) **Galvanizing**

a) Galvanizing of steel components and accessories shall conform to IS:2629 and IS:2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.

b) The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

xii) **Welding**

The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595.

5.6.4 **Installation**

i) **Cable tray and support system installation**

a) Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.

b) Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/ clamps on both top and bottom side rails at an interval of 2000 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted.

c) The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant tray layout drawings

d) All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

e) In certain cases it may be necessary to site fabricate portions of trays, supports and other nonstandard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining Project Manager's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

ii) **Conduits/ Pipes/ Ducts installation**

a) All openings in the floor/ roof/ wall / cable tunnel/ cable trenches made for conduit installation shall be sealed and made water proof.

b) GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

c) Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/ pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/ pipes shall be sealed with Glass-wool/ Cement Mortar/ Putty to prevent entrance of moisture and foreign material

d) Exposed conduit/ pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits / pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise:

Conduit / pipe size (dia).	Spacing
Upto 40 mm	1 m
50 mm	2.0 m
65-85 mm	2.5 m
100 mm	3.0 m

iii) **Junction boxes installation**

Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings or as decided by Project Manager and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

iv) **Cable installation**

a) Cable installation shall be carried out as per IS:1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For un-reeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

b) While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.

c) Cables shall be laid on cable trays strictly in line with cable schedule furnished.

d) Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, HT cables (11kV) shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multi-core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/ support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi-core power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multi-core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/ supports by aluminium strips at every five meter interval and at every bend.

e) Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.

f) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ PVC pipe.

g) Joints for less than 250 Meters run of cable shall not be permitted.

h) In each cable run some extra length shall be kept at suitable point to enable one LT (415V system) / two HT (6.6kV) straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

i) Wherever few cables are branching out from main trunk route troughs shall be used.

j) The installation work shall be carried out in a neat workman like manner and areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. RCC/ Steel trench covers shall be replaced after the installation work in a particular area is completed or when further work is not likely to be taken up for some time.

k) Separation- At least 300mm clearance in horizontal configuration and 100mm in vertical configuration shall be provided between:
- HT power and LT power cables,
- LT power and LT control/ instrumentation cables,

l) Segregation

- Segregation means physical isolation to prevent fire jumping.
- All cables associated with the unit shall be segregated from cables of other units.
- Interplant cables of unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

m) Minimum number of spare cores required to be left for interconnection in control cables shall be as follows :

No. of cores in cable	No. of spare cores
2C, 3C	NIL
5C	1
7C-10C	2
14C and above	3

n) **Cable fire sealing**

Wherever the cables pass through walls/ floors, fire proof cable penetration seals rated for two hours shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS:476 (Part-20) or equivalent standard.

o) **Directly buried cables**

- Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255.
- RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription “Cable Joint”. The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

p) Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags may also be provided.

q) While crossing the floors, un-armoured cables shall be protected in conduits up to a height of 500 mm from floor level if not laid in tray.

v) **Cable terminations and connections**

a) The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer instructions, drawings etc. Cable jointer shall be qualified to carryout satisfactory cable jointing/ termination.

b) Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

c) The equipment will be generally provided with undrilled gland plates for cables/ conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

d) Control cable cores entering control panel/ switchgear/ MCCs etc. shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

e) The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number as per the drawings. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' along with cable numbers and coiled up after end sealing.

f) All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

5.6.5 **Earthing system**

i) Earthing system shall be in strict accordance with IS:3043/ IEEE-80/ IEC and Indian Electricity Rules/ Acts.

Wherever existing main earthing system is not available, the main earthing system will be designed considering suitable corrosion allowance based on earthing conductor material and type of soil, for a service life of at least forty (40) years for maximum fault current or system fault current of 40kA whichever is higher for 1 second. The minimum rate of corrosion of earthing conductor shall be considered as 0.12mm per year while determining the conductor size.

ii) The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.

iii) The material of the earthing conductors shall be as follows :

a	Conductors above ground level and trenches	Galvanized steel in built up
b	Conductors buried in earth	Mild steel
c	Earth electrodes	Mild steel rod

iv) The sizes of earthing conductors for various electrical equipments shall be as below:

	Equipment	**Earth conductor buried in earth**	**Earth conductor and in built- up trenches**
a	Main earth grid	40 mm dia. MS rod	65x12mm GS flat
b	11kV/6.6kV switchgear/ equipment		65X12MM GS flat
c	415V switchgear/ Transformers		50X6MM GS flat
d	415V Motors - above 125 kW - 25 kW to 125 kW - 1kW to 25 kW		 50 x 6mm GS flat 25 x 6mm GS flat 25 x 3mm GS flat

e	Control panel/ desk		25 x 3 mm GS flat
f	Push button station/ Junction Box		8 SWG GI wire
g	Columns, structures, cable trays and bus ducts enclosures		50x6mm GS flat
h	Crane, rails, rail tracks and other non-current carrying metal parts		25x6mm GS flat

v) Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.

iv) Each continuous laid lengths of cable tray shall be earthed at minimum two places by GS flats to earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.

v) Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.

vi) Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.

vii) Suitable earth risers shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

x) Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

xi) Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

xii) Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding/ cleating at interval of 1000mm and 750mm respectively.

xiii) Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm metre.

xiv) Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

xv) Separate Electronic earthing system (including earth pits, GI strips, Copper Cables as required) for earthing of automation system equipments, RIO panels any other electronic panel as per their manufacturer's recommendation.

5.6.6 **Lightning Protection System**

i) All lightning protection installation work shall be in accordance with the Indian Electricity Rules and IS Code of Practice for the Protection of Buildings and allied Structures against Lightning (IS:2309).

ii) Lightning protection system shall comprise vertical air terminations, horizontal air terminations, down conductors, test links and earth electrodes.

iii) Air terminations, down conductors and test links shall be of galvanized steel conductors and earth connection below ground level shall be of mild steel rod.

iv) For tall buildings and structures, early streamer emission (ESE) type air terminal systems such as marketed by Heary Brothers (USA) are preferred.

v) Lightning protection conductors/ air termination rods and circumferential bands provided at the top portion of chimney stack shall be lead coated in order to avoid melting by exposure to hot flue gases.

vi) Horizontal air termination flats provided on top of control building, pump houses and other buildings shall be laid such that no part of the roof shall be more than 9 meters

vii) Conductors of lightning protection system shall not be connected with conductors of earthing system above ground level.

viii) Down conductors shall be cleated on outer side of building wall at 1000 mm interval or tack welded to outside of building columns at 1000 mm interval.

ix) Down conductors shall be connected to separate earth electrodes through test points located at height of above 1000 mm above ground level. These earth electrodes shall in turn be connected to earth mat at two points.

x) Lightning protection conductors shall not pass through or run inside GI conduits.

xi) All metallic equipments on roof and exposed steel works within the vicinity of 2000 mm from lightning protection conductors in air shall be bonded to conductors of lightning protection system.

xii) Lightning protection system shall have as few joints as possible and avoid sharp bends. Down conductors shall have, as far as possible, no joint except at test point and end termination.

xiii) Termination at the metallic equipments on roof should be made by suitable nuts, bolts, pressure washers and bitumen washers with good electrical conductivity.

xiv) All lightning protection conductors shall be exposed to atmosphere unless specifically mentioned.

5.7 LIGHTING

5.7.1 Make of Equipment / Components

All components such as lighting fixtures, lighting/ welding branch boards/ Distribution boards, switches, sockets, MCBs, MCCBs etc. must be of standard reputed make. The bidder shall propose makes of the various components in his offer for proper assessment. The makes proposed by the bidder in his bid shall however not be binding on the purchaser and the same shall be finally decided during detailed engineering with a view to meet the specification requirements.

5.7.2 Normal Service Conditions

The equipment supplied by the contractor shall be suitable for installation in an area having hot and humid climate and dusty atmosphere.

5.7.3 Lighting System

i. A.C. Normal Lighting :
In this system, the lighting circuits would be fed on the normal A.C. supply available from the Main lighting boards. All the lighting fixtures connected to this system shall be 'ON' as long as the 415/240V normal supply is healthy.

ii. AC/DC Emergency lighting :
At strategic locations in the main building, control building, pump house viz. near entrance, stair-case landing, important control points etc. permanent type incandescent AC/DC lighting fixtures shall be provided to enable safe movement of operating personnel and access to important control points during station emergency involving total AC system failure.

5.7.4 Main Lighting Board (MLB)

The complete lighting of the FGD plant shall be met through 2 or 3 nos. Main Lighting Boards. Each main Lighting Board shall be having Dry type 415 V/ 415 V lighting transformer of adequate rating. The main lighting boards shall feed various lighting distribution boards to be located suitably near individual load centres. The incoming supply to Main Lighting Board shall be arranged from 415V Switchboard to be supplied by the bidder, through 1.1 kV grade armoured cable. MLBs shall be having MCCBs of adequate rating for incoming supply and outgoing feeder.

5.7.5 Lighting Distribution Board (LDB)

The outgoing feeders power from MLB shall be taken through stranded Aluminium conductor, PVC insulated, 1.1kV grade, armoured cable of appropriate size and shall be terminated on lighting distribution boards (LDB). The required number of LDB shall be wall mounting type having sheet metal enclosure, 3X63A copper bus bars and 63A Neutral terminal block.

The incoming cables shall be terminated on 63A TPN switch and 4 nos. MCBs each of 16A rating shall be provided on each of the three phases (i.e. total of 12 O/G MCBs) for outgoing circuits. The minimum interrupting capacity of the miniature circuit breaker (MCB) shall be 9kA rms. The LDB enclosure shall be duly earthed as specified.

The LDBs shall be located near entry doors. The LDB door shall have a cut out for operating the MCBs. The cut out portion shall have a transparent plastic/acrylic cover for its protection against dust. The LDB shall be of dust proof design.

5.7.6 AC/DC Emergency Lighting Distribution Board (ELDB)

In order to provide emergency lighting during normal AC failure, an AC/DC emergency lighting distribution cabinet (ELDB) shall be provided which shall incorporate AC/DC change over scheme and have outgoing feeders meant to provide functional lighting in control rooms, stair cases, exit points and vital locations during black out.

5.7.7 Guidelines for Design of Lighting Distribution System

Indoor Areas

i. Working plane shall be assumed about 800 mm above the finished ground level.
ii. Fluorescent luminaries with pendant suspensions shall be installed 3.5 metre above the finished floor level.
iii. Maintenance factor shall be taken as 0.7.
iv. Average illumination level shall be taken in the horizontal plane as specified.

Outdoor Areas:

i. Initial calculations shall be done by average illumination method with suitable coefficient of utilization which shall be then cross-checked/ verified for correctness and uniformity with sample calculations by 'point by point' calculation method.

ii Maintenance factor shall be taken as 0.6.

5.7.8 Illumination Level Design Factors and Type of Luminaires

The following table gives the desired average illumination level, recommended luminaire type, reflection factors and maintenance factors applicable to various rooms/ areas :

SN	Area	Average illumination level (Lux)	Reflection factors floor/wall/ ceiling
1.	Switchgear room	200	10/50/50
2.	Office rooms		
	w/o false ceiling	200	10/50/50
	with false ceiling	200	10/50/50
3.	Conference Room Library	300	10/50/50
4.	Control room / DAS room	450	10/50/70
5.	Control Equipment Room	300	10/50/50
6	Pump House	150	10/50/50
7	Battery room	200	10/50/50
8	Stair case, corridor, toilets, etc.	70	
9	Outdoor areas / Street lighting and adjacent GTG areas	20	
10	AC/DC Emergency lighting:- Control room, stair cases Exit points		Functional

5.7.9 All luminaire to be supplied complete with lamps, starting gear and all necessary accessories for mounting on ceiling/ poles/ false ceiling as required. Pendants/ brackets of suitable sizes shall be provided as required.

5.7.10 **Lighting Distribution System Design**

i. While designing the protection of the circuit, it shall be ensured that the circuit is not interrupted due to starting current.

ii. Distribution system shall be designed for 45^0C ambient for voltage drop at the end point limited to 5%.

iii. Distribution Boards / Cabinet shall be located as near as possible to the centre of the load which they are intended to supply.

iv. Each out going feeder of the lighting / power socket distribution board shall be loaded up to 70 to 80% the MCB rating.

v. The current rating of wires connected to the outgoing side of any MCB shall not be less than the MCB thermal rating. Similarly cables connected to MCCBs shall have current rating not less than the thermal current rating of its MCCB.

vi. As far as possible load shall be balanced on three phases of each lighting Dist. cabinet.

vii. Separate MCB and sub-circuits from the LDB shall be utilized for luminaries and 15A power socket outlets.

viii. Lighting load on individual sub circuit emanating from LDB shall be restricted to 2 kW.

5.7.11 **Emergency lighting Distribution system**

The AC/ DC Emergency Lighting Distribution system :

i. The AC/DC emergency lighting distribution board shall be wall mounted type sheet metal enclosure similar to the normal LDB in general constructional features.

ii. It shall have the provision to receive two incoming supplies viz. 240V, 2 wire AC and 220V, 2 wire DC which shall terminate on a 2 wire, 240V Bus through MCCBs and changeover AC & DC contactors. Suitable number of outgoing feeders shall be tapped from the bus through 2 pole MCB of adequate thermal and short circuit rating.

iii. The automatic changeover scheme between AC and DC sources shall incorporate positive interlock to avoid paralleling of two power supplies. The auto changeover scheme shall be achieved using AC and DC voltage sensing relays. Lockable type auto/manual selector switch shall also be provided. Normally the AC contactor shall be ON. In case of AC failure it shall open and DC contactor shall close. When the AC is restored, the DC contactor shall open and AC contactor shall reclose automatically.

5.7.12 **Spare Feeders**

Provision of at least 20% subjected to minimum of one spare outgoing feeder shall be kept on each Main Lighting Board and Lighting Distribution Board/ Cabinet.

5.7.13 **Power Socket Outlets**

All buildings/ rooms are to be equipped with 5A and 15 A utility power socket with individual control supply as required. 15A sockets shall be fed through independent circuits from the lighting distribution cabinets and that shall installed 250mm above floor level.

5.7.14 **Welding outlet**

A few welding outlets are to be provided in the power plant area as per the system requirement and these shall be directly feed from 415V switchboard. The welding outlets shall be of 63 A, 3 phase & neutral controlled by a switch suitable for indoor / outdoor duty as required. The plug tops shall be supplied loose and handed over separately.

All three phase welding power outlets shall incorporate a fourth pin for earthing purpose and shall be fitted with a mechanical interlock which will prevent the plug being inserted or withdrawn while the switch is in “ON” position.

5.7.15 **Drawings and Data**

The bidder shall submit the following drawings/ data after award of contract for approval:

- Lux level calculation for each area
- Lighting fixtures layout drawing for each area
- Single line diagram and GA drawing for MLB, LDB and ELDB
- Key distribution diagram for lighting, power socket and welding system.
- Typical voltage drop calculation for various application
- Scheme drawings for AC / DC changeover
- Leaflets .and instruction manual for all types of lighting fixtures etc.

5.7.16 **Standards**

The complete lighting equipment (lighting fixtures, Distribution boards, etc.) to be supplied by the tenderer shall conform to latest revision of I.S/ IEC. Bidder shall submit the type and routine test certificate as per relevant I.S. for approval.

5.8 DC SYSTEM

5.8.1 General Description

220 V DC supply : 2 spare feeders from 220 V DC supply for control and protection can be obtained from Main MCC room .Laying of cable, termination at both ends etc. for 220V DC will also the scope of the bidder.

DC distribution boards and sub-distribution boards for meeting the 220V DC power supply for continuous and emergency DC power and control requirements, emergency lighting and AC power requirement (through inverter), if any will also the scope of the bidder.

5.9 ELECTRICAL DETAILS OF HOISTS AND CRANES

5.9.1 Contractor's scope of supply shall include the following:-

i. Power cable junction box(fixed)
ii. Flexible festoon cable system with supporting rollers & guide rail for power cable and for control cable.
iii. Electrical panel housing main power disconnecting switch with fuses, main line contactor, control transformer with cut-outs on primary & secondary sides, individual mechanism motor control units & set of power & control terminals. If DC brakes & speed control system are employed, corresponding AC/DC converter & speed control devices are also to be included in the panel.
iv. Drive motors
v. Brakes
vi. Limit switches
vii. Suitably rated control transformer 415/110 V
viii. Power & control cables for fixed wiring & hoist unit
ix. Pendant control station with suspension / Control posts as per Clearance Diagram
x. Necessary erection & installation accessories required for wiring & set-up
xi. Power Isolator at operating height

5.9.2 Standards

i. The equipment shall be selected as per the guide lines provided in the latest edition of the relevant Indian Standards. The equipment shall also conform to the latest Indian Electricity Rules & other statutory regulations prevalent at the place of installation as regards to safety requirements, earthing & other essential provisions specified therein.

ii. Following shall be followed:
   a) Indian Standards, relevant international standards such as IEC, VDE, BS, JIS, NFPA etc.
   b) Indian Factory Act 1948
   c) Indian Electricity Act 1910

d) Indian Electricity rules- 1956, State's regulations.
e) Electricity regulatory commission Act 2002.
f) Ambient conditions
g) All electrical equipment including cables shall be selected for an ambient temperature of 50 deg C and relative humidity of 88 %.

5.9.3 Power supply condition

i. Power supply to the hoist shall be 415V +/- 10%, 3 phase, 50Hz +/-5% AC 4 wire with solidly earthed neutral to be tapped from ACDB as shown in electrical SLD.

ii. The following voltages shall be used in the hoist:-

a) 415 volts,3 phase, 50 HZ - for motors 110 volts, single phase, 50 Hz -for electrical circuit of pendant control / control posts. 220 volts, DC for DC electromagnetic brakes.

b) The different voltages mentioned above, other than 415 V, 3 phases, 50 Hz shall be obtained through individual separate transformers & transformer rectifier units connected to 415 V.

iii. Each transformer shall be provided with tappings at +5% & + 10% on the primary.

iv. Electrical system shall be designed for a fault level of 50 kA. Earthing system adopted shall be type TN-CS.

5.9.4 Power supply collection & distribution

i. Incoming power supply to the hoist shall be terminated at the line side terminal of sheet steel, dust proof cable junction box installed near hoist gantry in an accessible position. Contractor shall provide proper flexible festoon cable system/ DSL arrangement in case of Turbine hall hoists to deliver the power supply to the electrical control panel of the hoist. Electrical control panel of hoist shall contain following equipment/devices:-

a) A three pole isolator with suitably rated fuses to take care of the system fault. The rating of the isolator shall be sufficient to carry the combined full load currents of the hoist & travel motor.

b) A three pole main line magnetic contactor suitable to carry the combined full load currents of hoist & travel motor.

c) Fuse & over load relays in the individual motor power circuit. The over load relays shall be self reset type.

d) Reversing contactors for individual motor. The rating of the contactors shall be atleast 50% higher than the respective motor full load current at the specified duty cycle. The minimum rating of the power contactor shall be 30 amps. It shall be heavy duty & of class AC-4 as per IS: 2959-1985.

e) Transformer & transformer rectifier set for control voltage supply & for supply to DC electromagnetic brakes respectively.

f) Speed control equipment as necessary. Plugging of motors shall be avoided by suitable control.

ii. Suitable arrangement shall be provided to intimate control room during emergency in the form of audio-visual alarm. Necessary contacts/auxiliary relays shall be provided.

iii. The electrical panel shall be sheet metal clad (16 gauge), totally enclosed (IP-54) with hinged & gasketed front door. Cable entry/exit shall be through compression type cable glands.

5.9.5 Pendant control station

i. All drive motors shall be controlled with individual magnetic reversing type contactors operated through momentary contact push buttons (mounted on pendant unit/ control posts. The push button shall return to the 'off' position as soon as the pressure is released. The release of the push button shall immediately & automatically cause the brake to clamp. In addition to the start up 'ON' push button, which energies the main contactor, one lockable 'OFF' push button shall be provided in the push button station & shall be connected in the main contactor coil circuit. The push buttons shall be clearly marked as per the recommendations of IS: 3938-1983 to indicate the function of each button.

ii. The pendant unit shall be fixed either to the hoist unit or to the monorail as specified. It shall be capable of withstanding rough handling without damage. The weight of the pendant shall be supported independent of cable by means of PVC sleeved chain or wire rope. The pendant shall be effectively earthed. A chain or rope does not provide an effective earth connection & shall not be relied upon for that purpose.

iii. The reversing contactors for individual motors shall be electrically interlocked. The control scheme adopted shall ensure smooth normal speed lowering, hoisting & travel as specified.

iv. The pendant shall comprise of following push buttons and indicating lamps.

a) Start & stop
b) Trolley travel to & fro
c) Hoist & lower
d) Red lamp for supply ON

5.9.6 Limit switches

i. Hoist & travel motion shall be provided with limit switches to limit the ultimate positions of the hook & the hoist block.

ii. The limit switches shall conform to the requirements specified in IS: 3938-1983/ International Standards.

5.9.7 Motors

i. All motors shall be totally enclosed fan cooled, crane duty, squirrel cage induction motors. It shall be ensured that these are special motors suitable for crane duty with pull out torque of not less than 150% of the rated torque. Motors shall conform to IS:325-1996 . All motors shall be suitable for 60 starts/hour.

ii. The motors shall be selected for the duty class of hoist unit. The duty cycle factor for each motor shall not be less than 40%.

iii. The motor selected shall be suitable for frequent reversal, braking & acceleration. Motors shall have class ‘F’ insulation with max. utilisation to within class 'B' admissible temperature rise corresponding to ambient air temperature as per clearance diagram. All windings shall be impregnated for service in the tropics having ambient temperature as stated in the clearance diagram of the hoist.

iv. Each motor shall have a robust terminal box accurately fixed to the frame. Each terminal box shall have ample room for termination of the aluminium conductor cables.

5.9.8 Brakes

i. Separate electromagnetic brakes, operated through direct current shall be provided for each motor driven mechanism. Brakes shall be of approved make & shall be connected so as to apply automatically when power supply fails or when the push button is released or with adjustable delayed time lag preceded by electrical braking when the push button is released.

ii. Brakes shall be designed as per the latest edition of IS: 3938-1983/ International Standards.

iii. Disc brake may be provided for CT motion and shoe brakes may be provided for hoist motion.

5.9.9 Wiring

i. Fixed wiring on the hoist block shall comply with following requirement:-

a) All cables shall be installed with adequate protection against mechanical damage & damage from weather. Alternatively, multi-core armoured power & control cables, suitably clamped, may be used. Suitable clamping glands shall be provided at both ends of each multi-core cable.

b) All power & control cables shall be tagged at both ends (as per approved drawings) for quick identification. The cables & wiring system for each motion shall be independent & common runs shall be avoided. Power cables & control cables shall be effectively separated & all connections shall be terminated to terminal box suitable for outside connections.

c) Cable runs shall avoid locations where high temperature and mechanical damage are likely to be experienced under service conditions.

d) Adequate precautions shall be taken to prevent ingress or collection of water or oil in any part of conduit or trunking system.

5.9.10 Enclosure class

i. The equipment in the hoist shall be suitably protected against direct radiant heat and rain. It shall be rendered proof against ingress of dust and vermin.

ii. All electrical equipments like motors, junction boxes, electrical panel, limit switches, brakes etc. shall be provided with enclosure class IP-54 for non-dusty or indoor environment and IP-55 for outdoor application.

iii. Canopy shall also be provided for outdoor hoist.

5.9.11 Cables (For Hoists only)

i. The cables for power connection on the hoist block unto electrical panel shall comprise multi-strand XLPE insulated and FRLS PVC sheathed, copper conductor, 1.1 kV grade cables. The conductor sizes shall be selected after derating for the high ambient temperature, grouping & disposition of cables & keeping the voltage drop within the permissible limits & shall have a minimum cross sectional area of 4 mm^2 copper.

ii. Conductor for control cables from electric hoist to electrical panel shall be made of copper with standard construction & with a sectional area not less than 2.5 mm2. Festoon flexible cables for power & control applications shall have EPR insulation & CSP sheathing. Flexible cables shall be of finely stranded copper conductor having a min. Conductor section of 4 mm sq. copper for power circuits & 2.5 mm sq. for control circuits.

iii. All cables shall be adequately protected against mechanical damage, radiant heat & oil.

5.9.12 Power collection system

i. Power supply to the hoist unit shall be through flexible festoon cable system. The festoon cable shall be mounted on a retracting roller supports for the full length of the working zone parallel to the I beam carrying the hoist unit. The retracting trolleys shall run on a separate supporting beam. Vendors shall specify the supporting beam according to the retracting rollers offered by him to enable provide such beam in the building structure.

ii. One end of the festoon cable shall terminate in main cable junction box at the extreme end of the monorail beam. The other end shall terminate on to the main power disconnecting switch located in the control panel. The flexible trailing cable shall have ample length to cover full track length & shall be supported at suitable intervals by means of properly selected movable trolleys. These retracting rollers shall be prevented from bumping through suitable spacers so that undue stress is avoided on the cable. Similarly the trolleys shall be inter-connected through metallic drag chains to avoid pull on cables. Suspension of flexible cable system below the support rail shall be restricted to avoid mechanical damage & interference with operation.

5.9.13 Earthing

TN-CS type of earthing shall be provided. This would require a separate earth conductor in the power cables, both for fixed wiring as well as for flexible festoon cables. Earth bus shall be formed on the hoist and each equipment shall be earthed through this earth bus.

5.10 ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

5.10.1 SCOPE

5.10.1.1 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

5.10.1.2 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

5.10.2 CODES & STANDARDS

i. All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and / or supplemented by this specification.

Code	Name of standard
IS: 325	Specification for three phase induction motor
IS: 900	Code of Practice for installation and maintenance of induction motors.
IS: 996	Single Phase AC Motor
IS: 1271	Thermal evaluation and classification of electrical insulation
IS:2223	Dimensions of flange mounted AC induction motors.
IS: 3043	Code of practice for earthing
IS: 4029	Guide for testing three phase induction motors.
IS: 4691	Degree of protection for enclosures of rotating electrical machinery.
IS: 4722	Specification for rotating electrical machinery
IS: 4728	Terminal marking and direction of rotation for rotating electrical machinery
IS: 4889	Methods of determination of efficiency of rotating electrical machines.
IS: 5571	Guide for selection of electrical equipment for hazardous areas.
IS:6362	Designation of Method of Cooling of Rotating electrical machines
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 9334	Electrical Motor Operated Actuators
IS: 12065	Noise level of motors
IS: 12075	Measurement and evaluation of vibration of rotating electrical machines
IS: 12615	Induction motors-Energy efficient, three-phase, squirrel cage – Specification
IS: 12802	Temperature rise measurement of rotating electrical machines.
IS: 12824	Type of duty and classes of rating assigned
IEC: 60034-1	Rotating electrical machines
NEMA, MG-1	Motors and Generators

ii. Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

iii. The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

5.10.3 **SERVICE CONDITIONS**

5.10.3.1 The actuator shall be integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

5.10.3.2 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

5.10.4 **RATING**

5.10.4.1 Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%.

5.10.4.2 Sizing:-

i. For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

ii. For isolating service:- three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

5.10.4.3 Control voltage of the motor starter shall be 110V AC

5.10.5 **PERFORMANCES**

5.10.5.1 The actuator shall meet the following performance requirements:

5.10.5.2 Open and close the valve completely and make leak-tight valve closure, without jamming.

5.10.5.3 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

5.10.5.4 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

5.10.5.5 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energized and prevent drift from torque switch spring pressure.

5.10.5.6 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

5.10.6 SPECIFIC REQUIREMENT

5.10.6.1 Construction

i. The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, space heater and internal wiring. Actuator shall be integral type. Integral starters shall have facility to hook-up with plant DCS for positioning of limit and torque switches.

ii. The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

iii. All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

iv. The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

v. A lockable local/remote selector switch shall also be provided for selecting mode of operation.

vi. Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

vii. Manual Wheel:- Shall disengage automatically during motor operation.

5.10.6.2 **Motor**

i. The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii. The actuators shall be sized so as to open or close valves/ dampers at rated speed enclosure shall not be more than 70 degree 'C' over ambient temp. of 70 deg.C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be class-F and type of enclosure shall be IP-68.

iii. Insulation:- The motor winding shall be insulated with class-F insulation having temperature rise limited to Class-B.

iv. Performance:-The motor shall be capable of:

a) Starting at 85% of rated voltage
b) Running at 80% of rated voltage at rated torque for 5 minutes
c) Running at 85% rated voltage at 33% excess rated torque for 5 minutes.

v. Bearing
The motor bearing shall be double shielded, grease lubricated and antifriction type.

vi. Earthing
At least two earthing terminals shall be provided for the motor body. Separate earting terminal should be provided for terminal box.

vii. Protection:-The following electrical protections should be provided for the motor:-

a. Single Phasing Protection
b. Overload Protection
c. Overheating protection through thermostat

viii. The actuators shall be designed to be self locking upon loss of power. Motor shall be designed to close in 30 secs from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

ix. The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

5.10.6.3 **Limit Switches**

i. Each motor actuator shall have Four (4) position limit switches and 2 torque limit switches, each with 2 NO + 2NC contacts, out of which 2 limit switches shall be for intermediate operation and other two are for end position". The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC. All limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently to the terminal block.

ii. Each actuators shall have two (2) Nos. torque limit switch each with 2 NO and 2 NC contacts.

iii. The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired

torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

iv. The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v. The motor actuators shall have 2 nos. potentiometric type transmitters of 100 ohm rating.

vi. Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii. All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

5.10.6.4 **Position Indicator/Transmitter**

i. Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

ii. To be provided for 0 to 100% travel.

iii. As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

5.10.6.5 **Hand Wheel**

Hand wheel shall enable manual operation in case of power failure but it shall get automatically disengaged when once the motor starts functioning. The effort required to operate manually shall not exceed 18 Kg.

5.10.6.6 **Space Heater**

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

5.10.6.7 **Terminal Box**

i. The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system

having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

ii. 1100V grade for power cables.

5.10.6.8 **Wiring**

i. All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards mounted on the valve, having liberal space for wiring and making connections to Purchaser's external circuits. Plug in type/ screw type terminals shall be used suitable for analog/digital application. There shall be atleast 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii. Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii. Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

5.10.6.9 **Interfaces**:

i. Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

ii. For Binary Drive (both ON-OFF and INCHING type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

iii. Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

iv. For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.

v. Open/close command termination logic shall be suitably built inside actuator.

5.10.6.10**Name Plate**

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

5.10.6.11**Painting**

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in Chapter 1.

5.10.6.12 **Packing**

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

5.10.6.13 **Overload Protection**

The actuator motor shall be provided with integral starter along with thermostat for overload protection.

5.10.6.14 **Tests**

i. The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

ii. Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

iii. The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.

iv. Test Witness

Tests shall be performed in the presence of Purchaser/Purchaser's representative so desired by the Purchaser/ Purchaser. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

5.10.6.15 **Drawing and Manuals**

Following drawings/ data and Manuals to be submitted for approval:-

i. Instruction manuals on Installation, tests
ii. Actuator Data sheet.
iii. Internal wiring diagram and control schematic.
iv. Torque switch and Limit switch contact development.
v. QAP for Test reports.
vi. Manufacturers Catalogue
vii. Instruction manuals on installation methods. tests etc.

5.11 AIR CONDITIONING AND VENTILATION SYSTEM

5.11.1 **AIR CONDITIONING SYSTEM**

i) The air conditioning systems shall generally include Water cooled package air conditioner for cooling load between 5 TR to 20 TR complete with all accessories shall be supplied for Control rooms, PLC room, Server room, Computer rooms, VFD rooms, UPS & Battery room, office rooms etc to maintain DBT of 23±2 °C, 55±5 % RH. However, the type of equipment shall be decided on the basis of cooling capacity required.

ii) Split air conditioners with high wall mounted indoor unit and complete hoist with all accessories shall be supplied for isolated office rooms for cooling load less than 5TR to maintain DBT of 23±2 ¼C.

e) Air conditioning system (24 Deg.C) for ZLD control room, PLC/DCS rooms, Computer room, UPS, VFD rooms and other local rooms housing electronic equipments, HMI etc. complete with instruments, electrics, controls etc.

f) All rooms with air conditioning facility shall be provided with false ceiling and decorative type recessed mounted LED type light fittings.

5.11.2 VENTILATION SYSTEM

a) The washed air ventilation system (to be placed in a separate ventilation room) with centrifugal fan to maintain 38 ¼C (maximum) with minimum 90% saturation efficiency and Pressurization of 2-3 mmWC, shall be provided for Cable cellar & Rooms housing PCC, MCCs, PDBs, MLDBs etc, considering a minimum of 15 Air Changes irrespective of heat load conditions.

b) Tube axial/propeller type exhaust ventilation to maintain maximum 3°C rise above ambient temperature considering a minimum of 20 Air Changes shall be considered for the following areas:

-RO Plant building -Dewatering plant building -Pump house -Store rooms, pantry rooms, toilets, etc

c) Tube axial exhaust ventilation (Bifurcated type in flame proof/explosion proof construction) to maintain maximum 3°C rise above ambient temperature considering a minimum of 20 Air Changes shall be considered for the following areas:

-Chemical house

-RO plant (Fumes generating areas in the building layout), etc

Natural ventilation for building / shops

5.12 UN-INTERRUPTED POWER SUPPLY (UPS)

Dual parallel redundant UPS system with provision of bypass line with static bypass switch & stabilizer shall be provided for ZLD plant. Each UPS set shall be rated for full capacity and in normal condition both the UPS shall be sharing the total load and in case of failure of any one UPS, other healthy UPS shall take the full load.

Each UPS set shall consist of individual battery bank (SMF VRLA type 2V/12V) for 30 minute back up in case of power failure. UPS system shall include UPS Power distribution board, sub-distribution boards for distribution of UPS power supply to DCS/PLCs, RIO panels, Automation system equipments, Instrumentation system equipments, FDA system & any other equipment in the battery limit as per requirements. Minimum 50% spare capacity shall be provided with each UPS for future use by purchaser.

50% spare capacity over and above the actual requirement shall be made available for individual UPS. e.g. In case actual UPS requirement comes to 100 kVA the UPS shall be 150 kVA.

UPS power shall also be provided for control circuitry of important drives & VFDs.

5.13 ERECTION OF ELECTRICAL EQUIPMENTS

5.13.1 SCOPE OF WORK

a. The scope of work shall cover complete and efficient Erection, Testing and Commissioning and putting into successful commercial operation of all Outdoor and Indoor electrical equipment supplied under Package.

b. The scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this specification.

5.13.2 SCOPE OF SUPPLY

a) The work involves timely procurement and transportation to site in properly packed condition of all hardware, materials and miscellaneous items required to complete the erection job under this specification.

b) Miscellaneous steel structures, tray supports, hangers & brackets for cable trays, mounting of local panels, push button stations etc. shall be supplied. Any material or accessory, which may not have been specifically mentioned but which is usual and / or necessary shall be supplied.

c) All hardware, materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

d) All relevant drawings, data sheet and technical leaflets on each piece of devices.

5.13.3 SCOPE OF SERVICE

The work includes but is not limited to the followings:

a) Furnishing of all erection tools and tackles, testing equipment, implements, supplies, consumables and hardware for timely and efficient execution of the erection work. Hydraulic jacks or motorized jacks necessary for lifting of heavy equipment shall be provided by the Bidder.

b) Transport vehicles necessary for efficient transportation of equipment from stores to site of erection and excess materials back to stores.

c) Complete assembly, erection and connection, testing and commissioning, putting into successful and satisfactory commercial operations of the Outdoor and indoor Electrical Equipment and accessories listed below but not limited to:-

i. Service Transformers
ii. 415V Busduct
iii. Neutral Grounding Resistors
iv. 6.6 kV Switchgear
v. Power cum Motor Control Centre, Motor Control Centres, A.C/ D.C. Distribution Boards, Main Lighting Distribution Boards and Miscellaneous items.
vi. Illumination system
vii. 6.6 kV Power cable, 1.1 kV Power & Control Cables, FS Power and Control cables, special cables including cabling system.
viii. All electrical equipment and systems integral with mechanical equipment, systems and sub-systems.

d) The complete erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the Bidder for this purpose.

e) The erection schedule, as approved by the Purchaser's Engineer shall be strictly followed by the Bidder. If, for any reason beyond the control of the Bidder, the work is held-up then the Bidder shall bring it to the notice of the Purchaser's Engineer without any delay.

f) All erection work of equipment shall be carried out in a neat and efficient way so as not to impair their normal functioning in any way.

g) The pre-commissioning checks as well as commissioning of different equipment shall be carried out as per guidance of actual manufacturer's supervisor and or as per written instructions in Erection manuals. In case of

any site related problem in commissioning activities, Bidder shall seek advice of Purchaser's engineers.

h) All erection work under this specification shall be carried out strictly in accordance with the approved drawings.

i) In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off.

5.13.4 METHOD AND WORKMANSHIP

a) All work shall be installed in a first class, neat workmanlike manner by mechanics / electricians skilled in the trade involved.

b) The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

c) All details on installation shall be electrically and mechanically correct.

5.13.5 CONSUMABLES AND HARDWARE

a) The Bidder shall furnish all erection materials, hardware and consumables required for the completion of the installation.

b) The materials shall include but not be limited to the following:

i)	Consumables	Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc
ii)	Hardware	Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
iii)	Materials	Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

c) Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

5.13.6 TESTING EQUIPMENT

a) The major testing equipment that ar required to be provided by the Bidder are listed below:

i. Insulation Tester :
   a) Power Operated Megger – 1 kV and 10 kv Grade
   b) Hand Operated Megger – 1kV Grade

ii. Hand driven earth Resistance Meggar, range 0-1/3/30 Ohms
iii. High Potential testing Set – roller mounted type for LV, HV & EHV Equipment.

iv. Tong testers of suitable ranges

v. Contact resistance measuring set of Micro-ohms

vi. Multi-meters, test lamp, field telephone with buzzer set, spirit level, different gauges etc.

vii. Insulating oil testing set of range 0-60kV.

viii. Stream line filter for transformer

ix. Current Transformer for primary injection set

x. Relay testing and checking bench

b) Other test equipment as required shall be arranged by the Bidder.

5.13.7 INSTALLATION – GENERAL

a. Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

b. Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

c. All erection work shall be carried out in strict compliance with manufacture's instructions and shall include all necessary adjustments, checks and measurements.

d. All internal wiring of the equipment which has been left incomplete because of shipping split or which requires minor modifications shall be carried out by the Bidder.

e. The Bidder shall record results of all erection tests and measurements. The Bidder shall submit copies of those test results to the Purchaser for his reference and record.

f. High voltage test of transformer oil shall be carried out taking samples from individual transformer and also from each insulating oil drum. If the result of di-electric test is not to the satisfaction of the engineer, oil filtration, heat run

and conditioning shall be carried out for the concerned transformer to improve the dielectric strength of oil and insulation to the acceptable value.

g. The storage and installation of transformer with all its accessories shall be carried out in strict compliance with manufacturer's instructions. Extreme care shall be taken to avoid ingress of moisture and foreign practicals into the transformer tank.

5.13.8 STEEL FABRICATION

i. All racks, supports, hangers and brackets wherever necessary shall be fabricated by the Bidder.

ii. Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edges.

5.13.9 PAINTING

The Bidder shall paint all racks, supports and miscellaneous steel fabrication with two (2) coats of red oxide primer and two (2) coats of synthetic enamel paint

5.13.10 FOUNDATION & CIVIL WORKS

a) Equipment foundations, equipment mounting structure foundation, panel foundations and other civil work shall be provided by the Bidder.

b) The Bidder shall check these foundations before commencement of erection to ensure their suitability.

c) All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and fastening devices shall be carried out by the Bidder including minor modification of civil work as may be required for erection.

5.13.11 CLEANING UP OF WORK SITE

a) The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

b) Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

5.13.12 TESTS

a) Site Tests

i. Bidder shall thoroughly test and megger all cables, wires and equipment to prove the same are free from ground and short circuit after erection and installation at site.

ii. If any ground or short circuit is found the fault shall be rectified or the cable and / or equipment replaced.

iii. AL equipment shall be demonstrated to operated in accordance with the requirements of this specification.

iv. All equipment shall be subject to High Potential test.

v. All protective relays shall be checked for correctness of operations.

vi. All current transformers shall be subjected to Primary Injection test.

b) Pre-Commissioning Tests at Site

a. The installation of different type of equipment and accessory shall be tested by the Bidder after completion of his erection work with an advance notice to the Engineer concerned so that he may witness the same also.

b. The test result of any installation or equipment or its parts, if considered unsatisfied to the Engineer, the concerned installation /equipment and its accessories shall be properly rectified and tested again to the satisfaction of the Engineer by the Bidder at his own cost.

c. The site tests to be carried out by the Bidder on completion of installation / erection of equipment are broadly listed below for ready reference of Bidder.

d. The major testing equipment which shall be necessary for carrying out pre-commissioning tests at site are already listed in this specification.

5.14 TESTING AND COMMISSIONING CHECKS

5.14.1 GENERAL

a. Test of all equipment shall be conducted as per latest IS. Tests shall also confirm to International Standards IEC / VDE / DIN / BS.

b. Routine tests and Type tests shall be conducted as given in earlier relevant chapters.

c. The site tests and acceptance tests to be performed by Bidder are detailed below, The test mentioned are in general and additional site tests as mentioned by the manufacturer of the equipment shall also to be performed.

d. The Bidder shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

5.14.2 SITE TESTS AND CHECKS

a. All the equipment shall be tested at site to know their condition and to prove suitability for required performance.

b. The test indicated in following pages shall be conducted after installation. All tools, accessories and required instruments shall have to be arranged by Bidder. Any other test that is considered necessary by the manufacturer of the equipment, Bidder or mentioned in commissioning manual has to be conducted additionally at site.

c. In addition to tests on individual equipment some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests but these shall not be limited to as indicated and shall be finalised in consultation with the client before charging the system.

d. The Bidder shall be responsible for satisfactory working of complete integrated system and guaranteed performance.

e. All checks and tests shall be conducted in the presence of Client's representative and test results shall be submitted in six copies to Client and one copy to Electrical Inspector. Test results shall be filled in proper proforma.

f. After clearance from Electrical Inspector, system / equipment shall be charged in step by step method.

g. Based on the test results clear cut observation shall be indicated by testing engineer with regard to suitability for charging of the equipment or reasons for not charging are to be brought out by the Bidder.

5.14.3 TRIAL RUN TEST

After the successful test of each equipment as per standard test procedure, the entire control system shall be put on trial run test on actual site conditions and operation of the system.

5.14.4 SITE TESTS

i. Oil filled transformers

- IR test on each winding to ground and between winding
- Turns ratio test on each tap
- Polarity and vector group test
- Measurement of winding resistance for HV at all taps and also for LV winding.
- IR, wiring and operational tests on all control devices in control cabinet, winding temperature indicators, etc.
- Checking of earthing wrt transformer tank (flexible from top cover to tank) other parts, neutrals.
- Check insulators for cracks.
- Measurement of magnetising current and no load loss.
- Measurement of PI value.
- Conducting magnetic balance test
- Testing of Buchholtz relay for alarm and trip conditions
- Testing of Pressure Relief Valve for trip contacts
- Checking of OTI/WTI temperature contacts for the settings and healthiness of alarm & trip contacts
- Checking for magnetic oil level gauge for the mercury contacts, Oil leakages and arresting of oil leakages (if there)
- Checking of operation of all valves and ensure their close / open positions.
- Transformer Oil tests. (BDV, water ppm, Resistivity of oil)

ii. Neutral Grounding Resistors

a) Measurement of resistance
b) IR test by HV megger between terminal and earth.
c) Checking of earth connection for terminal and for body
d) Check for isolator operation and continuity of aux. contacts (if applicable)
e) Check for temp. rise of enclosure and current flow in the resistances.

iii. Segregated Phase Busduct

a) IR measurement before and after HV Test
b) HV Test
c) Checking tightness of bolts with torque wrench
d) Checking for phase sequence marking
e) Check for clearances between phase to phase and phase to earth.
f) Check for minor damages and cracks in supporting insulators and bushings after cleaning.
g) Checking for inspection openings and accessibility for replacement of insulator etc.
h) Check tightness of earthing connections on enclosure
i) Checking of silica gel breather (if there)
j) Checking of working of space heater

k) Milli volt drop test.

iv. HT Switchgears

a) IR Test before and after HV test

b) H.V. Test

c) Functional test for all feeders

d) Testing and calibration of all meters

e) Checking and calibration of overload relays and protective relays as per supplier commissioning manuals.

f) Check operation of contactors from local and remote points

g) Checking of interlocking between incomers / bus coupler and other feeder

h) Test to prove interchangeability of similar parts.

i) Tests to prove correct operation of breakers at minimum and maximum specified control voltages

j) Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.

k) Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc., as per the scheme.

l) Check test, services and draw-out position of all the breakers and operations of mechanical flag indicators and electrical indication lamps.

m) Check functioning of various electrical schemes like auto-changeover signaling etc.

n) Contact pressure test.

o) Testing of CT as per CT testing details enclosed above.

p) Breaker:

i. IR value checking with breaker ON Phase to phase & phase to earth and between phase in off position

ii. Measurement of contact resistance and timing.

q) LT Switchgear / PMCC / MCC

i. IR test before and after HV test.
ii. HV test with 2.5 kV megger
iii. Functional test for all feeders
iv. Testing and calibration of all meters.
v. Checking and calibration of overload relays and protective relays as per supplier commissioning manuals.
vi. Check operation of contactors from local and remote points.
vii. Checking of interlocking between incomers / buscoupler and other feeders.
viii. Test to prove interchangeability of similar parts.
ix. Tests to prove correct operation of breakers at minimum and maximum specified control voltages.
x. Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.
xi. Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc., as per the scheme.
xii. Check test, services and draw-out position of all the breakers and operations of mechanical flag indicators and electrical indication lamps.
xiii. Check functioning of various electrical schemes like auto-changeover signaling etc.
xiv. Contact pressure test.
xv. Testing of CT as per CT testing details enclosed above
xvi. Breaker

r) PDB/ACDB / DCDB / MLDB etc

i. IR test before and after HT test.
ii. HV test by HV megger.
iii. Checking for functions of components for each module.
iv. Checking for interchangeability of similar components.
v. Checking of tightness of earth connection.
vi. Testing and calibration of all indicating meters.
vii. Check output of each feeder after energisation.

s) Non Segregated Phase Busduct

i. IR measurement before and after HV test.
ii. HV test.
iii. Checking tightness of bolts with torque wrench.
iv. Checking for phase sequence marking.
v. Check for clearances between phase to phase and phase to earth.
vi. Check for minor damages and cracks in supporting insulators and bushings after cleaning.

vii. Checking for inspection openings and accessibility for replacement of insulator etc.
viii. Check tightness of earthing connections on enclosure.
ix. Checking of silica gel breather (if there).
x. Checking of working of space heater.
xi. Milli volt drop test

t) AC Motors (including slip rings motor)

i. IR test of stator and rotor windings.
ii. Heating of both windings upto the permissible temp. limit from heating curve (only for HT motors).
iii. Ensure that checking / testing of associated switchboard, cables, relays / meter inter lockings as mentioned in relevant chapters are completed.
iv. Check tightness of cable connection.
v. Winding resistance measurement of stator and rotor.
vi. Checking continuity of winding.
vii. Check tightness of earth connections.
viii. Check space heaters and carryout heating of winding (if required).
ix. Check direction of rotation in decoupled condition during kick start.
x. Measure no load current for all phases.
xi. Measurement of temperature of body during No-load and load conditions.
xii. Check for tripping of motor from local / remote switches and from electrical / technological protection including differential protection.
xiii. Checking of vibration (if required)
xiv. Checking of noise level (if required).
xv. During load running, measurement of stator and bearing temperatures (if applicable) for every half an hour interval till saturation comes.
xvi. Checking tightness of foundation bolts.
xvii. Check operation of speed switch (if there).
xviii. Check continuity of temp. detectors.
xix. Check alignment, paralleling of shafts, level of lubricating oil etc. as per manufacturer's manual.
xx. Check contact of slip ring brush and measure brush pressure (150-200 gm/sq.cm).
xxi. For CACW drive check cooling water and system / piping, availability of pressure cleaning and pressure testing of pipelines etc.

xxii. Check for polarisation index of stator windings R10 / R1 by motorised megger. (The value should not be less than 2.0). R60/R10 absorption co-efficient shall not be less than 1.5
xxiii. Dielectric test (only for HT motors).
xxiv. Measurement of open circuit rotor winding voltage for slip ring motor.

u) For actuator drives following shall be checked / tested.

i. Visual and dimensional
ii. Hydraulic pressure for valves
iii. IR and operation of limit switches
iv. Winding resistance

v) CRANE/HOIST

i. Check IR of all drives, panels and other equipment
ii. Check & clean surface of shop leads(if there)
iii. Check earthing system and earthing of all metallic part
iv. Measurement of no load and load currents for all drives
v. Observations on speed of hoisting/lowering for main and aux.hoists & brake.
vi. Measurement of deflection at full load and as per mechanical requirement at overload for main hoist.
vii. Checking for operations of all limit switches
viii. Testing & calibration of indication meters
ix. Check condition of painting and arrange repainting (if required)
x. Checking tightness of panel junction boxes fixing arrangement
xi. Checking of contacts and operation of master controllers for all motions at all positions
xii. Checking of rotor resistance values at each steps.
xiii. Checking of scheme and cable connections (control and power)

w) Cables & Cable Supporting Structures

i. Checking of continuity / phasing and IR values for all the cables before and after HV test.
ii. HV test and measurement of leakage current after termination of cable kits (for HT cables).
iii. Checking of earth continuity for armour.
iv. Check for mechanical protection of cables.
v. Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.
vi. Check earthing of cable structures.
vii. Check safe head room in gallery area.

viii. Check clearance from ventilation duct and light fittings for cable structures.
ix. Check proper fixing of cable structures.
x. Check for proper drainage and removal of water (if any).

x) Indoor Lighting

i. Check dressing of cable.
ii. Measurement of lux level at various places.
iii. Check accessibility for replacement of lamps.
iv. Checking for black spots or poor visibility near operating and indicating equipments.
v. Check for mechanical protection of cables.
vi. Checking for adequacy of emergency DC light.
vii. Checking for starting system of periphery lighting.
viii. Check for auto switching of battery supply on failure of AC.
ix. Checking of earthing of light panel, socket boards light fittings.
x. Checking of type of fittings wrt specification at various locations.
xi. Check adequacy of support of fittings.
xii. Check water tightness of outdoor located panels.

y) Outdoor Lighting System

i. Check lux level of general lighting.
ii. Check for visibility of insulators, bushings and indicating instruments of transformers, breaker and isolator cabinets etc. during night.
iii. Check for adequacy of escape light during night after failure of general light.
iv. Check for proper painting of lighting supporting structures.
v. Check for automatic switching of light
vi. Check for earthing connections on light fittings and other control accessories.
vii. Check for mechanical protection of cables.
viii. IR measurement of lighting cables.

z) Earthing

i. Check tightness of all earth connections.
ii. Check earthing of all metallic equipments, cable trays, busbar supporting structures, building column (if steel all elect equipments, pipe lines etc. as per the drawing / specification)
iii. Measurement of earth resistance for each electrode.
iv. Measurement of total earth resistance.

v. Measurement of earth loop resistance for E/F path of biggest LT drive.

aa) Lightning Protection

i. Check continuity of all the earth strips / shield wire.
ii. Check tightness of all connections.
iii. Measure earth resistance of each electrode and combined system.

bb) Variable Speed Drive

i. IR Test before and after HV test
ii. HV test with 2.5 KV megger
iii. Functional test for all feeders
iv. Testing and calibration of all meters
v. Checking and calibration of overload relays and protective relays as per manufacturer's commissioning manuals.
vi. Check operation of drives from local and remote points.
vii. Physical checking of all components and wiring.
viii. Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc as per the scheme.
ix. Check functioning of various electrical scheme like auto changeover, signaling etc.
x. Testing of CT as per CT testing details

cc) Miscellaneous

i. Checking of continuity of the system.
ii. Checking of phase sequence from overhead line consumer end.
iii. Checking safe accessibility of all operating points
iv. Check availability of emergency lighting
v. Check availability of control aux. supply.
vi. Ensure availability of first aid box, fire fighting equipments, earth discharge rods, rubber mats, rubber glove.
vii. Check oil drainage system for transformer oil
viii. Check filling of gravels in transformer pits.
ix. Check working of ventilation system for battery room transformer room
x. Check for safe movement of operators control room / switchgear etc., wrt proper illumination, escape light uncovered openings provision of hand railings in stairs etc.
xi. Check proper covering of cable channels.
xii. Placement of shock treatment chart, danger boards provision of boards indicating 'Man on work' Do not switch ON' 'Do not switch OFF'. 'EARTHED' etc.

xiii. Provision of route map at gallery entry points for indication of escape.

xiv. Check proper dressing of cables, mechanical protection of cables, and placement of cable markers.

COMMISSIONING CHECKS AND TESTS

Following checks and tests shall be performed on electrical equipment during commissioning:

S No.	Equipment	Test to be conducted	Volume
1	Transformer	1. Insulation Resistance Test	100%
		2. Voltage Ratio Test for Each Tap	100%
		3. Magnetising Current Measurement for One Tap	100%
		4. Magnetising Balance Test (HV & LV Side)	100%
		5. Winding Resistance Test	100%
		6. Vector Group Test	100%
2	HT Panel	1. Visual inspection	100%
		2. IR Test for breaker and complete panel	100%
		3. HV test **(# Note-1)**	100%
		4. Ratio test of CT and PT (Used for protection purpose and incomer metering only)	100%
		5. Protection Relay Testing	100%
		6. Contact Resistance Test of breaker and busbar	100%
		7. Operation of breaker in test and service position	100%
		8. Operation and functionality checks of breaker	100%
		9. Checking of logic and interlocks	100%
		10. Checking of relay setting	100%
3	LT Panel	1. IR test for breaker and complete panel	100%
		2. HV test **(# Note-1)**	100%
		3. Ratio test of CT and PT (Used for protection purpose and incomer metering only)	100%
		4. Protection Relay Testing	100%
		5. Contact Resistance Test of breaker and busbar	100%
		6. Operation of breaker in test and service position including shutter closing	100%
		7. Operation and functionality checks of breaker and feeders.	100%
		8. Checking of logic and interlocks	100%
		9. Checking of relay setting	100%
		10. Visual inspection	100%

4	Busduct	1. Visual inspection	100%
		2. IR test	100%
		3. Checking of tightness of joints	100%
		4. Operation of space heater	100%
5	Battery and battery charger	1. Visual inspection	100%
		2. IR test	100%
		3. Operation and functionality checks	100%
6	Cables	1. IR test	100%
7	Motor	1. IR test	100%
		2. Run test	100%

NOTE-1 : HV test is already performed at manufacturer works hence not recommended for testing during commissioning.

5.15. QUALITY APPROVED PLAN:

ELECTRICAL SYSTEMS

5.15.1 **Auxiliary Service Transformers**														
5.15.1 **Oil-filled Outdoor Transformers**														
	Tests/ Checks													
Items/ Components/ Sub-systems	Visual and Dimensional	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss (on first Job) Hot	NDT, DP or MPI, UT	Ageing Test	Voltage Ratio, Vector Group and	Make, Type, Rating, Model, TC,	WPS and PQR	Vacuum and Pressure Test	Routine Tests
Tank, HV and LV Cable Box/ Flange throat	Y	Y						Y					Y	
Conservator/ Radiator/ Cooler/ Pipes	Y	Y						Y						
Copper Conductor (IS:191)	Y	Y	Y		Y									
Insulating Material	Y	Y	Y	Y	Y	Y								
CRGO Lamination and Built Core	Y	Y	Y		Y	Y	Y							
Bushing / Insulator (IS:2544/ 5621)	Y	Y									Y			Y

Gasket	Y				Y	Y			Y					
Transformer oil (IS:335)														Y
Off-circuit tap changer	Y										Y			
Core coil assembly and pre-tanking	Y									Y				
Marshalling box	Y	Y						Y						
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Globe and Gate Valve,	Y										Y			
Welding (ASME Sect-IX)	Y											Y		
Complete Transformer (IS:2026)	Y													Y
Y =Test applicable														

5.15.2 **Motors**

Item/ Components/ Sub-system	Tests/ Checks																	
	Visual	Dimensional	Make,Type,Rating,TC,General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283	Vibration	Over speed	Tan delta, shaft voltage and polarisation
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									

Magnetic material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor copper/ Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating material	Y		Y	Y			Y					Y						
Tubes for cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve bearing	Y	Y	Y	Y	Y				Y		Y							
Stator, Rotor coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication and machining of stator, rotor, terminal box	Y	Y			Y				Y									
Wound stator	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				
Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT, Brushes, Diodes, space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y															
Complete motor (IS: 325/ IS:4722/ IS:9283)	Y	Y	Y												Y	Y	Y	Y 1
Y =Test applicable, Y1 = for 11kV and 3.3kV motors only																		
Note																		
This is an indicative list of tests/ checks. The manufacture is to furnish the detailed Quality Plan indicating the practices and procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for 415V motors upto 50 KW.																		

SITE TESTS :

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

i) Measurement of vibration.

ii) Measurement of insulation resistance and polarization index

iii) Measurement of full load current.

iv) Test running of the motors, checking the temperature rise and identifying the hot spot etc.

5.15.3 **6.6kV Switchgear** **(Table 1/2)**

Items/ Components/ Sub-systems	Tests/ Checks													
	Make, Type, Model, Rating and TC	Electrical Properties	Mechanical properties	Chemical properties	Dimensions and Finish	Functional and operational features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion and	Functional Checks	HV and IR Test	Degree of Protection - Routine test	CB Operation timing check	All Routine Tests as per relevant standards
Aluminum busbar material (IS: 5082)	Y	Y	Y	Y	Y		Y							
Copper busbar material (IS:613)	Y	Y	Y	Y	Y		Y							
Bus bar support insulation (IS:9431)	Y	Y	Y		Y		Y				Y			
HT Circuit Breaker (IEC:56)	Y				Y	Y	Y			Y			Y	Y
HT Contactors (IS:9046)	Y				Y	Y	Y			Y				Y
Protection and auxiliary Relays (IS:3231/ 8686)	Y				Y	Y	Y			Y				Y
HT CT's and PT's (IS:2705/ 3156)	Y				Y		Y							Y
HT Fuses (IS:9385)	Y				Y	Y	Y							
Surge arrester (IEC:99-4)	Y				Y		Y							Y
LT Contactors (IS:13947)	Y				Y	Y	Y			Y				
Control and selector switches (IS:6875)	Y				Y	Y	Y			Y				
Indicating meters (IS:1248)	Y				Y	Y	Y			Y				Y

Indicating lamps (IS:13947)	Y				Y	Y	Y			Y				
Push buttons (IS: 4794)	Y				Y	Y	Y			Y				
Control transformer (IS:12021)	Y				Y	Y	Y							Y
LT fuses (IS:13703)	Y				Y	Y	Y							
Energy meters (IS:722)	Y				Y	Y	Y							Y
Transducers (IEC:60688)	Y				Y	Y	Y							Y
Y =Test applicable														

5.15.3 **6.6kV, Switchgear** **(Table 2/2)**

Items/ Components,/ Sub-system	Tests/ Checks													
	Make, Type, Model, Rating and TC	Electrical properties	Mechanical properties	Chemical properties	Dimensions and Finish	Functional and Operational features	Item to conform to relevant standards	Pretreatment as per IS: 6005	Paint shade, thickness, adhesion and	Functional checks	HV and IR Test	Degree of Protection - Routine test	CB Operation timing check	All Routine Tests as per relevant standard
Diodes	Y	Y				Y	Y			Y				
Terminal Blocks	Y	Y				Y	Y							
Synthetic Rubber Gasket (IS:11149/ 3400)	Y	Y			Y		Y							
Breaker Handling Trolley	Y				Y	Y			Y	Y				
HT Switchgear Panel (IS:3427)	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Y =Test applicable														

Site tests: The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shallalso be carried out.

a) General
   i) HV test on complete switchboard with CT and breaker/ contactor in position.
   ii) Check continuity and IR value of space heater.
   iii) Check earth continuity for the complete switchgear board.

b) Circuit Breaker/ Contactors

i) Check control wiring for correctness of connections, continuity & IR values.
ii) IR values, resistance and minimum pick up voltage of coils.
iii) All functional checks and electrical & mechanical interlocks provided.
iv) Checks on spring charging motor, correct operation of limit switches and time of charging.

c) Current and Voltage Transformers
   i) Insulation resistance test
   ii) Ratio test on all cores
   iii) Polarity test

d) Relays
   i) Insulation resistance between AC to DC terminals and between all terminals and body
   ii) Check minimum pick up voltage of DC coils
   iii) Relay settings

5.15.4 **415V Switchgear and Busduct**

5.15.5.1 **415V Switchgear** **(Table 1/2)**

(MCC, PCC, ACDB, DCDB, Local push button station, Local motor starters)

Items/ Components/ Sub-system	Tests/ Checks													
	Make, Model, Type, Rating and TC	Dimensions and Finish	Electrical properties	Mechanical properties	Chemical properties	Functional and Operational features	Item to conform to relevant standards	Pretreatment as per IS 6005	Paint shade, adhesion, thickness and	Functional checks	Milli-volt drop Test	IR – HV – IR Test	Degree of protection Routine test	All Routine tests as per relevant
Sheet steel (IS:513)	Y	Y		Y	Y		Y							
Aluminum bus bar material (IS:5082)	Y	Y	Y	Y	Y		Y							
Copper bus bar material (IS:613)	Y	Y	Y	Y	Y		Y							
Support insulator (IS:943, IS:10912, IEC: 660)	Y	Y	Y	Y			Y							

Air circuit breaker (IS:13947)	Y	Y				Y	Y			Y	Y			Y
Energy meters (IS:722)	Y	Y				Y	Y			Y				Y
Power and auxiliary contactor (IS:13947)	Y	Y				Y	Y			Y				
Protection and auxiliary relays (IS:3231)	Y	Y				Y	Y			Y				Y
Control and selector switches (IS:6875)	Y	Y				Y	Y			Y				
CT and VT (IS 2705/ 3156)	Y	Y					Y							Y
MCCB (IS:13947)	Y	Y					Y			Y				
Indicating meters (IS:1248)	Y	Y				Y	Y			Y				Y
Indicating lamps (IS:13947)	Y	Y				Y	Y			Y				
Air break switches (IS:13947)	Y	Y				Y	Y			Y				
Control terminal blocks	Y	Y				Y	Y							
Y =Test applicable														

5.15.4.1 **415V Switchgear (Table 2/2)**
(MCC, PCC, ACDB, DCDB, Local push button station, Local motor starters)

Items/ Components/ Sub-system	Tests/ Checks													
	Make, Model, Type, Rating and TC	Dimensions and Finish	Electrical properties	Mechanical properties	Chemical properties	Functional and Operational Features	Item to conform to relevant standards	Pretreatment as per IS: 6005	Paint Shade, Adhesion, Thickness and	Functional checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection - Routine test	All Routine tests as per relevant
Fuse (IS:13703)	Y	Y				Y	Y			Y				
Control transformer (IS:12021)	Y	Y				Y	Y			Y				Y
Push buttons (IS:4794)	Y	Y				Y	Y			Y				
Transducer (IEC:60688)	Y	Y				Y	Y			Y				Y
MCB (IS:8828)	Y	Y				Y	Y			Y				

Breaker handling trolley	Y	Y				Y			Y	Y				Y
Synthetic rubber gasket (IS:11149)	Y	Y		Y	Y		Y							
415V Switchgear (IS:8623)	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y

Y =Test applicable

5.15.4.2 **415V Busduct**

Items/ Components	Tests/ Checks														
	Dimension and surface finish	Make, Type, Rating and Test certificate	Electrical properties	Mechanical properties	Chemical properties	Item to conform to relevant IS	WPS approval, Welder qualification	Weld quality check (DP test and X-ray)	Paint shade, Thickness, Adhesion and	Tightness by torque measurement	Electrical clearances	Galvanizing test as per IS 2629/ 2633	IR – HV – IR test	Phase sequence check	Degree of protection routine test
Aluminum sheets/ plates/ strips / flexibles/ tubes (IS:5082/ 737)	Y	Y		Y	Y	Y	Y	Y							
CRCA flats/ ISMC (IS:2062)	Y	Y		Y	Y	Y									
Neoprene/ synthetic rubber gaskets (IS:11149/ 3400)	Y	Y		Y	Y										
Rubber bellows (IS:3400)	Y	Y		Y	Y										
Support insulator (BS:2782, IEC:660, IS:10912)	Y	Y	Y	Y											

Galvanized structure and GI earthing flat (IS:2629/ 2633/ 4749)	Y	Y				Y						Y			
Space heater and Thermostat		Y	Y												
LT busduct (IS:8623 Part 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y
Y = Test applicable															

SITE TESTS :

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

a) General
   i) HV test on complete switchboard with CT and breaker/ contactor in position
   ii) Check continuity and IR value of space heater
   iii) Check earth continuity for the complete switchgear board

b) Circuit Breaker/ Contactors
   i) Check control wiring for correctness of connections, continuity and IR values
   ii) IR values, resistance and minimum pick up voltage of coils
   iii) All functional checks and electrical & mechanical interlocks provided
   iv) Checks on spring charging motor, correct operation of limit switches and time of charging

c) Current and Voltage Transformers
   i) Insulation resistance test
   ii) Ratio test on all cores
   iii) Polarity test

d) Relays
   i) Insulation resistance between AC to DC terminals and between all terminals and body
   ii) Check minimum pick up voltage of DC coils
   iii) Relay settings

e) Bus duct
   i) Power frequency voltage withstand test
   ii) Insulation resistant measurement of equipment and all wiring
   iii) Milli-volt drop test

5.15.5 **Power and Control Cables**

5.15.5.1 **6.6kV Power Cables** **(Table 1/2)**

Item/ Components/ Sub- system	Tests/ Checks													
	Make, Type, Rating and TC	Dimension/ surface finish	Mechanical properties	Chemical composition	Spark test	Curing properties	Electrical properties	Hot set test, Eccentricity and Ovality	Lay length and sequence	Armour coverage, cross over, looseness, gap between two wire	Sequential marking/ surface finish/ cable length	Tensile strength and elongation before and after ageing on outer sheath and	Thermal stability on outer sheath	Metallic screening (if applicable)
Aluminium (IS-8130)	Y	Y	Y	Y			Y							
Semi conducting compound	Y		Y			Y	Y							
XLPE compound (IS-7098- Part-II)	Y		Y			Y	Y					Y		
FRLS PVC compound (IS-5831, ASTM-D2843, ASTM-2863, IEC-754 Part-1)	Y		Y									Y	Y	
Triple extrusion and curing/ Manufacturing of core		Y			Y			Y	Y					
Copper tape	Y	Y	Y				Y							
Polyster tape	Y	Y												
Armour wire/strip	Y	Y	Y											
Copper tapping	Y	Y						Y						
Inner sheath	Y	Y												
Armouring										Y				Y
Outer sheathing		Y									Y	Y	Y	
Power cable (Finished) (IS : 7098 Part-II) IEC:332, IS-5831, ASTM-D2843, ASTM- 2863,IEC-754 Part-1)	Y								Y	Y	Y	Y	Y	
Wooden drum (IS:10418)/ Steel drum		Y												

Y =Test applicable

5.15.5.2 **HT Power cables** **(Table 2/2)**

Item/ Components/ Sub-system	Tests/ Checks			
	Anti termite coating on wooden	Constructional requirements feature	Routine and acceptance test as per	FRLS tests
Aluminium (IS-8130)				
Semi conducting compound				
XLPE compound (IS-7098- Part-II)				
FRLS PVC compound (IS-5831, ASTM-D2843, ASTM- 2863, IEC-754 Part-1)				Y
Triple extrusion and curing/ Manufacturing of core				
Copper tape				
Polyster tape				
Armour wire/strip				
Copper tapping				
Inner sheath				
Armouring				
Outer sheathing		Y		Y
Power cable (Finished) (IS : 7098 Part-II) IEC: 332, IS-5831, ASTM-D2843, ASTM-2863,IEC-754 Part-1)		Y	Y	Y
Wooden drum(IS-10418) /Steel Drum	Y			

Y =Test applicable

Notes

1)	Additional acceptance tests like FRLS, thermal stability, tensile strength and elongation after ageing shall be done on one sample/ lot
2)	Length measurement/ surface finish/ eccentricity/ ovality shall be checked on one length/ size/ lot
3)	Routine test shall be carried out on each drum length as per specifications.

5.15.5.3 **1.1 kV PVC and XLPE cables** **(Table 1/2)**

Item/ Components/ Sub-system	Tests/ Checks											
	Make, Rating, Type and TC	Dimension/surface finish	Mechanical properties	Chemical composition	Electrical properties	Spark test	Hot set test (XLPE)	Lay length/ sequence	Armour coverage, cross over, looseness, Gap between two armour wire/ strip	Sequential marking/ surface finish/ cable	Tensile strength, elongation before and after ageing of insulation and outer	Thermal stability of insulation and outer
Aluminum (IS-8130)	Y	Y	Y	Y	Y							
PVC compound (IS-5831)	Y		Y		Y						Y	
XLPE compound (IS-7098 Pt-I)	Y		Y		Y		Y				Y	
FRLS PVC compound (IS-5831) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-I	Y		Y								Y	
Armour wire/strip (IS-3975)	Y	Y	Y									
Insulated core		Y				Y	Y					Y
Laid up core		Y						Y				
PVC Inner sheath		Y										
Armouring		Y							Y			
Outer sheath		Y								Y	Y	Y
Finish cable (IS-1554 and 7098 –Part-1) ASTM-D-2843/ ASTM- D-2863 IEC-754 Part-I Swedish Chimney SS 4241475 for (F3 category) Flammability test IEC-332 Part –3 Cat-B	Y	Y							Y	Y	Y	Y
Wooden drum (IS-10418) /Steel drum		Y										
Y =Test applicable												

5.15.5.4 **1.1 kV PVC and XLPE Cables** **(Table 2/2)**

Item/ Components/ Sub-system	Tests/ Checks			
	Anti termite treatment on wooden	Constructional/ requirement as per specification	Routine and acceptance test as per relevant standard and specification	FRLS Tests
Aluminum (IS-8130)				
PVC Compound (IS-5831)				
XLPE Compound (IS-7098 Pt-I)				
FRLS PVC Compound (IS-5831) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-I				Y
Armour wire/strip (IS-3975)				
Insulated Core				
Laid up core				
PVC Inner sheath				
Armouring				
Outer sheath				Y
Finish cable (IS-1554 & 7098 – Part-1) ASTM-D-2843/ ASTM- D-2863 IEC-754 Part-I Swedish Chimney SS 4241475 for (F3 category) Flammability test IEC-332 Part –3 Cat-B		Y	Y	Y
Wooden drum (IS-10418) / Steel drum	Y			

Y =Test applicable

Notes

1)	(*) Not applicable for XLPE insulation
2)	Additional acceptance tests like FRLS, thermal stability, tensile strength and elongation after ageing shall be done on one sample / lot.
3)	Length measurement / surface finish shall be checked on one length/size/ lot
4)	Routine test shall be carried out on each drum length as per specifications.

5.15.5.5 **1.1 kV PVC Control cables** **(Table 1/2)**

Item/ Components/ Sub-system	Tests/ Checks										
	Make, Type, Rating, Test certificate (TC)	Dimension/ surface finish	Mechanical properties	Chemical composition	Electrical properties	Spark test	Lay length/ sequence	Armour coverage, cross over, looseness, gap between two armour wire	Sequential marking/ surface finish/ cable	Tensile strength, elongation before and after ageing of insulation and outer sheath	Thermal stability of insulation and outer
Copper conductor (IS-8130)	Y	Y	Y	Y	Y						
PVC compound (IS-5831)	Y		Y		Y					Y	
FRLS PVC compound IS-5831 ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-1	Y		Y							Y	
Armour wire/strip (IS-3975)	Y	Y	Y								
Insulated core		Y				Y	Y				
Laid up core		Y					Y				
PVC Inner sheath		Y									
Armouring		Y						Y			
Outer sheath		Y							Y	Y	Y
Finished cable (IS-1554) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475(F3 category) Flammability test IEC-332 Part-3 Cat-B	Y	Y						Y	Y	Y	Y
Wooden drum(IS:10418)/ Steel drum		Y									
Y =Test applicable											

5.15.5.6 **1.1 kV PVC Control cables** **(Table 2/2)**

Item/ Components/ Sub-system	Tests/ Checks			
	Anti termite treatment on wooden	Constructional feature as per	Routine and Acceptance test as per relevant standard and	FRLS test
Copper conductor (IS-8130)				
PVC compound (IS-5831)				
FRLS PVC compound IS-5831 ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-1				Y
Armour wire/strip (IS-3975)				
Insulated core				
Laid up core				
PVC Inner sheath				
Armouring				
Outer sheath				Y
Finished cable (IS-1554) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475 (F3 category) Flammability test IEC- 332 Part-3 Cat-B		Y	Y	Y
Wooden drum(IS : 10418) / Steel drum	Y			
Y =Test applicable				

Notes

1)	Additional acceptance tests like FRLS, thermal stability, tensile strength and elongation after ageing shall be done on one sample/ lot
2)	Length measurement / surface finish shall be checked on one length/ size/ lot
3)	Routine test shall be carried out on each drum length as per specifications.

5.15.6 **Installation of Cables, Earthing system and Lightning Protection system**

Items/ Components/ Sub-systems	Tests/ Checks													
	Make, Type, Model, Rating and TC	Dimension	Pre-treatment of sheet	Paint shade, paint thickness, adhesion	IP protection	Bought out items/ Bill of material	HV and IR	Galvanize test	Functional test as per specification	Proof load	Deflection test	Constructional feature as per	All Routine and acceptance tests	Item conform to relevant standard
Switch box/ Junction box/ Receptacles (IS-513, IS:5, IS:2629, IS:2633, IS:6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	
Cable glands (BS:6121)	Y	Y												Y
Cable lug (IS:8309)	Y	Y												Y
Lighting wire (IS:694)	Y	Y										Y		Y
Flexible conduits	Y	Y										Y		Y
Conduits (Galvanize and Epoxy) IS:9537, IS:2629, IS:2633 and IS:6745	Y	Y	Y					Y					Y	
RCC hume pipe (IS:458)	Y	Y												Y
Cable termination and Straight through joint (VDE-0278)	Y	Y			Y	Y						Y	Y	
Cable Trays, Flexible supports system and accessories IS:513, IS:2629, IS:2633 and IS:6745	Y	Y	Y			Y		Y		Y	Y	Y	Y	
Trefoil clamp	Y	Y												Y
GI flats for earthing and lightning protection (IS:2062, IS:2629, IS:6745 and IS:2633)	Y	Y	Y					Y						Y
GI wire (IS-280)	Y	Y	Y					Y						Y
Y =Test applicable														

SITE TESTS :

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

i) Cables

a) Check for physical damage

b) Check for insulation resistance before and after termination/ jointing.

c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning

d) Check of continuity of all cores of the cables.

e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/ inserting, shorting, change in terminal connections, etc. shall be carried out

f) Check for correct polarity and phasing of cable connections

g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.

h) Check for provision of correct cable tags, core ferrules, tightness of connections

ii) Cable trays/ supports and accessories

a) Check for proper galvanizing/ painting and identification number of the cable trays/ supports and accessories.

b) Check for continuity of cable trays over the entire route.

c) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.

d) Check for earth continuity and earth connection of cable trays

iii) Earthing and Lightning protection system

a) Earth continuity checks

b) Earth resistance of the complete system as well as sub-system.

5.15.7 **VFD Module**

Attributes/Characteristics / Items/ Components/ Sub-system assembly	Visual & Dimensional checks	Make / Type/ Rating etc.	Final Inspection as per IS/ IEC	Remarks
HT Breaker (IEC-56)	Y	Y	Y	
DC Reactor	Y	Y		For details refer table for DC Reactor
Transformer	Y	Y		For details refer table for Transformer
Motor	Y	Y		For details refer separate table for Motor
VFD Panel	Y	Y		For details refer table for VFD Panel

Note:

1) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed alongwith relevant supporting documents during QP finalization

2) Make of all major Bought-out Items will be subject to purchaser's approval

5.15.8 **Transformer (Oil Filled)**

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical Properties	Electrical Strength	Thermal Properties	Chemical composition	Compatibility with oil	NDT/ DPT/ MPI/ UT	Ageing Test	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make/ Type/ rating/ Model/ TC/ general Physical Inspection	WPS & PQR	Routine Test as per relevant test	Routine test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y						
Conservator / Radiator / Cooler / Pipes	Y	Y					Y						
Copper Conductor (IS:191)	Y	Y	Y		Y								
Insulating Material	Y	Y	Y	Y	Y	Y							
CRGO Lamination & Built Core	Y	Y	Y		Y	Y							
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y		Y	
Gasket	Y				Y	Y		Y				Y	
Transformer Oil (IS:335/ IEC296)												Y	
Off-Circuit Tap Changer	Y									Y			
Core Coil Assembly & Pre-tanking	Y								Y				
Marshalling Box	Y	Y					Y					Y	
WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Globe & Gate Valve,	Y									Y			

Welding (ASME Sect-IX)	Y										Y		
Complete Transformer (IS:2026/ IEC-60076)	Y												Y

Note: 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2) All major Bought Out Items will be subject to Purchaser's approval.

Attributes / Characteristics Items/Components Sub Systems	Visual & Dimensional Checks	Mechanical Properties	Electrical Strength	Thermal Properties	Chemical Properties	NDT/ DPT/ MPI/ UT	Voltage Ratio, Vector Group & Polarity	Make/ Type/ rating/ Model/ TC/ general Physical Inspection	WPS & PQR	Routine Test as per relevant Standard	Measurement of Capacitance and tan delta between winding	Routine test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		

WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

5.15.9 **VFD Panel**

Attributes Characteristics **Item/ Components/ Sub-system/ Assembly**	Electrical Properties	Mechanical Properties	Chemical properties	Dimension/ Finish	Type/ Rating/ Functional Check	HV/ IR	Routine Test as per relevant Standard	Constructional Features	IS : 6005, Seven tank process	Paint finish/ Shade/ Thickness	Mounting/ BOM/ Make,	Interlock functional & operation testing/ Simulation check	Degree of Protection Test	Final testing as per relevant standard
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Busbar (IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS6875)					Y	Y	Y							
Contactor/ MCB (IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier (IS-13703)					Y	Y	Y							

Terminals/lugs/PVC wires(IS13947//IS-694)	Y			Y	Y	Y	Y							
Timers (IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS12021)					Y	Y	Y							
Mimic, Annunciator					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. All major Bought-out items will be subject to Purchaser's approval.

5.15.10 **Station Lighting**

Attributes / Characteristics / Items/Components Sub Systems	Make, Type, Rating/ TC	Dimension	Pre-treatment of sheet	Paint shade thickness Adhesion & Finish	Galvanization Tests	IP Test	Bought-out items/ Bill of Material	HV & IR	Functional check as per spec.	Constructional feature as per spec.	Routine tests as per relevant standard & spec..	Acceptance tests as per relevant standard & spec.	Item to conform to relevant standard
Luminaries (IS:10322 Pt.5 Sec.1 (Non-LED type)	Y					Y		Y			Y	Y	Y

Electronic Ballast	Y										Y	Y	Y
Lighting wire (IS:694)	Y										Y		
Fans (IS:374)	Y										Y		
Pole (IS:2713)	Y			Y						Y	Y	Y	
Lamps (IS:9800, IS:9974)	Y										Y	Y	
Lighting Mast (with raise & lower lantern type)	Y	Y			Y					Y	Y	Y	
Wall mounted Lighting Panel (IS:513, IS:5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/ Receptacles/ Local Push Button Station/ Lighting Panel (IS:513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS:6121)	Y	Y									Y		
Cable lug (IS:8309)	Y	Y									Y		
Flexible Conduit	Y										Y		
Lighting Transformer (IS:11171)	Y									Y	Y		
Epoxy & Galvanised Conduit (IS:9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y

5.16 DRAWINGS AND DOCUMENTS

Bidder shall submit the drawing and documents as per technical specification. Bidder shall also furnish soft copies of all the drawings & documents.

Work shall be carried out exactly as indicated on the approved drawings and specification. No alterations shall be made without prior written approval by Employer / his consultant.

The Bidder shall check all the drawings prepared by them and/or received from their vendors/supplier/sub-supplier and satisfy themselves about the correctness of drawings before issuing to Employer/Consultant. After checking, properly stamped drawings shall be sent to Employer/Consultant for approval / clearance.

Comments on all drawings shall be forwarded to Bidder for incorporation and resubmission.

The approval of drawings wherever applicable by Employer or their authorised representative does not absolve or relieve the supplier from any of his obligations under this contract and he shall be wholly and solely responsible for the satisfactory operation and guaranteed performance of his supply.

a) General Instructions for document submission

1 All the drawings/ documents submitted for approval shall be submitted in neatly filed/ spiral bound sets.

2 Drawings with multiple sheets & sub-titles shall be submitted with index sheet indicating page numbering for each sub-title & separator sheets shall be provided for different subjects.

3 Drawings with multiple sheets shall have unique sheet number on all sheets (viz. sheet 2 of 10). Total number of sheets shall be indicated on first sheet inside the title block.

4 All sheets of drawings shall indicate the drawing number & project name, if the title sheet cannot be provided on all sheets (drawings of A3 & A4 size).

5 Revised drawings shall always be submitted with point wise compliance report.

b) For Approval (Basic Engineering)

1. Electrical Consumer (Motor and component list) including field mounted electrics.
2. Maximum Demand calculation

3. Overall plant power distribution diagram
4. Typical schemes of DOL, RDOL feeders, VFDs, Motorised valve feeders, indicating interlocking, inputs & outputs to PLC, interface with LCB etc applicable to the various feeders indicated in SLDs of MCC/ MCPs.

5. Equipment layout drawing for Electrical building/control room sizing for Civil assignment
6. Interplant cable route layout with sections.
7. Single Line diagrams of MCC, PCCs, VFD, PDB, MLDBs etc.

c) For Approval (Detail Engineering)

1. GA, Data sheet & BOM of all distribution/ lighting transformers, isolators etc.

2. Single line diagrams, GA, Wiring & Schemes, BOM & General notes about constructional features of HT/ LT switchgear equipment, PCCs,MCCs, MCPs, PDBs, MLDBs, SLDBs, VFD drive panels, LCBs etc. with ratings of components cable sizes and details of protection and metering. Scheme & terminal detail drawing of LCBs of any equipment shall be furnished along with related MCC/ VFD panel.
3. General arrangement of all electrical equipment/ electronic panels/ controllers with GA, plan, internal view & arrangements front view and sectional views, Scheme & wiring, comprehensive bill of material with description, quantity,
make and type.
4. Layout of cable trays in cable cellars inside the substation & other electrical premises, cable channels, overhead cable structures, cable shafts etc.

5. GA drawing for erection accessories like cable trays, supporting structures etc.

6. Cable layout drawings in cable bridges, cable channels, overhead cable structure (as applicable), and incoming cable route etc.
7. Illumination layout of all the indoor & outdoor premises. Layouts at each floor of Electrical/ Technological/ Utility building with details and numbers & locations of light fittings, lighting distribution boards etc. SLDs of lighting distribution board.
8. Detail scheme of FDA system, List of annunciation/alarm points (location wise) & wiring scheme.

9. Earthing and lightning protection scheme and layout of earthing and lightning protection network including special electronics earthing.

10. Technical data sheets for Motors, Brake, Proximity switches & all field mounted electrics, GA drawings.

11. Data sheets for HT, LT power, control & special cables.

12. GA, BOM, foundation details along with structural calculations for lighting masts.

13. Data sheets & General arrangement of Light fittings, switches, sockets, junction boxes, welding sockets etc.
14. Data sheet, BOQ etc.for FDA, Telecom equipment

d) For Information / Reference

1. Bus-bar sizing calculation with respect to temperature rise & short circuit withstand capacity for PCCs, MCCs & Bus-duct.

2. HT/ LT feeder requirement with individual maximum demand.
3. Control circuit diagrams.

4. Static and dynamic loading of all major equipment
5. External connection diagram, panel wise and scheme wise.

6. Characteristics curves for Motors & field devices:-Speed-torque, current vs. time, thermal withstands characteristics for motors.

7. Cable layout drawings of technological floors, pump houses etc.
8. List of interfaces between Bidder's equipment and Purchaser's equipment.
9. Relay settings with calculations for total network to ensure proper co-ordination.

10. Cable termination plans with terminal block arrangement and markings.
11. Internal wiring diagrams of equipment.

12. Fire detection systems: layout & cable list.

13. Bill of materials and volume of work for erection.
14. Procedure for testing and commissioning of the entire plant, electrical & automation equipment. This shall also be furnished in soft copy.

15. Erection specification with bill of materials of erection materials, earthing materials, junction box, GI conduits etc. This shall also be furnished in soft copy.
16. Spare part list and drawings.
17. Instruction for storage /erection, testing & commissioning.

18. Operation and maintenance manual for all electrical equipments.

19. Detailed technical literature/ catalogue of manufacturer for all electrical equipments & components.
20. Terminal plan drawings.

21. Power & control cable schedules.

22. Type tests certificates (on either the equipment or similar equipment) of all major equipment like transformers, switchgear etc.

5.17 CONSTRUCTION POWER SUPPLY

For construction power supply, 11kv AC power supply from Purchaser's nearest source/substation will be provided by purchaser.

Bidder shall supply construction power distribution boards and power cables f r o m Purchaser's nearest source/substation. Supply, laying, erection, testing and termination at both ends of incoming power cable to bidder's construction power distribution boards

5.18 LAYOUT REQUIREMENTS

The Contractor shall offer the optimum design and layout to accommodate the ZLD system

For finalizing switchgear room size, following points shall be considered:-

Minimum clearance between any obstruction like column, wall, vertical raceway, etc. and rear of LV switchboard shall be maintained as 1500mm respectively.
Minimum clearance between two LV switchgear facing each other shall be maintained as 2000mm.
Minimum rear to rear clearance of LV switchgear shall be maintained as 1500mm respectively.
Minimum rear to front clearance for PCC to PCC shall be maintained as 2000mm.
Clearance between the bottom of ventilation duct and top of electrical panel shall be as per statutory requirement
Minimum clearance between two non-draw out panels facing each other shall be maintained as 1500mm.
Minimum clearance between wall and end of switchgear shall be maintained as 1500mm.
Minimum clearance between the sides of two switchgears shall be 1000 mm (preferable) or within 200 mm.
Minimum clearance between LV switchgear to dry type transformer shall be kept as 2000mm.
Access to rooms, doors, etc. to be provided in various floors shall consider movement of the panels during erection and later during maintenance.
Switchgear room/MCC room and cable vault shall be pressurized above the atmospheric pressure to prevent ingress of dust.

Control room, switchgear room shall be provided with separate entry and exit door.
Rating of fire proof door to be provided in cable vault shall be 2 hours.
Walkways shall be provided for accessing the cable laid on cable trays in all pipe racks & cable racks.
Cable vault floors shall have all openings properly ridged to prevent water drainage into the room below. In addition, proper facilities shall be provided at cable vault floor to drain the water in case of operation of sprinkler system.
Air-conditioned rooms shall be provided with double door.
During design stage adequate space shall be provided for expansion of board on either side to accommodate addition of panel to take care of unforeseen factors.
All bus ducts shall enter the 415V PMCC from top.
Minimum clearance between two HV/MV switchgear facing each other shall be maintained as 3500mm.
Minimum clearance between any obstruction like column, wall, vertical raceway, etc. and rear of HV switchboard shall be maintained as 2000mm respectively
Minimum rear clearance(Panel cover to wall/Column) of HV switchgear shall be maintained as 1500mm respectively.
Minimum clearance between the sides of two HT switchgears shall be 1000 mm (preferable).

Bottom of roof beam in HT/LT switchgear room from finished floor level shall be 4.5 metres when the room has bus ducts and shall be 4.0 metres without bus duct.

6.0 CONTROL AND INSTRUMENTATION

GENERAL

i) The bidder shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Instrumentation and Control System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

ii) The bidder shall also include in his proposal and shall furnish all equipment, devices and services which may not be specifically stated in specification but are needed for completeness of the equipment/systems furnished by the bidder and for meeting the intent and requirements of the specification.

SCOPE OF WORK

Tenderer's scope of work for this ZLD part includes furnishing the required Control & Instrumentation System. equipment and materials including design; engineering; manufacture/ procurement; assembly; calibration; shop testing; inspection at works & at site; painting; packing; transportation to site including loading, unloading, storage & handling of all instrumentation equipment including electrical accessories, cables, pipes, erection accessories, panels/ cabinets and all associated hardware, as required for completeness of instrumentation system in all respect, site fabrication (Structural Items), erection, testing, and successful commissioning of the complete instrumentation system for completeness & satisfactory stable operation of Plant for Zero Liquid discharge Plant. The scope of work shall also include liquidation of defect points, participation in tests for establishment of plant performance guarantee (PG) and post commissioning activities till issue of final acceptance certificate (FAC) by Customer.

6.1 Scope of Supply, Erection, Testing and Commissioning

The scope of supply includes the following:

1) Programmable Logic Controller (PLC) based control system along with work stations, LED screens, Printer & other peripherals for implementing measurements, modulating controls, interlocks & protections, sequential controls for entire ZLD system. The latest proven Microprocessor based control system (PLC) specifically designed for this application shall be provided.

2) All necessary field instruments, sensors, final control element with actuators shall be as per finalized P&ID's approved during detailed engineering stage.

3) System Cabinets, Marshalling/ termination panels, Interposing relay panels, local

control panels (if required), Control desks, Printer tables, Chairs and any other panels.

4) Industrial graded parallel redundant Uninterruptible Power Supply (UPS) System with one hour battery backup along with ACDB and SCVS shall be provided.

5) Facilities required to upload data if any to CPCB/SPCB shall be in bidder's scope.

6) Supply, erection, laying & commissioning of Instrumentation, Compensating, Instrument Power cables, Fibre Optic Cables, prefab cables and connectors including all interconnection cables.

   Cabling and interconnection shall include complete cabling work, earthing of all panels / racks / cabinets / junction boxes etc, up to ground lug / riser with appropriate cable; special cabling between sensing devices to converter cabinets and cabling work of prefabricated and Ethernet cables. Cabling work shall include pulling, laying, marking, splicing, glanding, dressing, ferruling, crimping and termination of cables with associated conduit and sub-tray work; followed by testing of cables.

7) Erection Hardware, Process Connection & Piping, etc.

8) Special tools & tackles and test equipments.

9) Performance test and guarantee tests.

10) Engineering documentation.

11) Training to Owner's personnel.

12) Any other item not listed, but required and mentioned elsewhere in the specification for completion of project.

13) Instrumentation equipment as per the measurement list covered in this specification.

14) Impulse pipes, isolation valves, fittings, trays, conduits, steel structures & frames, erection hardware & accessories, as required for this package.

15) All electrical accessories for instrumentation system and other instrument power supply equipment as applicable.

16) Fully wired cabinets/ panels/ control desks, junction boxes, pull boxes, transmitter cabinets, etc., as applicable.

17) Galvanized trays, conduits, protection pipes, fittings, steel structures & frames,

erection hardware & accessories, as required for this package.

18) Erection, testing, calibration and commissioning of the total equipment included in this specification. Successful Tenderer shall arrange tools, tackles and consumables as may be required for erection, testing, calibration and commissioning activities.

19) Arrangement of and participation in inspection of Instrumentation equipment by Purchaser/ Consultant. Inspection and Testing shall be carried out in compliance with the Quality Assurance Plans, to be approved during detailed engineering stage.

20) All the instrumentation tapping points, sensors, field instruments, equipment etc. shall be located at safe and approachable locations. Provision of sufficient working space, suitable working platforms, safe & proper approach (monkey ladders shall be avoided) and lighting points shall be included.

21) Submission of drawings and documents as per clause "System Documentation" of this document pertaining to instrumentation, control and automation system.

22) Providing maintenance platforms with approach ladder for the instrumentation items/ tapping points which are at inaccessible locations.

23) Liquidation of defect points, participation in tests for establishment of plant performance guarantee (PG), final acceptance certificate (FAC) and post commissioning services.

24) Commissioning spares.

25) It may be noted that any item / equipment not specifically mentioned under the scope clause, but required for completeness and successful operation of the system, Subject to Purchaser's approval shall be supplied by bidder.

Bidder's scope for erection, installation and commissioning work under this specification shall include:

Installation, interconnection, testing and commissioning of all field instruments, equipment, cables and Control systems furnished by the bidder as per this specification. This shall include all required erection, testing and commissioning work for ensuring satisfactory operation of control and instrumentation equipment as per intent and requirements of this specification.

Supply of all necessary tools, tackles, test instruments and experienced personnel for completion of the above erection, testing and commissioning works. Services of collaborators specialist or OEM if necessary or felt necessary by Purchaser for successful commissioning of the system shall be provided by the bidder within overall package price.

6.2 DESIGN CRITERIA

General Requirements

The instrumentation & control system equipment shall be adequately designed to monitor and control all significant variables in accordance with the process & operating requirements along with process/ safety interlocks, protections & alarms for abnormal conditions. The system shall be designed to ensure that the accuracy of instruments and the overall system accuracy meet the process requirements.

Design & selection of instrumentation & control system shall take care with the following features as a minimum:

1. Latest state-of art and proven technology.
2. High accuracy, reliable performance, easy expandability, modular design.
3. Standardisation of items & makes for maximizing interchangeability and minimizing inventories.
4. Computer compatibility.
5. Easy maintainability and diagnostic features.
6. Fail-safe features.
7. User friendly testing & calibrating facilities in both local & remote mode.
8. Flexibility for carrying out maintenance work with the process on.
9. Safety to plant equipments and operating personnel.
10. Aesthetically & ergonomically designed control rooms.
11. Provision for future expansion in design & selection, e.g. sizing of final control elements, flow sensors, space inside the control room, space on the panels/cabinets/desks etc.
12. Provision for auto/remote/ manual operation for all automatic control loops.
13. Final control elements with electric, pneumatic, hydraulic or hybrid actuators depending on application requirement. Final control elements with local valve position indicators and valve position transmission to control room.
14. Dual redundant devices for measurement & control of critical parameters.
15. Uninterruptible Power Supply system & other auxiliary power supply system:

Contractor shall include 240V AC UPS system to cater to the power requirement for Zero Liquid Discharge System and other services. 240V AC, single phase UPS supply shall be utilized for PLC, instruments, solenoid valves and Man Machine Interface equipment. The details of the above power supply system namely, Batteries, Battery chargers, Inverters, stabilized supply, static switch, main distribution board are covered in clause no 4.6. 220V DC, if required, shall be utilized for equipment like solenoid valves. This shall be taken from 220V switchgear. 110V AC if required shall be derived from 240V AC UPS system.

16. Calibration/ configuration of HART based instruments from PLC & also through hand held calibrator.

17. Hand held calibrators/ configurator shall be provided with adequate memory capacity & device description of all HART certified devices loaded therein. Hand held calibrators/ configurator shall be suitable as per the area classification of the field instruments for which it is to be used.

18. All instruments shall have standard ranges.

19. In hazardous area applications, electronic/electrical instrumentation equipment shall be suitable for hazardous area classification as per IEC. These equipment shall be intrinsically safe conforming to CENELEC standard and certified by appropriate statutory bodies (ATEX, FM, BASEFA etc.). Intrinsically safe systems shall be designed using zener/ IS barriers. Where intrinsically safe design is not feasible, ex- proof equipment/enclosure, certified by statutory bodies like CMRI Dhanbad/ CCOE Nagpur shall be supplied. Other acceptable safety procedures (e.g. increased safety procedure, pressurisation etc.) shall be used, wherever applicable. Required documentation/certificates shall be submitted in conformance with all such features.

20. All transmitters shall have built-in digital output indicators calibrated in engineering unit of flow, pressure, level, temperature, differential pressure etc.

21. Flow switches shall be with digital display.

22. Isolator cards shall be provided for isolation / multiplication of 4-20 mA DC instrument signals, wherever necessary.

23. Transmitters installed in the field (outdoor) and also in dusty & harsh indoor environment shall be housed inside cabinets.

24. All field-mounted instruments shall be of suitable weatherproof construction, as per details indicated for respective items.

25. Temperature sensors shall be with head, covers & SS chain.

26. Vibration sensors shall be provided in X-Y direction for HT drives.

27. Wetted parts of the instrumentation equipment shall be selected so as to withstand physical and chemical properties of the service fluid coming in direct contact with the instrument.

28. Colour codes for panels/cabinets, cables, JBs shall be followed for the plant as per industry/plant standard.

29. All the manufactured/fabricated items, cables, cable trays / conduits, impulse pipes & fittings shall be properly painted/ coated/ wrapped/ protected as per requirement & standard practice, depending upon nature of environment in which these are to be installed. Selection of primer and finish paint shall be done as per relevant IS standard or equivalent international / industry standards.

30. All impulse lines & fittings shall be of SS material & fittings shall be double compression type. However, for steam service, carbon steel pipes & socket welded fittings shall be used.

31. All fittings & accessories shall be new & rust protected. All flanged type instruments shall be supplied with companion flanges, nuts, bolts & gaskets.

32. Wherever corrosive atmosphere is present, all instruments and associated equipment exposed to such a medium shall be designed & protected to withstand the adverse effects.

33. Wherever instrumentation equipment is installed underground, suitable approach, sufficient space for maintenance, drainage, ventilation and illumination shall be provided. For instruments/ tapping points at inaccessible / unapproachable locations, suitable maintenance platforms with railings, stair cases, approach ladders etc. shall be provided or/and remote transmitters/ converters shall be provided at approachable, convenient and safe locations.

34. Necessary certificates from appropriate authorities shall be submitted for all applicable items regarding their suitability & installation.

35. In case, instrumentation & control equipment are supplied from foreign sources / manufacturers, care shall be taken to select only those vendors/products who have their own set up or qualified service support in India with ability to provide required technical assistance & after sales service.

36. <u>Unit of measurements</u>

    Generally following units shall be used for measurements of different process parameters:

    Pressure: kg/cm^2g or mmWC.

    Flow: Liquid: $m^3/hr.$; Gas/Air: $Nm^3/hr.$; Steam/vapour: T/hr. or kg/hr. Level/length:

    mm or mtr.

    Viscosity (dynamic) : Poise / Centipoise. Temperature: ^0C

Density: Liquid/steam: kg/m^3; Gas/Air: kg/Nm^3

6.3 Environmental Conditions

Instruments, devices and equipments shall be designed to suit the environmental conditions and shall be suitable for continuous operation in the operating environment of a gas based combined cycle power station as per specification requirements covered under Section B Volume-1 part II SCC of Project Information.

6.4 Reliability and Availability

i) Each component and system offered by the bidder shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, power supply, peripheral etc. shall be established by the bidder, considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%.

ii) When more than one device uses the same measurement or control signal, the transmitter and other components/ module shall be fully equipped to provide all signal requirements. The system shall be arranged so that the failure of any monitoring device or control components or spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.

iii) To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria as mentioned above. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.

6.5 Operability & Maintainability

i) The design of the control systems and related equipments shall adhere to the principle of 'Fail Safe' operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that occurrence of false trips are avoided / minimized.

The types of failure which shall be taken into account for ensuring operability of the plant shall include but not be limited to:

a) Failure of sensor or transmitter,
b) Failure of main and/or redundant controller/other modules,
c) Loss of motive power to final control element,
d) Loss of control power.

e) Loss of instrument air

ii) The choice of hardware shall also take into account sound maintainability principles and techniques. The same shall include but shall not be limited to the following:

a) Standardization of parts.
b) Minimum use of special tools.
c) Grouping of functions.
d) Interchangeability.
e) Malfunction identification facility/self-surveillance facility.
f) Easy modular replacement.
g) Fool proof design providing proper identification and other features to preclude improper mounting and installation.
h) Appropriate derating of electronic components and parts.

iii) The equipment shall employ latest state of the art technology to guard against obsolescence. In any case, bidder shall be required to ensure supply of spare parts for 15 years of the plant. In case, it is felt by the Bidder that certain equipment/component is likely to become obsolete, the Bidder shall clearly bring out the same in his bid and indicate steps proposed to deal with such obsolescence.

6.6 Standardization and Uniformity of Hardware

To ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management of various C&I instruments/equipment, the Bidder shall ensure that all instruments/devices are of the same make, series and family of hardware to the extent possible.

6.7 Protection, Class of Cabinets / Panels, Enclosures etc.

All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below as per IEC EN 60529.

1.	In-door Air-conditioned (A.C.) areas	IP32
2.	In-door Non A.C. areas:	
a.	Ventilated enclosures	IP 42
b.	Non Ventilated	IP 54
3.	Out-door (As per the requirement)	IP 65

Enclosures for peripheral equipments like printers, etc. shall ensure minimum possible noise disturb to the working personnel.

6.8 SYSTEM DOCUMENTATION

Following drawings and documents shall be submitted by the Tenderer for Instrumentation system:

To be submitted by the successful Tenderer :

I) <u>For Approval</u>:

i. Finalized process and instrumentation (P & I) diagram indicating all local & remote measurements, alarms and interlock functions, using ISA symbols and using suitable tag numbers against each instrumentation equipment.
ii. System Design Philosophy, Test protocol, System Configuration, QAP of PLC system.
iii. Instrument Schedule.
iv. Input / Output List.
v. Logics & Write-ups.
vi. Instrument Cable Schedules, JB Schedules, Interconnection Diagrams & terminal details.
vii. Finalized list of measurements, alarms & interlocks, along with BOQ and specification of each instrumentation item indicating make, model number, scale range, quantity, application and tag number (as per P&I diagram).
viii. Detailed specification datasheet for each instrumentation item, filled in as per the format finalized for this plant.
ix. Overall general arrangement drawings & sectional views of various cabinets, panels, desks etc., showing internal disposition of all components/ units, with dimensional details and bill of materials.
x. Single line power supply diagram with specification and bill of quantities of electrical accessories.
xi. Quality assurance plan for each instrument.

II) <u>For Scrutiny and Records</u>:

i. Detailed technical literature/ catalogue for each instrumentation item.
ii. Instrument Installation/ Hook up diagrams with bill of materials.
iii. Instrumentation layout drawings showing location of instruments and route of cables from these upto control room.
iv. Wiring and termination diagrams with details of termination of field signals to local JBs/ panels and from JBs to panels/ marshalling racks/ cabinets including internal wiring drawings.
v. Cable schedule.
vi. Manufacturer's test, calibration and guarantee certificates for all instruments.
vii. Operation and maintenance manuals for instruments.
viii. 'As-built' documentation.
ix. Soft copy of all the above approved drawings & documents in CD- ROMs/ DVDs.

6.9 CODES & STANDARDS

All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipment / systems will be installed. The bidder shall fully acquaint himself with these requirements and shall ensure compliance with them.

The requirements of statutory authorities (e.g. MOEF, Inspectors of factories, BEE, CPCB, SPCB etc) with regards to plants area shall be complied, even if not actually spelt out.

Reference Codes and Standards:
The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall confirm to the latest editions of codes and standards mentioned below and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, VDE, NFPA, and Indian Standards and their equivalents. Bidder to note that in no case, OEM / manufacturer's own standards shall be accepted.

6.10 PROGRAMMABLE LOGIC CONTROLLER

6.10.1 General Requirements

i) Bidder shall provide latest system available at the time of detailed engineering and all the hardware/ software shall be latest and field proven as available in the market.

ii) Bidder shall provide independent control systems for safe, efficient and reliable operation of each of the plant auxiliary systems. The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardized. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit, instrument air supply failure etc. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering. System shall be designed such that there will be no upset when Power is restored.

iii) IRIG port shall be provided in one of the controllers for time stamping**.**

iv) ON/OFF control, indication, annunciation of incomers and bus-coupler are also to be performed from contractor's control system for each of the above system as applicable.

v) The control system shall be located in air conditioned area. However, the control system shall be designed to operate in non-air conditioned area also during air-conditioning failure.

vi) Local control panels shall be provided if recommended by respective OEM, in case of which necessary hardwired interface with PLC shall be provided as per OEM recommendations.

6.10.2 Functions of PLC

i) The PLC shall be capable of executing the following functions:-

a) Provide complete controls of the Zero Liquid Discharge (ZLD) system
b) Receive input signals that represent the status of process variables and equipment status; condition the signals; and utilize them for control, protection, monitoring, status display, annunciation and SER.
c) Provide the output signals to modulate and control the final devices, such as control valves, control drives and pumps.
d) In addition to redundant Soft links, hard wired interfacing shall also be provided for signals required for control & protection as specified elsewhere in the specification.
e) Status of all drives, pumps, tanks, etc should also be available in control room.

ii) The controller shall provide all basic functions for binary gating operations, modulating controls, storage, counting, timing, logging, transfer operations and comparison functions.

iii) All functional controllers shall be provided with 100% hot standby controllers and shall be identical in hardware and software to their corresponding main controller. The 100% hot back up controller shall continuously track/update its data corresponding to its main controller. There shall be an automatic and bump less switchover from the main controller to its corresponding backup controller in case of main controller failure and vice versa. Any switchover from main controller to 100% hot backup controller and vice-versa, whether automatic or manual shall not result in any process upset or change in control status.

iv) The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future.

v) The OWS shall perform control, monitoring and operation of all auxiliaries/ drives interacting with PLC system. It shall basically perform the following functions:

a) Operator interface for PLC based control system. Operator functions shall as minimum include local/ remote selection, A/M selection, open/ close operation, sequence auto, start/ stop selection, ON/OFF, bypassing criteria etc.
b) Supervisory functions like:-
Mimic displays, which shall depict the process in graphical form and shall cover all the process areas being monitored.

Alarm monitoring/reporting, generation of logs, calculations, printing of logs & reports etc.

vi) The data to be stored in the PLC system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalized during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last seven (7) days shall be available on the disk.

vii) In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database as well as processed/computed data based various calculations/ transformation. The retrieved data from long term storage media should be possible to be presented in form of alarms, logs, reports etc.

viii) On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification. A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program. Programming shall be possible OFF line.

ix) Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

x) All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program listing so that it is possible for the Purchaser to carry out modification at a later date.

xi) The Contractor shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

a) Industry standard operating system like UNIX/ WINDOWS (Latest) etc. to ensure openness and connectivity with other system in industry standard protocol OPC shall be provided. The system shall have user oriented programming language & graphic user interface.

b) All system related software including Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

c) All application software for PLC system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

d) The Contractor shall provide software locks and passwords to Purchaser's engineers at site for all operating & application software so that Purchaser's engineers can take backup of these software and are able to do modifications at site.

6.10.3 Redundancy Criteria

The control system shall have appropriate Redundancies built in for modules such as Controller, Communication cards, Input / Output Cards and power supplies as indicated below.

i) Controller Card, Communication card and Power supply cards shall be redundant.
ii) System Power supply and Field Interrogation supply shall be independent and one to one redundant.
iii) The Input & Output Card redundancy shall be as follows
   a. Redundant Digital output cards shall be considered and provided for HT Drives & LT Drives.
   b. Redundant Analog output cards for all Modulating drives shall be provided.

6.10.4 Input/ Output Modules

i) Input Output modules, as required in the Control System for all types of field input signals (4-20 mA, RTD, Thermocouple, non-changeover/change over type of contact inputs etc.,) and outputs from the control system (non change over/change over type of contact, 24/48 VDC output signals for energizing interface relays, 4-20 mA output etc.) are to be provided by the Contractor.

ii) Electrical isolation of 1.5 kV with optical couplers between the plant Input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment.

iii) The Input/output system shall facilitate modular expansion in fixed stages, which shall be easily accessible for maintainance and repair. The types of modules shall be kept to minimum possible in order to have interchangeability and spares inventory.

iv) All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off power supply.

v) The Contractor shall provide the following monitoring features:

1. Power supply monitoring.
2. Contact bounce filtering.
3. Optical isolation between input and output signals with the internal circuits.
4. In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Contractor during detailed engineering.

vi) Further, keying-in of individual wire connectors shall be provided to ensure that only the correct card is plugged on the I/O module. It shall be possible to remove I/O module without disconnecting wiring from field inputs or outputs. There shall be at least 20% spare capacity available on input, output and memory modules, over and above the system requirement.

vii) Only one changeover contact shall be provided in MCC for control and interlock requirement. Further multiplication, if required, shall be done by the contractor in PLC system.

viii) In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper annunciation.

ix) Wiring Scheme for inputs to control system shall be as follows:

1. Input sensors used for interlock/protection shall be dual redundant. Each of the redundant binary & analog inputs shall be wired to separate input modules. These input modules shall be placed in different racks, which will have separately fused power supply distribution. Implementation of multiple measurement scheme of these inputs will be performed in the redundant hardware. Loss of one input module shall not affect the signal to other modules. Other channels of these modules can be used by other inputs of the same functional group.
2. The single (i.e. non-redundant) binary & analog signal required for control purposes shall be wired as follows:

a) All single analog & binary inputs including the limit switches of valves/dampers MCC/SWGR check-backs of all drives & information related signals shall be wired to single (i.e. non redundant) input modules.

b) The on-off status of HT drives etc., however, shall be wired to two separate input modules.

3. Inputs and Outputs related to each of the redundant drives / equipments (e.g. each of the 3x50 % drives, each of the storage vessel/sump/tank storing same fluid, each of the streams and its related drives etc.) shall be wired to separate input and output modules.

6.10.5 Interface with other Control system

1. The data exchange for critical signals between Main plant DCS and ZLD PLC shall be hardwired input / output in the form of galvanically isolated 4 – 20 mA signal and potential free contact input / output. However, necessary I/O channels, marshalling JBs as required at main plant DCS shall be in owner's scope.
2. The bidder shall provide OPC Protocol to Interface ZLD PLC with other control systems.
3. To protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc. shall be deployed.
4. The communication link cable for the OPC shall be through fibre optic cable with necessary LIU, optical converter & de-converter units at both ends are in the scope of the bidder.

6.10.6 UPS

Industrial graded UPS consisting of 2 X 100%, 1 – Phase, 240 V, 50 Hz parallel redundant UPS with 50% load sharing mode and stand by servo stabilizer to supply power at full load to ZLD system, HMI's and printer with one hour battery backup shall be provided. UPS shall be of "parallel redundant with static bypass to regulated supply" type with 2 x 100% Plante type battery, 2 x 100% battery chargers, inverters, static bypass switch, and regulated AC supply. It shall include AC distribution board with air break switch, fuses, current transformers, alarms and indications.

The details of the AC distribution board, i.e. exact design, number of feeders etc. of the ACDB shall be as finalized during detailed engineering and as approved by the purchaser.

6.11 HUMAN MACHINE INTERFACE SYSTEM (HMIS)

6.11.1 General

i) Operator work station (OWS) shall perform control, monitoring and operation of all auxiliaries/ drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC and the Human Machine Interface System. It shall basically perform the following functions. In case the PC based OWS cannot be used as programming station of the PLC and the Human Machine Interface System, then separate PC based programming station shall be provided.

ii) Operator shall be able to access all control/information related data under all operating conditions including a single processor/computer failure in the HMIS.

iii) All frequently called important functions including major displays shall be assigned to dedicated function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions.

iv) The operator functions for each OWS shall as a minimum include Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local- remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.

v) The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets.

vi) The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).

vii) When any drive or sequence is being controlled from one OWS, the system shall inhibit control access of the same drive or sequence from other OWS or Local Control Panel.

6.11.2 Programming station/operating work station/PC

The hardware of Programming station/operating work station/PC shall conform to the following minimum requirements:

Sl. No.	Features	Programming station/workstations for information functions	Operator workstations/ PC
1	Processor	Intel Xeon Six (6) Core 64 bit Processor capable 3.6 GHz with 16MB L3 cache memory per processor, Dual independent 1333 MHz system bus (2 way SMF) or better.	64 bit/32 bit - On board Intel – Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
2	Memory	64GB ECC DDR – 3, 800 SDRAM.	8 GB DDR3 RAM
3	Drives	HDD – RAID 5 (1000 GB) Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB DVD/ CDROM – 24X CD– RW/ DVD IDE combo USB – 4 ports DAT – 36 / 72 GB 2048MB Graphic Accelerator	1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher. 2048 MB Graphic Accelerator.
4	Monitor (colour)	LED based 24” sized Monitors. With noninterfaced refresh rate min. 75 Hz. Full HD resolution 1920 X 1080, 256 colors with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.	LED based 24” sized Monitors with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 X 1080, 256 colours with MRPII compliant, viewing angle 178° vertical & horizontal and fastest response time.
5	RAID	SAS-channels, hardware RAID level 5 implemented	
6	Redundant hot swappable power-supply	2 nos.	

7	Removable bulk Storage drive (DVD)	6 GB (minimum)	
8	Removable bulk storage media for above (with each server/ work-station)	10 nos.	
9	DVD R/W	16x or higher	16x or higher
10	Power Supply	240 V AC UPS with 30 mins. Battery backup on machine load and 10% design margin at full load.	240 V AC UPS with 30 mins. Battery backup on machine load and 10% design margin at full load.
11	Keyboard	ASCII	ASCII
12	Pointing Device	Optical Mouse	Optical Mouse
13	Accessories	Industrial grade furniture as approved during detailed engineering	Industrial grade furniture as approved during detailed engineering
14	Software	Latest & proven version of Windows Operating system. General MS Windows latest, MS- Office Professional, Adobe Acrobat, anti-virus software with IPS, etc. Application engineering & HMI software - to suit project Specific requirement.	Latest & proven version of Windows OS with Multimedia. Third party operating system, graphical users interface and software, if required. General MS Windows latest, MS-Office, Adobe Acrobat, anti-virus software with IPS, AutoCAD etc. Application engineering & HMI.
			Software - to suit project specific requirement.
15	Additional general purpose software (for using over network by servers/ workstations PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/ antivirus, etc. (like "Norton System Works")	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/ antivirus, etc. (like "Norton System Works")

The supervisory functions like log, calculations, shall be implemented in redundant Server/Information workstation, so that no functions are lost due to a signal failure.

Individual Monitors shall be supplied for all stations.

6.11.3 Peripheral Quantities

Quantities specified for ZLD control system are as follows

Sl. No	Item	Qty (no.s)
1.	Work stations (1 OWS + 1 EWS)	2
2.	LED type video screen	1
3.	A4 size Black and white Laser Jet Printer	1

6.11.4 Data Communication System

The Data Communication System shall include a redundant System Bus with hot back-up and other applicable bus systems like cubicle bus, local bus, I/O bus etc.

The Data Communication System shall have the following minimum features:

a) Redundant communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLC and between PLC and operator work station.

b) The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.

c) If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility.

d) Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/ logged.

e) The design and installation of the system bus shall take care of the environmental conditions as applicable.

f) Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion.

g) Passive coaxial cables or fibre optic cables shall be employed.

The Contractor shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.

6.11.5 Annunciation System

i) Contractor shall provide OWS based annunciation system as integral part of PLC system with audio alarm facility. Field contacts shall be acquired through PLC only. The annunciation sequence logics shall be implemented as a part of PLC controllers.

ii) The annunciator sequence shall conform to ISA sequence ISA-2A. Alarm boxes shall be provided in each display to alert the operator about an alarm when he is viewing some other picture. The number of alarm boxes and the provision for original input will be on as required basis.

6.11.6 Printer

One number A4 size color laser printer shall be provided as a part of the supervisory system. It shall print out all alarm/trip conditions and event changes in plant status along with date and time of occurrence. 5 set of print cartridges shall be provided with each type of printer.

6.11.7 Furniture

Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe. Each module shall have transparent cover and adjustable partition. It shall have locking provision for security. The components shall be suitable for integration/fabrication without any welding technology.

i) **Work Station furniture**

Modular work station furniture, suitable for mounting OWS, printer (A4 laser) etc. is to be provided. The exact details shall be finalized & approved by Purchaser during detailed engineering.

ii) **Chairs**

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back. The exact details shall be finalized & approved by Purchaser during detailed engineering.

iii) **Tables**

Industry standard printer table shall be provided & shall be as approved by Owner during detailed Engineering.

iv) **Almirah**

1 no. of vertical Steel Almirah shall be provided for keeping documents etc. Final quantity shall be decided by owner during detailed engineering.

Thickness of steel almirah sheet shall be 18 gauges with neat finish.
Tentative size of Almirah shall be 78"(H) x 36"(W) x 19"(D). 4-5 mm thick Glass doors for each rack shall be provided such that the documents are visible from outside. Minimum 5 no. horizontal partition/rack shall be provided in the almirah. 3 point locking system shall be provided. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by owner during detailed engineering.

6.12 CONTROL ROOM DESIGN

1. Control room shall be aesthetically and ergonomically designed as per modern features with adequate safety features.

2. Control room shall have false ceiling, false floor and double wall. Fresh air entering the control room shall pass through chemical filters.

3. The control room shall be air-conditioned.

4. Walls shall be paneled with aluminum strips and painted with dust free, wear and fire resistant paints.

5. Floors shall be of linoleum / hard rubber fire-inhibited asbestos filled vinyl floor with antistatic properties.

6. Control room illumination level shall be adjustable in the range of 250-550 lux and generally maintained at 500 lux. Illumination shall be done with shadow less and glare free concealed fittings.

7. Cable troughs or openings in the floor shall be provided to bring the cables to the

panels. The opening shall be sealed after completion of erection.

8. Normally gas impulse lines shall not be permitted in the control room. If however, gas lines do enter the control room, proper ventilation shall be provided with more air changes to ensure safety.

6.13 LIST OF MEASUREMENTS AND CONTROLS

An indicative list of measurements, controls, alarms & interlocks for Zero Liquid discharge Plant is given below and Tenderer shall comply with the same. However, Tenderer shall offer all the measurements, controls, alarms & interlocks as may be required for efficient & satisfactory operation of their process and equipment and are included in their scope of work & supply. Unless specifically mentioned, all monitoring & control of the process parameters shall be achieved in PLC based automation system and displayed in HMI stations and field instrumentation equipment shall be offered accordingly. The measurements signals will be brought to the control room RO plant building unless otherwise stated.

For critical application, multi signals shall be provided i.e. more than one sensor for the same service shall be considered.

I. MEASUREMENT OF PRESSURE:

a) Pressure gauge at the suction and discharge of each pumps
b) Pressure gauge at the delivery of each blowers, chemical dosing pumps
c) Sensing of high & low pressure at each effluent feed inlet to collection cum equalization tank with high & low pressure alarm.
d) Pressure gauge at the inlet header and outlet header water line of Filters, RO train.
e) Sensing & signaling of low pressure at outlet of each pump including chemical dosing pumps and starting of corresponding standby pumps.
f) Sensing & signaling of low pressure at suction and high pressure at the delivery of each high pressure pumps (RO).

II. DIFFERENTIAL PRESSURE MEASUREMENT:

a) Differential pressure sensing & signaling across each filters, each UF unit and each Cartridge filters along with high DP alarm annunciation.
b) Differential pressure measurement between inlet water line and outlet concentrate water line of each RO train along with high DP alarm annunciation.

III. MEASUREMENT OF TURBIDITY USING TURBIDITY METER:

a) At delivery header of effluent feed pump after collection cum equalization tank along with high feed turbidity measurement & alarm annunciation.
b) At UF unit common outlet header with high turbidity measurement & alarm annunciation.
c) At Cartridge filter common outlet header turbidity measurement & alarm

annunciation.

d) Wherever required, measurement for TSS (Total Suspended Solids) & TDS (Total dissolved solids), Silica shall be provided.

IV. FLOW MEASUREMENT (MAGNETIC FLOW METER):

a) Flow measurement at the inlet to collection cum equalization tank.
b) Flow measurement at delivery header of each set of pump groups installed at ZLD complex.
c) Flow measurement at the outlet of filters.
d) Flow measurement at the outlet of UF unit with flow indicator, flow totalizers and high and low flow alarm annunciation.
e) Flow measurement at the inlet of backwash water lines from back wash water pumps with flow indicator, flow totalizers.
f) Measurement of concentrate water flow at the outlet of each RO train with flow indicator, flow totalizers and high and low flow alarm annunciation.

V. LEVEL MEASUREMENT:

a) Level measurements for each tanks, sumps and make-up water overhead tank with high, low & low-low level alarms along with necessary interlocks with corresponding pumps such as effluent feed pumps, clarified water pumps, cartridge filter feed pumps, chemical dosing pumps, etc.

VI. MEASUREMENT OF TEMPERATURE (RTD/THERMOCOUPLE):

a) Measurement of temperature at the outlet header of Cartridge filters with indication along with alarm annunciation for high temperature on PLC.
b) Temperature measurement of degasified permeate make-up water with indication on PLC.
c) Measurement of Temperature at the delivery header of pumps with indication on PLC.

VII. MEASUREMENT OF PH:

a) Measurement of pH at the inlet to collection cum equalization tank with indication of high and low pH with alarm annunciation.
b) Measurement of pH at the outlet header of Cartridge filters and RO train with high & low pH alarm and necessary interlock with acid dosing pumps.
c) Measurement of pH of degasified permeate water with high and low pH alarm and necessary interlock with pH correction pumps. In case of high pH value, the alkali (pH correction) pump shall trip.

VIII. MEASUREMENT OF CONDUCTIVITY:

a) Measurement of conductivity at the outlet header of Cartridge filters with alarm for high conductivity.

b) Measurement of conductivity at the outlet line of each RO train with alarm for high conductivity.

c) Measurement of conductivity of water in degasified permeate water tank with alarm for high conductivity.

IX. MEASUREMENT OF SILT DENSITY INDICATOR (ONLINE SDI) AND ORP ANALYZER AT THE OUTLET HEADER OF CARTRIDGE FILTERS TO BE PROVIDED.

NOTES:

a) Required measurements, controls, alarms and interlocks of balance units like sludge dewatering, evaporator and other technological units coming under Zero Liquid discharge Plant and not covered in the above list shall be provided by the Tenderer.

b) Flow, temperature and pressure measurement at take over point of steam & instrument air (required for ZLD plant). Facility for interfacing of these signals with EMD system of Purchaser through OPC connectivity of automation system of tenderer shall also be envisaged.

c) If any technological units along with its instrumentation facilities are being provided by Tenderer through any technology provider then make of similar type of instruments shall be identical throughout the plant including that being directly procured by Tenderer themselves.

Temperature Measurements

1. The following types of primary sensing elements shall be used, depending on temperature of process fluid & application requirements:

i. Pt-Rh 13% / Pt (ISA Type "R")
ii. Pt-Rh 10% / Pt (ISA Type "S")
iii. Pt-Rh 30% / Pt-Rh 6% (ISA Type "B")
iv. Chromel – Alumel (ISA Type "K")
v. Nicrosil-Nisil (ISA type N)
vi. Chromel – Constantan (ISA Type "E")
vii. Copper – Constantan (ISA Type "T") viii.Iron – Constantan (ISA Type "J")
ix. RTD (Pt 100/ Pt 1000)

2. RTD shall generally be used for measurement in the temperature range of -200ºC to 300º C and thermocouples for higher temperatures.

3. RTDs shall usually be three-wire type. Four-wire type RTDs shall be used, wherever specifically required.

4. RTD/ Thermocouple assembly shall be spring-loaded to ensure positive contact with thermowell mineral insulated.

5. RTD's shall be ungrounded and shall be supplied as an assembly complete with

thermowell meeting latest ANSI requirements.

6. Thermocouples shall normally be mineral insulated duplex type with an accuracy of ±0.5% of span.

7. Thermocouple calibration shall be in accordance with IS, IPTS or equivalent standard.

8. Thermowells shall be provided for all applications to enable maintenance work of thermocouple / RTD without affecting production. Thermowells shall be bar stock type for upto 600 mm immersion length and fabricated type for immersion length more than 600mm.

9. AISI 316 shall be used as thermowell material, unless other special material is required due to process fluid and conditions.

10. Thermocouples shall be complete with compensating leads, installation fittings.

11. The temperature gauges shall be designed in accordance with ASME B40.200/ BS 5235/EN 13190 or other international standards.

12. In case, temperature elements, extension cables, compensating leads are to be laid on the top of hot surface, suitable heat insulation protection shall be provided. Use of asbestos shall be avoided. Mineral insulated cables shall also be used for such applications.

13. Junction boxes for connecting compensating cables shall have terminal blocks suitable for type of thermocouples to be connected.

Flow measurement

i) For Fluids:

1. Normally orifice plates, magnetic flow meters or vortex flow meters shall be used for flow measurement of industrial service fluids, depending on the merit of the application.
   Positive displacement, turbine and Coriolis flow meters shall be used in custody transfer measurements and in processes, where high measurement accuracy is required.
   However, other types of flow meters e.g. ultrasonic, microwave, thermal type etc. may also be used when necessitated by particular technical requirements.

2. Vortex flow meters shall be generally used for steam for line sizes of >2" and ≤ 8".

3. Magnetic flow meters shall be generally used for water & other liquids having conductivity greater than 5 µS/cm.

4. Coriolis type mass flow meter shall be used for all viscous materials.

ii) For solids:

Generally, flow measurement of solids in powdered, amorphous or granular form shall be done using ultrasonic type sensors or microwave type sensors, depending on the merit of the application.

iii) Differential pressure type devices

1. Normally, concentric square-edge type orifice plates shall be used.
2. For sizing calculation latest edition of BS 1042/ EN ISO 5167-1 standard - Measurement of fluid flow in closed conduits shall be followed.
3. Quarter-circle and conical entrance type orifice plates shall be used for viscous fluids.
4. Eccentric or segmental type orifice plates shall be used with dirty fluids.
5. Flow nozzle, venturi or averaging pitot tube may be used in high flow applications or where the allowable pressure-drop is low. Averaging Pitot tube shall only be used for clean fluid.
6. All orifice plates shall normally be made of AISI 316 material, unless otherwise called for by process requirement.
7. Generally flange tappings shall be used. However, corner or D & D/2 type tappings can be used as per requirement.
8. Tag no., orifice plate bore diameter, upstream (+) and downstream (-) side marking, and plate material shall be engraved on the handle of the orifice plate.
9. Tag no., flange size, flange rating and flange material shall be engraved on all flanges.
10. Gasket material for orifice plates shall be suitable to withstand physical and chemical properties of process fluid and shall be matched with the pipeline standard, as required.
11. Supply of orifice plate assembly shall include the orifice plate, flanges, stud-bolts, nuts, jackscrews, gaskets, pressure tapping nozzles and plugs.
12. Control valves shall be installed after the orifice plates in the direction of flow.
13. All flow meters shall have drainage valves.
14. Corrosive media shall be separated from transmitters by separating chambers with valves for isolation.

15. For steam flow and flow of liquid at temperature greater than 120°C condensation chambers of identical dimensions shall be used. Condensation chambers shall be installed as near to flow sensor as possible.

16. For slurries, viscous and corrosive liquids, 1.5”/2” size D & D/2 tappings with remote diaphragm seal type transmitters shall be used.

17. Depending on specific requirements/applications, averaging pitot tubes with multi-holes (eg, Anubar type) placed in the direction of fluid stream may also be used. The calculations and design shall be as per manufacturer’s standard.

18. IBR certification shall be provided for steam and vapour applications, as per IBR standard.

19. In contaminated water, orifice plates shall be installed in bypass line with isolation valves to facilitate on-line maintenance.

iv) Vortex flowmeters:

For selection of vortex flow meters, following to be taken into account: -

1. Reynold’s no. shall be at least 20000 and minimum flow velocity shall be as specified by manufacturer.

2. Vortex flow meters shall not be considered for viscous, waxy or erosive services.

3. Straight length requirement shall be as specified by manufacturer. If meter size is smaller than the line size, concentric pipe reducers shall be used. Eccentric reducers shall not be used as they disturb the flow profile.

4. All vortex flow meter shall be SMART type with HART protocol. Local display of vortex flow meters shall be calibrated in engineering unit.

5. For flow meter sizes of less than the process line sizes, suitable reducer vortex (expander/ reducer integral to the flow meter) shall be generally used.

6. Accuracy of the vortex flow meter shall be ± 1% or better.

7. Enclosure class of vortex flow meter shall be minimum IP 66.

v) Electro - magnetic flow meters:

Selection of Electromagnetic flow meters, shall be decided based on the following:

1. All electro-magnetic flow meters shall be SMART type with HART protocol with 4-20 mA DC output.

2. Liner material shall be selected based on service. Generally, for liner material PTFE shall be used.
3. Installation of electromagnetic flow meters shall be avoided near large conducting surface e.g. metal surfaces. (Large surface may interfere with magnetic field of instrument thus affecting accuracy).
4. Pulsed DC excitation or dual frequency shall be provided for field excitation of Electro-magnetic flow meter. Power & signal circuits of electro-magnetic flow meter shall be completely isolated from each other.
5. Minimum one no. of grounding ring for metallic pipelines and two nos. of grounding rings for non-metallic pipelines shall be provided for installing the electro-magnetic flow meters.
6. Accuracy of electro-magnetic flow meter shall be ±0.35 % or better. Local display shall be calibrated in engineering unit unless otherwise specified.
7. For contaminated water services, electro-magnetic flow meters shall be installed with bypass arrangement along with bypass & isolation valves.
8. Separate sensor & transmitter type electro-magnetic flow meters shall be provided for line sizes ≥ 400 mm and also, wherever there are installation/ approach problem for integral type.
9. Electro-magnetic flow meter shall be provided with built-in auto zero facility for ensuring stable zero point.
10. For dirty liquid application, replaceable type electrode shall be used.
11. Separate earthpit shall be provided exclusively for earthing of electro-magnetic flow meters, if recommended by manufacturer. Preparation of such earthpits shall be governed by the general methodology as described in IS: 3043, 1987 or relevant international standards.
12. Enclosure class of electro-magnetic flow meters shall be minimum IP 66.

vi) Coriolis mass flow meters:

For selection and sizing of coriolis type flow meters, following shall be taken into account:

1. If required flow rate cannot be handled by one meter, two or more meters can be used in parallel.

2. Selection of wetted part materials shall be carefully chosen to suit process fluid.

3. SS shall not be used for liquids containing Halogen. Hastelloy tubes shall be used for all application containing Halogen.

4. Coriolis mass flow meters shall not be used in two-phase fluid application.

5. Pressure drop across flow meter shall be selected, ensuring no cavitation occur under any process condition.

6. For congealing service, steam jacketing shall be provided for the sensor tube to avoid jamming inside flow tube in case of zero flow.

7. Flow meter support shall be as per manufacturer's recommendation.

vii) Ultrasonic flow meters:

For selection of Ultrasonic flow meters, following to be taken into account:

1. For fluids containing suspended particles, ultrasonic flow meters, working on Doppler effect principle shall be used. For clean fluid application, transit time type ultrasonic flow meters shall be used.
2. Ultrasonic flow meters shall be used where allowable pressure drop is minimum.
3. On critical services Ultrasonic flow meters with insertion probes shall have retraction mechanisms to allow on stream maintenance.
4. Clamp on type shall be used only for liquid metering in low accuracy application.

Pressure measurement

1. Either bourdon tube (spiral or helical), bellows or diaphragm type sensing element shall be used in pressure gauges/ switches, depending on the process service.
2. The pressure gauges shall be designed in accordance with IS: 3624, 1987 or BS EN 837 or ASME B40.100.
3. Pressure gauge accuracy shall be ±0.5% of span or better. Accuracy shall include the combined effect of linearity, hysterisis and repeatability.
4. The element and other wetted part materials of pressure gauges/ switches shall be of AISI 316, unless process media necessitates use of other materials.
5. Movement material of gauges shall be of AISI 304. Outer casing and bezel material shall be made of stainless steel.
6. Pressure gauges shall have external zero adjustment facility and minimum IP65 housing.
7. Pressure gauges shall have dial size of 150 mm diameter. Gauges of smaller dial size may be used for machine mounted applications. Pressure gauges shall have ½" NPT thread in general.
8. Pressure gauges/ switches used in pulsating pressure applications (e.g. delivery side of pumps, compressors, etc.) shall be provided with externally adjustable pulsation dampener or snubber. For machine mounted applications or in case of mechanical vibration at mounting location, either liquid (glycerin) filled gauges shall be used or standard gauges mounted away from tapping point shall be used. All pressure/ differential pressure gauges & switches for compressors & pumps shall be separately mounted on panel or stand and connected with SS braided Teflon hose.

9. Wherever the process pressure exceeds 50 kg/cm^2, solid front type pressure gauges shall be used (i.e., a metal partition shall be provided between dial and element).

10. For pressure measurement in slurries, viscous and corrosive fluids, diaphragm seals of suitable material shall be provided along with pressure sensing devices. Diaphragm seals shall be integral with the gauges /switches, unless otherwise specified.

11. Depending on process application, suitable chemical seal along with capillary of required length shall be provided.

12. Diaphragm seal type pressure gauges / switches used in applications where the temperature exceeds 100°C, shall have bourdon / bellows type element. The bourdon/ bellows shall be selected to withstand temperature upto 200°C.

13. The working range of pressure switches shall be selected in such a way that the set pressure is between 35% and 65% of the range.

14. The switch enclosure shall be weatherproof to IP 65.

15. Dry contact type micro switches with minimum rating of 240V DC at 0.4A shall be used for pressure switches in non-hazardous area applications.

16. In hazardous areas, hermetically sealed micro switches with minimum rating of 240V DC at 0.2A shall be used.

17. Pressure switches shall have an accuracy of at least +/- 1% of span and repeatability of at least +/- 1% of span.

18. DP transmitters with digital display in engineering units shall be provided for all differential pressure measurements & interlocks. However, DP switches and DP gauges shall also be used as back-up for critical applications. Accuracy of DP gauges shall be +/- 0.5% of span or better. Accuracy shall include the combined effect of linearity, hysterisis and repeatability

19. Pressure gauges shall be supplied with three-way gauge cock. DP gauges shall be supplied with 3-valve manifolds of AISI 316 material of suitable pressure and temperature rating. The above items shall be in addition to the process isolation valves/ root valves at the process tapping point.

Transmitters

1. Pressure, flow, differential pressure and level transmitters shall be rugged, industrial, microprocessor based 'Smart' type Transmitters shall work on 24 V DC power supply having 2-wire, 4-20 mA DC output & based on 'HART' protocol.
2. Accuracy of all transmitters shall typically be ±0.1% or better, of calibrated span for turn-down ratio of minimum 10:1 and range ability of 100:1. Accuracy shall include the combined effects of linearity, hysteresis and repeatability. In any application, the worst

case error (WCE) consisting of static pressure effect, temperature effect, humidity effect and stability (1 year) shall not be greater than 0.75%, unless specified otherwise. Zero and span adjustments shall be non-interacting to each other.

3. Transmitters shall be suitably compensated against any thermal effects in the process medium.
4. Transmitters shall be able to withstand a minimum over pressure of 150 % of the rated pressure.
5. All the transmitters shall be weather-proof to IP-67.
6. All transmitters shall have integral local linear digital indicators calibrated in engineering unit. DP transmitters for flow applications shall have built-in square root extractors. Local indications shall be adjusted / calibrated through hand held calibrator.
7. Power supply effect on transmitters shall be less than ± 0.05 % of calibrated span/10 V.
8. Pressure transmitters shall be supplied with 2-valve manifolds of AISI 316 material. Flow; DP and level transmitters shall be supplied with 3-valve manifolds of AISI 316 material having suitable pressure and temperature rating. Standard zero suppression/ elevation facilities and output reversal facility shall be available for all transmitters. All the required accessories for mounting shall also be supplied with the transmitters. However, for purging requirement, pressure transmitter shall be supplied with 3-valve manifold and DP type transmitter shall be supplied with 5- valve manifold.
9. All transmitters shall be provided with traditional mounting arrangement along with manifolds. For corrosive atmosphere, transmitter body, mounting accessories, nuts & bolts etc. shall be of stainless steel.
10. One hand-held calibrator with required software, rechargeable battery and battery-charger shall be supplied for calibration checks of the transmitters. For HART protocol based instruments.
11. Transmitters shall be provided with external lightning arrestors, wherever required.
12. Wherever transmitters shall be installed in a room, proper ventilation shall be provided for that transmitter room.

Level Measurement

i) General

1. Selection of primary elements shall be based on the service conditions. A general guideline is given below. However, selection of particular type of sensor shall be decided on the basis of application requirement.

1. For Liquid Service

a. Pressure / differential pressure type level transmitter with/without diaphragm seals
b. Float or Displacer type level transmitters
c. Ultrasonic type
d. Radar type
e. Gauge glasses
f. Magnetic level gauges
g. Capacitance type
h. Conductivity type
i. RF Type

j. Time domain reflectometry type

2. For Solid Service
a. Ultrasonic
b. Load Cell (weighing) system
c. Electromechanical servo gauges
d. Tilt switches
e. Capacitance switches
f. RF Type
g. Time domain reflectometry type
h. Laser based

3. For sumps
a. Conductivity switches
b. Capacitance switches
c. Bubbler Tube System
d. Rope & float type
e. Ultrasonic

4. Tank gauging
a. Servo gauges
b. Radar

2. Level instruments shall have weatherproof, dust and corrosion resistant enclosures of minimum IP-65 grade.

3. Additionally, explosion-proof enclosures shall be provided for hazardous area applications.

4. In Tank Gauging applications, communication port shall be provided in level instruments, for connectivity to a computer.

5. For level measurement with high accuracy, multi variable type level instruments shall be used.

6. Lap top based configurator along with required connectors, cables, software etc. for radar or ultrasonic type level instruments shall be supplied wherever quantity of level instruments is more than 10.

ii) Gauge Glasses

1. All gauge glasses shall normally be steel armoured reflex or transparent type. Magnetic level gauges may also be used when liquid temperature permits and liquid specific gravity is greater than 0.9.

2. Reflex gauges shall be used on clean, clear, non-corrosive liquids.

3. Transparent gauges shall be used for the following applications:
   - ➢ Interface service

➢ When the process is dirty or viscous

4. If the process is a solvent that can dissolve the internal coating of the chamber of the reflex gauge, thereby reducing the effectiveness of the prisms, reflex gauges shall not be used.

5. Reflex gauge glasses shall not be shielded.

6. Transparent level gauges, in general, shall be equipped with minimum 40 W illumination and switch (ex-proof for hazardous area).

7. Large chamber type gauge glasses shall be used for boiling / evaporating and heavy viscous liquids. Also steam jacketing shall be used for congealing service.

8. Gauge glass material shall be toughened borosilicate glass having adequate resistance to thermal and mechanical shock.

9. Gauge glass body and cover shall be made of carbon steel with rustproof finish, unless otherwise specified.

10. Gauge glass shall be provided with safety ball check offset type gauge cocks, vent and drain connection (with 1/2" vent & drain valves), nipples, caps etc.

11. Gauge glasses shall be provided with top and bottom or side connections. Where side connections are specified, the gauge glasses shall have two connections at each end, 180 deg apart, with one connection at each end plugged.

12. Unless otherwise specified, gauge cocks shall be of the quick-closing type with bolted bonnet, outside screw and renewable seats.

iii) Displacer & Differential Pressure type

1. External displacer type instruments with ratable head shall usually be used for level measurement upto 1200 mm (48"), wherever process permits.

2. Displacers shall be made of AISI 316 with Inconel torque tube, unless otherwise specified or unless the process calls for any special material.

3. Side-side flange connection shall normally be used. Heat insulator / finned extension shall be used for temperatures above 230°C.

4. All such instruments shall have drain valves and vent plugs.

5. Stilling wells shall be provided for internal displacer type level instruments.

iv) Ultrasonic type

1. Ultrasonic type level transmitters shall be microprocessor based and shall use digital signal processing technique for signal conditioning. Possible to calibrate through universal

HART calibrator for HART based transmitter

2. Suitable protection box for mounting ultrasonic type level transmitters shall be provided for mechanical protection & dust.

3. Transmitter/ control unit shall be preferably single channel or a maximum of two channels.

4. The transmitter shall have the capability to use statistical filtering techniques, wherever required, to suppress false signal due to heavy dust or fill-stream interference.

5. The sensor shall have inbuilt temperature sensor for ambient temperature compensation.

6. Chemical compatibility of the sensor material with the process material shall be ensured, to avoid corrosion.

v) Capacitance & conductivity type

1. Capacitance / conductivity type probes shall be as follows:

   - ➢ Rod type : for lengths up to 2000 mm.
   - ➢ Rope type with gravity weight : for length exceeding 2000 mm.

2. For level measurement in non-conducting tanks or sumps or when the tank profile is non-linear, capacitance type instruments shall be provided with a reference electrode/ ground probe.

3. Capacitance type level probes may be used for both switching as well as for continuous level measurement in liquids.

4. Capacitance type level probe shall not be used for level measurement in solids when there is likelihood of material build-up on the probe. Capacitance type level probe shall not be used in liquid service where there is a chance of di-electric value change (due to oil spillage etc.).

vi) Radar Type

1. 2 wire, Non- contact Radar type level instrument shall be used when the physical properties of the medium between the sensor and the measured interface may vary. 4-wire type shall be considered only when necessary.

2. The Radar type level instrument shall be microprocessor based with HART protocol and shall use digital signal processing techniques for signal conditioning. Possible to calibrate through universal HART calibrator.

3. Suitable antennae shall be considered for the intended application.

4. Radar type level transmitter shall have facilities for storing echo profile, manipulation of the echo profile to remove noise, multiple profile-averaging etc.

5. The transmitter shall have the capability to use statistical filtering techniques, wherever required, to suppress false signal due to heavy dust or fill-stream interference.

6. Transmitter/ control unit shall be preferably single channel or a maximum of two channels.

7. The sensor shall have inbuilt temperature sensor for ambient temperature compensation.

8. Chemical compatibility of the sensor material with the process material shall be ensured, to avoid corrosion.

10. Necessary software, cables, connectors, HART to 232C converters etc. For calibration, noise suppression, etc. of Radar type level transmitters through windows based desktop PC / Laptop shall be supplied.

11. Suitable protection box for mounting radar type level transmitters shall be provided for mechanical protection & dust.

vii) Time domain reflectometry type (TDR)

1. TDR type level measuring system shall be mainly used.

a. For level measurement of Liquids, interface in immiscible fluids, granules & fine powders

b. For medium having dielectric within 1.8 to 100.

2. Co-axial type, twin rods, twin cables, single cable / rod type probes shall be selected depending on tank height, properties of medium/media & application.

3. For interface level measurement top layer shall be of lower dielectric and minimum difference of dielectric between top & bottom layer shall be as per manufacturer's recommendation

4. For adhesive/sticky in nature materials, coated probes as per manufacturer's recommendation shall be used.

viii) Radio frequency (RF) type

1. Radio frequency (RF) continuous/ point level measuring system, based on capacitance or admittance shall be used for level measurement of liquids, slurries, granulars, and liquid-liquid interface.

2. RF transmitter shall be
   a) Smart type
   b) Self-calibrating type i.e. as the level rises in the vessel, the span is set automatically and electronically by the smart transmitter.

3. For high temperature application, remote mounted transmitters shall be used.

4. RF type shall also be used for detection of absence or presence of liquids, slurries, interfaces and granules.

5. Hand-held calibrator with rechargeable battery and battery-charger shall be provided.

6. It shall be possible to calibrate RF transmitters using calculated or known levels of capacitance directly entered by the hand held calibrator.

ix) Others

Tilt Type, paddle type, bubbler type, electromechanical type, etc. level instruments may also be used, depending on application specific requirement.

Solenoid Valves

Solenoid valves shall fulfill the following requirements:

1. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.

2. Power supply 240 VAC UPS.

3. Plug and socket electrical connection.

4. Insulation: Class 'H'.

Electrical Actuators

i) The actuators shall have integral starters along with overload relays with built in SPP (single phasing preventer). A 415, 3 phase 3 wire power supply shall be given to the actuator from contractor's switch board through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply. In case supplier's standard control voltage for open/close contactors is 110V AC, the same is acceptable if suitable up to - isolation circuit is provided with coupling relays for 24 V DC command inputs.

ii) Open/close command termination logic with position and torque limit switches, positioner circuit shall be suitably built in the PCB inside the actuator.

(a) For binary drive, open/close command and status thereof and disturbance monitoring signal (common contact for overload, thermostat, control supply failure, L/R selector switch at local, other protections operated) shall be provided.

Interface with the control system shall be through hardwired signal only. Interposing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

(b) For modulating drive, the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided

(c) Open/close command termination logic shall be suitably built inside actuator.

iii) The actuators shall be rated for supply voltage & frequency: 415V +/- 10%, 3- phase, 3 wire 50Hz +/-5%. Sizing for open/close at rated speed against designed differential pressure at 90% of rated voltage. For isolating service, three successive open-close operations or 15 mins, whichever is higher. For regulating service, 150 starts per hour or required cycles, whichever is higher.

iv) Four nos. (2 each in open and close position) position limit switches and two nos. (one in open and other in close direction) torque switches each having two nos. NO and two nos. NC contacts shall be provided. A single shaft shall actuate all contacts of limit switches at each position.

v) It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator

vi) Position Indicator shall be provided for 0 to 100% travel.

vii) Position Transmitter (for modulating/inching type) shall be provided as required it shall be suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

viii) Space heater of suitable rating shall be provided. The supply shall be derived from the main power supply available in the actuator**.**

6.14 DRIVE CONTROL PHILOSOPHY

Interface of the system with M.C.C/ Switchgears, AC Solenoids, DC Solenoids and contactors (AC&DC) shall be in the form of potential free contacts via interposing relay modules mounted in the respective switchgear or MCC unit. All other interfacing relays shall be mounted in a separate cabinet or a separate section of the cabinet. For AC solenoids and contactors directly driven from output cards, arc suppressors shall be provide across the coil.

The Drive control Philosophy is as follows:

Sl. No.	Description	Type of I/O	No of I/O
1.	**PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE (Signal Exchange has been envisaged between PLC and switchgear)**		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Swgr Disturbance (Overload relay operated/ control supply fail/Emergency LPBS stop)	DI	1
f.	Electrical Trip (Motor Protection Relay)	DI	1
g.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged)	DI	1
h.	Pump / Fan bearing temperature measurement	RTD	2
i.	Motor Bearing temperature measurement	RTD	2
j.	Motor Winding temperature measurement	RTD	6nos duplex or 12nos simplex type
k.	Current Transducer input	AI	1
2.	**PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE (Signal Exchange has been envisaged between PLC and PMCC/MCC)**		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/Emergency LPBS stop)	DI	1
f.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
3.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Integral starters Fault	DI	1
d.	Open limit switch feedback	DI	1
e.	Close limit switch feedback	DI	1
f.	Open Torque switch feedback	DI	1
g.	Close Torque switch feedback	DI	1
h.	Position Transmitter (For inching type Drive)	AI	1
4.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Swgr/MCC Disturbance (Overload relay operated/	DI	1

Sl. No.	Description	Type of I/O	No of I/O
	control supply fail/Emergency LPBS stop)		
d.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
e.	Open limit switch feedback	DI	1
f.	Close limit switch feedback	DI	1
g.	Open Torque switch feedback	DI	1
h.	Close Torque switch feedback	DI	1
i.	Position Transmitter (For inching type Drive)	AI	1
5.	**PLC INTERFACE FOR SOLENOID DRIVE (Single coil)**		
a.	Energise or DeEnergise	DO	1
b.	Open limit switch feedback	DI	1
c.	Close limit switch feedback	DI	1
6.	**PLC INTERFACE FOR SOLENOID DRIVE (Double coil)**		
a.	Energise	DO	1
b.	De-energize	DO	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
7.	**PLC INTERFACE FOR PNEUMATIC DRIVE**		
a.	Command to I/P converter	AO	1
b.	Position Transmitter	AI	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
e.	Command to Solenoid valve (Wherever applicable)	DO	1

6.15 CABLES

Instrumentation cables shall be 1100 Volts grade with standard high conductivity annealed, tinned copper, twisted pair (with min. 20 twists per meter) extruded PVC insulated with overall and /or individual screening, extruded PVC inner sheathed, extruded outer sheathed with FRLS PVC compound and galvanized steel wire armored. The conductor size shall be minimum 0.5 Sq.mm. The cable shall confirm to relevant latest standards.

Power cables to be supplied shall be 1100v grade, single core having wire armoring of aluminum and multicore cables having galvanized steel wire /stripe armoring with FRLS properties.

All cable shall have galvanized steel round wire armoring. The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.

6.16 SYSTEM CABINETS, LOCAL PANELS, TRANSMITTER RACKS & ENCLOSURES

i) All control desks, panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads, internal piping and accessories as per IS:5039-1969 as required for completeness of the system.

ii) All panels, desks, cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of desks, panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire. System cabinets with 2 mm thick sheet metal of cold rolled steel, key locks, door switches, and removable gland plate of 3mm thick shall be provided.

iii) All electronic system cabinets shall be designed for 50 deg C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10 deg. C above ambient temperature under all operating conditions. Necessary louvers, fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.

iv) Desk, panels, cabinets enclosures wiring and piping shall be arranged to enable the removal of instruments and devices without unduly disturbing them.

v) All panels, desks, enclosures interiors shall be illuminated with rapid start fluorescent strip fixtures with door actuated switches. Door switch terminals shall be shrouded. All illuminated lights shall be provided with individual switch in parallel with door switch.

vi) All panels, desks, cabinets shall be properly grounded. The grounding scheme shall be as approved by the purchaser.

vii) Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish colour shall be applied to all surfaces.

6.17 JUNCTION BOX (JB)

a) Double door type with cable entry from bottom.
b) No. of ways 12/24/36/48/64/72/96/128 with 20% spare terminals.
c) Material shall be 4mm thick fibre glass reinforced polyester.
d) Type Screwed at all four corners for door. Door handle shall be of SS. Self-locking with common key. Door gasket shall be of synthetic rubber.
e) Mounting Suitable for mounting on walls, columns, structures clamps and etc. The brackets, bolts, nuts, screws, glands and lugs accessories required for erection shall be of brass, included in Bidders scope of supply.

f) Type of Rail mounted maxi termi or cage-clamp type suitable terminal for conductor size up to 2.5 mm^2. A M8 earthing stud blocks shall be provided.

g) Protection Class IP:65 minimum

6.18 AIR SUPPLY REQUIREMENT

Air supply required for the instruments/ equipments and other services shall be as per specification covered under mechanical technical specification.

6.19 GUIDELINES FOR SELECTION OF ERECTION MATERIALS:

6.19.1 Instrument Fittings:

Carbon steel Fittings

a) Fittings shall be as per ANSI B16.11.

b) Fittings shall be socket-weld type forged pipe fittings of material cadmium plated ASTM A105. The minimum rating shall be class 3000.

SS tube Compression Fittings

a) Fittings shall be as per ISA RP 42.1.

b) Fittings shall be flare less compression type and of three piece construction with ferrule, nut and body suitable for use on SS tube conforming to ASTM A269 TP316, hardness not exceeding RB 80.

c) Hardness of ferrules shall be in the range of RB 85-90 so as to ensure minimum hardness difference of 5 to 10 between tube & fittings for better sealing.

d) Threaded ends of fittings shall be NPT as per ANSI B1.20.1.

6.19.2 Instrument valves

a) The impulse line isolation and drain valves shall be forged gate/ ball/ globe valves with inside screwed bonnets. CS/ SS valve material shall be used depending on requirement. For steam application, gate valves of suitable rating shall be used and 3-piece ball valves for other applications. Ball valve seat material and rating shall be selected based on process requirement. For socket welded ball valves, nipple at both ends shall be welded at valve manufacturer's works before assembly, to avoid damage of seat at site while welding.

b) For SS valves, body and trim material shall be ASTM A182 Gr. F316. For CS valves body material shall be ASTM A105 Gr.II and trim material shall be ASTM A182 Gr. F316.

c) For screwed valves packing material shall be teflon only. However, for socket-weld valves packing material shall be grafoil only.

d) Valve hand-wheel material shall be cadmium or nickel plated steel.

e) Minimum valve rating shall be 800 class.

6.19.3 Impulse pipes & tubes

a) Impulse pipe shall be fully annealed, seamless and cold drawn 316SS tube as per

ASTM A269

b) Tube wall thickness shall be minimum 0.049" unless otherwise specified.

c) 316 SS tubes along with 316 SS double compression fittings shall be used as impulse pipe for all application, except where the material is not compatible and for steam application. For steam service, socket weld type fittings of proper rating/ schedule shall be provided.

6.19.4Cable trays and conduits

a) Perforated cable trays with sheet thickness of min. 2 mm shall be used for laying of cables.

b) The width of cable trays shall be so selected that 20% of tray space is available for future use of the complete installation.

c) Conduits used for cable laying shall be as per IS-1239 class medium & galvanized.

d) Material of trays with covers and conduits in corrosive environment, shall be corrosive resistant. Suitable material (FRP/GRP) shall be provided based on the corrosive atmosphere.

6.20 INSTALLATION OF INSTRUMENTS

1. For installation of instruments and primary sensors, standards practice of instrumentation according to the international standard shall be followed.

2. For installation of any kind of special type of instrument/ sensor manufacturer's recommendation for installation shall be followed.

3. Plugging of extra holes in JBs, panels, cabinets, etc., plugging of extra holes for conduits, filling up the conduits & conduit opening with water proof sealing compound shall be done after completion of erection.

6.21 CALIBRATION

1. All instruments shall be calibrated as per manufacturer's instructions prior to installation at site.

2. During the loop checking and commissioning, if required, to obtain the satisfactory performance of the instrument, the same shall be recalibrated as and when required.

3. All instruments shall be calibrated at 0%, 25%, 50%, 75% & 100% of the measured range for both increasing and decreasing values. The instruments are also to be calibrated for at least three points within the operating range. Discrete instruments, switching devices shall be functionally checked for general performance and especially for assigned set points.

4. Hand-held calibrator shall also be used for calibration checks of transmitters.

5. All calibration reading shall be recorded in proper format and submitted.

6.22 TESTING & COMMISSIONING

6.22.1 Testing

1. All cables shall be tested for insulation with 1000V/ 500V megger before termination at panel & field. Insulation shall be checked from conductor to ground and between conductors in a cable. All conductors shall also be tested for continuity.
2. All impulse piping shall be tested hydrostatically/ pneumatically to 1.5 times the operating pressure after isolating the instruments. Lines shall be blown after hydro- testing.
3. Instrument air headers (N2) & air supply lines shall be cleaned and tested for leaks at a pressure 6-8 bar, before they are placed in service.
4. For all measurement & control circuits, loop testing shall be properly carried out. Overall integrated loop testing shall be performed together with Automation System.
5. All results of site inspection, instrument site calibration, impulse pipe leak test, panel site test report and loop test results shall be recorded in the approved format. These results shall form part of the completion documents. Any work not conforming to the execution drawings, specifications or codes shall be rejected and the Tenderer shall carry out the rectification at his own cost.
6. Magnetic flow meters & Vortex flowmeters shall be tested by injecting frequency signal. Thermocouples shall be tested by simulating millivolt signals.
7. All the equipment required for erection shall be brought by Tenderer to site, on returnable basis.
8. All the required testing & calibration equipment shall be brought by Tenderer to site, on returnable basis, for testing & calibration work at site.
9. Quantity of all these items shall be as per actual requirement at site, to meet the erection schedule. All test & calibrating equipment shall be approved by NPL/IDEM/ ERTL authorities.
10. Loop test shall be performed after calibration of all instruments and leak test of instrument impulse lines. It shall be carried out to check the functional performance of all elements comprising the loop thereby ensuring proper connection of the following:

i. All elements are properly installed, calibrated and function properly.

ii. All scales are introduced with proper ranges in automation system.

iii. All alarm units and shut down devices are set properly and accomplish their intended purpose.

iv. Controller settings for various modes of operation in automation system (proportional band, reset and rate action) are at nominal values.

v. The action (direct or reverse or split) of the controller is set as prescribed.

vi. DP transmitter with automation system in the control room shall be loop tested by applying impulse signal to the transmitter by means of a squeeze bulb and a U-tube manometer at the field and performance of the receiver instruments/display in automation system in the control room shall be checked at 0%, 25%, 50%, 75% and 100% FS inputs in both ascending & descending modes..

vii. Pressure transmitter with automation system in the control room shall be loop tested using a dead weight tester and a standard gauge with accuracy better than + 0.1% at field and performance of receiver /display in automation system in the control room shall be checked at 0%, 25%, 50%, 75% and 100% FS inputs in both ascending & descending modes.

i. For temperature loops with resistance thermometers in field and automation system control room, known resistance shall be injected at signal cable near the resistance thermometer in the field through decide resistance box and automation system display shall be checked for input signals of 0%, 25%, 50%, 75% and 100% FS in both ascending & descending modes.

ii. For temperature loops with thermocouple in field and automation system display in control room, a known milli-volt signal shall be injected at the compensating cable end in the field from milli-volt simulator and automation system display shall be checked for input signals of 0%, 25%, 50%, 75% and 100% FS in both ascending & descending modes.

iii. In case of control loops, the set point of PID controllers shall be adjusted manually from HMI for output of 0%, 25%, 50%, 75% and 100% FS and control valves shall be checked for rate strokes in both ascending & descending modes.

iv. Alarm system shall be checked by simulating abnormal conditions in the

field mounted differential pressure switches by shorting the wires at terminals and the function of the alarm system.

6.22.2 Commissioning

1. This activity shall be planned in consultation with & as per the directives of Client/ Consultant.
2. Before commissioning, loop checking for all the measurement & control loops shall be completed and results shall be recorded in approved formats.
3. Initially, the instrumentation equipment & systems shall be checked & tested to establish their specified performance and to ensure readiness for integrated testing with the automation system and commissioning of the plant. All these results shall be properly documented for records.
4. Subsequently, when the plant units are to be commissioned, Tenderer shall actively participate in these activities by providing required manpower in general shift as well as in three shifts round the clock to ensure reliable & trouble-free performance of all the instrumentation equipment & systems supplied by him.
5. All the data/ performance of Instrumentation equipment/ system during commissioning & acceptance tests shall be properly documented & submitted.

6.23 SELF DIAGNOSTIC & MONITORING FEATURES

a) Respective PLC shall have exhaustive self-diagnostic & monitoring features including the following :

- Fault detection upto channel level of card including failure/ status of central processor unit, memory, I/O status and power supply.
- Parity errors, cycle errors and under voltage
- Address monitoring.
- Bus & Communication signal monitoring & all types of failure feedback.
- Network diagnostic displays.
- Broken sensor detection.
- Automatic turning off of all outputs or optionally holding of all outputs in their last state on failure detection.

- Indication of all other type of failures.

b) On-line displays shall indicate the results of self-diagnostic tests. Failure diagnosis shall be sufficiently specific to indicate which modules, or devices are at fault. The displays shall be designed to help maintenance and engineering personnel to diagnose faults in the system and communication paths. Each category of diagnostic display shall be organized hierarchically.

c) All events generated by the system shall be captured and electronically logged chronologically to the event database on a hard disk on one or more designated workstations. Events shall be time-stamped by the event generator. Events and their associated time stamp are passed on to the event handler for capture.

d) It shall be possible to retrieve and sort events by time (ascending or descending order) or by type. The Operator shall be able to filter the events on certain criteria such as time, tag name, area name, or any specific event. Events and the historical trend information for a control tag shall be integrated into a single view.

e) All events shall be time stamped at the point of origin. Events generated in the controller shall be time-stamped in the controller. Those generated in the workstation shall be time stamped in the workstation.

f) Print on demand shall be included for all views possible with the event viewer application.

g) Invalid value status shall be generated for inputs and calculated variables. A value shall be declared invalid if any of the following conditions are true:

- If a value is out of range.
- If a value cannot be measured or calculated.
- If a value is declared invalid by an application program.
- If a value is declared invalid by the source instrument.

Invalid value status shall be propagated through control schemes. Invalid value status shall be displayed in descriptive text along with its alarm.

h) It shall be possible to inhibit the detection and propagation of an invalid value status. This selection shall be available on individual tag basis.

i) It shall be possible for an invalid value status to be used as a logical input to initiate control algorithm changes.

6.24 EARTHING

i. Vendor shall provide a separate electronic earthing system. Electronic components of workstations, cabinets, consoles etc. of PLC and drain wires of

the instrumentation signal cables shall be connected to this earthing system.

ii. The body earth of the PLC cabinets and workstations / consoles shall be connected to the 'Electrical Earth grid' in the plant, which shall be separate from the 'Electronic Earth'. The electronic earth pit(s) shall be at least 3 m away from the nearest electrical earth pit.

iii. The design of the electronic earth pit shall be as per IS:3043, 1991.

6.25 QUALITY ASSURANCE, INSPECTION & TESTING

i. The automation system shall be designed, selected & supplied ensuring proper quality & performance. Vendor's procedures for Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) shall be submitted at least 60 days prior to the scheduled conduct of these tests for review/acceptance.

ii. The proposed FAT & SAT procedures of vendor shall be reviewed and modified as required to generate mutually agreed & finalised procedures, based on which these acceptance tests will be performed and supervised by authorized agency.

iii. All system hardware & software used for testing shall be complete as specified and shall use actual equipment to be shipped to the site as per scope.

6.25.1 Factory Acceptance Tests (FAT)

i) The factory acceptance test shall be held at vendor's works. Prior to the FAT, all the equipment shall be fully assembled, wired and properly connected & tested to establish all the specified features & functional requirements of the systems.

ii) During FAT, functional integrity of the system hardware and software shall be tested & demonstrated. All the necessary simulation kits as may be required for testing of software shall be arranged.

iii) Vendor shall perform functionality tests of complete system and satisfy himself of the results before giving notice regarding readiness of the system and its availability for FAT. Such notice shall be given minimum 15 days before the scheduled start of the FAT.

iv) The factory acceptance tests shall include visual and mechanical testing to establish correctness, completeness, good workmanship and functional testing.

v) The tests shall systematically, fully & functionally establish performance of all the hardware & software in presence of authorized representatives. All the sub-systems shall be interconnected to simulate, as close as possible, the total integrated system. Each test carried out shall be documented. Simulators shall be used for simulating field inputs. Any deficiency or problem faced shall be

clearly brought-out and corrected.

vi) Before start of the FAT, the complete integrated system shall be kept powered on for 72 Hrs.

vii) All assemblies shall be aligned & adjusted and all test results shall be documented.

viii) For System Power up Test, Vendor as a minimum shall check the functions of all the system hardware and software including diagnostic software at sub-system levels with stimulated inputs.

ix) Functional testing shall include the simulation of each input and output to verify proper system response for both analog and discrete signals. This shall also include checking of various control loops, system scan time, checking of system loading including data highway, checking of system shutdown, alarm & interlock functions, checking of redundancy management, checking system diagnostics, checking various display parameters, etc.

x) The test log book shall contain the following information about the tests:

- Date/ time
- Assembly/loop tag number
- Test input
- Test results and sign off with personnel name
- Action required (if deficiency is detected).
- Actions taken, date of completion and sign off.
- Special test methods (including special equipment requirement, bypass used etc.).

xi) The automation system shall be shipped to site only after successful completion of FAT and receipt of dispatch clearance from authorized agencies.

6.25.2 Site Acceptance Test

i. At site, the system shall be properly installed taking care of manufacturer's recommendation, after which Site Acceptance Tests (SAT) shall be carried out taking into the actual field instruments/ equipment in the loops.

ii. All the system and application software installed prior to FAT or during FAT, shall be re- loaded from beginning at site as per standard procedures & demonstrated in presence of client's personnel.

iii. The Site Acceptance Test shall be held at site after the system has been

installed as per the finalised SAT procedures. The tests shall be witnessed by authorized representatives.

iv. The minimum tests to be carried out shall be as indicated in clause no. 18.3.

v. Continuous testing of the entire system for 14 consecutive days shall be done in continued presence of supplier's/ manufacturer's engineers & technicians during this period round the clock.

vi. A log of all failed/ mal-operating components /modules in a sub-system shall be maintained by Vendor, with description of the affected components /modules, cause of failure, effect of failure on the sub-system and number of hours of operation before it failed. This will start from the date of powering on of the system for cold commissioning.

6.25.3 Test Details

Following tests shall be performed as a minimum during both FAT & SAT, in presence of authorized representatives and documented test results shall be compiled:

Sl. No	Test Description	FAT	SAT
1.	Check of supply completeness	☑	☑
2.	Visual & dimensional check	☑	☑
3.	Check of complete system configuration loading	☑	-
4.	Check of system diagnostic features. These shall include failure of any sub-system, module, power supply, interface unit, failure of transfer to redundant module on main module failure etc.	☑	☑
5.	Power-off and power-on of any single unit	☑	☑
6.	Test of alarm system	☑	☑
7.	Check of correct functionality of keyboards	☑	☑
8.	Testing of proper working of the printers	☑	☑
9.	Simulation of power failure and restart. Self-booting up of system configuration & program after power restoration.	☑	☑
10.	Analog / digital input / output check	☑	☑
11.	Check of scan time for PLC	☑	☑
12.	Check of scan time, screen update time and loop cycle time	☑	☑
13.	Check of loop configuration for correct entry of ranges, limits etc.	☑	S
14.	Check of CRT displays (all kind of displays)	☑	S

15.	Checking of CRT refresh rate, data base update and display call-up time.	☐	S
16.	Check of system internal loading (processor, communication system etc.)	☐	-
17.	Check of various log formats, shutdown reports etc.	☐	S
18.	Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/deletion of a rung or an element in a rung generation of dynamic graphics and other views, report generation etc.	☐	☐
19.	100% checking of healthiness of hardware components.	☐	-
19.	100% checking of logic functions/ logic configured in the PLC by connecting switch/lamp at input/output.	☐	-
20.	Redundancy check for PLC including correct changeover of the back-up unit in case of failure of main unit. These shall be applicable for following: • CPU Redundancy • CPU Power supply redundancy • Each CPU to host system communication interface & communication link redundancy • I/O subsystem to processor system communication redundancy • IO rack power supply redundancy	☐	☐
21.	Checking of output status on processor failure for PLC & checking of first-out alarm generation.	☐	☐

FAT = Factory Acceptance Test; to be performed at Vendor's workshop SAT= Site Acceptance Test; to be performed at site.
☐ = Complete test; 100% of devices/ functionality will be tested. S = Sample test

All the necessary simulation kits as may be required for testing of software shall be arranged.

6.26 WARRANTY

The Bidder shall provide an unlimited warranty on all equipment and software for One (1) year after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepencies at no cost to PURCHASER.

In case of any hardware failure which hampers normal operation, the Bidder during

the warranty period must provide on-site technical expertise to repair/rectify the problem within a week and if any component is not available at site, the Bidder must arrange to supply these components at site within additional 48 hours. If a software problem is identified, the problem shall be corrected within two weeks.

6.27 TRAINING

Basic and advance training shall be provided on programming, operation and maintenance of PLC both at the factory & also at site. The time period and number of persons to be trained shall be decided as per requirement.

Reference:

1. GEOTECHNICAL INVESTIGATION REPORT-----PE-DC-409-602-C001- It is only for reference, tenderer shall carry out the geotechnical investigation at all the relevant locations before carrying out the design and construction. Geotechnical investigation report shall be submitted.

2. GRADING & LEVELLING DRAWING -----PE-DG-409-603-C001

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7.1. GENERAL

This section covers the civil design basis for buildings, tanks, facilities & architectural works pertaining to Zero Liquid Discharge Scheme. This memorandum contains a general description of the facilities, structural framing system and type of foundation, the design loading conditions and load combinations, the design basis including codes, standards and material specifications. The criteria furnished in this document shall govern the design of Civil, Structural and Architectural works of buildings. This document covers the general description of structural framing system, applicable design codes and standards, specific design criteria, design loads and combinations, design methodology and characteristics of construction materials to be adopted for the structures as mentioned in scope of ZLD system.

7.2. SCOPE OF WORK

The scope includes civil, structural and architectural works of ZLD Scheme. The civil structures pertaining to ZLD Scheme are listed below.

- Centrifuge Building
- UF & RO Building
- Crystallizer (with Mechanical vapour recompression) Building
- Chemical House
- Dyke Area for UF & RO
- Flash Mixer
- High Rate Solid Contact Clarifier(HRSCC)
- Sludge Sump
- Filter Feed Tank/Clarified Water Storage Tank
- Pressure Sand Filter Foundation(Leg Support/Pedestal)
- UF Feed Tank
- UF Permeate Tank/RO Feed Tank
- Backwash Water Collection Tank
- RO-I Reject Storage Tank
- RO-II Reject Storage Tank
- RO Permeate Tank - above ground RCC tank, top covered
- Crystallizer feed tank
- Condensate Tank
- Pump foundations
- Cable racks, Pipe racks, Trenches and Pipe pedestals

- ZLD Plant shall be complete in all respects and any Buildings/equipment foundations/tanks/sumps etc., not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant will be deemed to be carried out under the scope of work of the Tenderer.

7.3. SITE INFORMATION

o Site Location

The plant site is located at approx. 23 km from Kempegowda International Airport, Bengaluru, in Bengaluru district Karnataka. Plant is located at state highway Doddaballapur road (State highway 9, Karnataka). Nearest railway station Yelahanka railway station Bengaluru which is located approximately 2 km from plant.

o Soil Condition

Foundation depth and safe bearing capacity etc., shall be as per the approved Geotechnical Investigation report.

o Seismic Location

The project site lies in zone II as defined in IS: 1893 (Part 1)-2002. All the structures shall be designed complying with the requirements specified in IS: 1893 (Part 1) - 2002 and (Part 4) - 2005.

o Wind Pressure

Wind force on structures has been considered as per the provisions of IS: 875 (Part 3) - 1987. The basic wind speed of 33 m/sec at a height of 10m above the ground level and Category of Terrain – Category 2 shall be considered for all structures. Wind shall be assumed to blow in any direction and the most unfavourable condition shall be considered for design.

7.4. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING

The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system) and shall be made on AUTOCAD (latest version) in executable format.

a) General plant layout drawing with Co-ordinates of roads, buildings and facilities, pipe / cable pedestals, equipment lay down areas etc.

b) Drawing showing underground facilities with coordinates of these facilities like, trenches, sewer, drains, sumps pits, culverts, foundations etc.,

c) Soil investigation report carried out by Contractor along with foundation recommendation for ZLD buildings/facilities.

d) Design basis memorandum for ZLD buildings/facilities. Designs shall commence only after approval of memorandum.

e) Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings.

f) Design calculations and drawings for foundations / substructure and superstructure of all buildings, tanks and other structures.

g) Design calculations and drawings for all facilities and services culverts, paving, drains, sewers, water supply, water tank, sumps, trenches, ducts etc.,

h) Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling etc.,

i) Design calculations and drawings for plumbing and building drainage.

j) All other designs, details/drawings or any other submissions as indicated elsewhere in this specification and as required by the owner.

k) Details of corrosion protection measures for all structures.

l) Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings.

7.5. REFERENCES, CODES AND STANDARDS

Structural design shall be developed on the basis of the standard codes and documents listed below. The analysis, design and construction for structural and civil works shall be in accordance with the BIS codes/standards or equivalent International codes, applicable at the time of issue of LOI. All the Bureau of Indian Standards codes referred to shall be the latest revision (including all amendments issued thereto) at the time of issue of LOI unless specified otherwise. Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards will be substituted if available.

o **Excavation And Filling**	
IS: 2720	(Part-II, IV to VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.
IS: 9758	Guide lines for Dewatering during construction
IS: 10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade
o **Properties, Storage and Handling of Common Building Materials**	
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 455	Specification for Portland Slag Cement
IS: 432	Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement
IS: 702	Specification for Industrial bitumen
IS: 712	Specification for building limes
IS: 808	Rolled steel Beam channel and angle sections
IS: 1077	Specification for common burnt clay building bricks
IS: 1161	Specification of steel tubes for structural purposes
IS: 1363	Hexagon head Bolts, Screws and nuts of production grade C
IS: 1364	Hexagon head Bolts, Screws and Nuts of Production grade A & B
IS: 1367	Technical supply conditions for Threaded fasteners
IS: 1489	Specification for Portland Pozzolona Cement Fly ash based (Part I)
IS: 1542	Specification for sand for plaster
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement
IS: 1786	Specification for high strength deformed bars for concrete reinforcement
IS: 2062	Specification for steel for general structural purposes
IS: 2116	Specification for sand for masonry mortars
IS : 2185 Part I	Specification for Concrete Masonry, Hollow and Solid concrete blocks
IS : 2185 Part II	Specification for Concrete Masonry, Hollow and solid Light weight Solid concrete blocks

IS: 2386	Testing of aggregates for concrete (Parts-I to VIII)
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495	Methods of tests of burnt clay building bricks (Parts-I to IV)
IS: 3812 (Part I & II)	Specification for Pulverised Fuel Ash Part I -for use as Pozzolona in Cement, Cement Mortar and Concrete; Part II – for use as Admixture in Cement Mortar and Concrete
IS: 4031(All Parts)	Methods of physical tests for hydraulic cement
IS: 4032	Methods of chemical analysis of hydraulic cement
IS: 4082	Recommendations on stacking and storage of construction materials at site
IS: 8112	Specification for 43 grade ordinary Portland cement
IS: 8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary Portland cement
IS: 12894	Specification for Fly ash lime bricks
o **Cast-In-Situ Concrete And Allied Works**	
IS: 280	Specification for mild steel wire for general Engineering purposes
IS: 456	Code of practice for plain and reinforced concrete
IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures
IS: 516	Method of test for strength of concrete
IS: 650	Specification for standard sand for testing of cement
IS: 1199	Methods of sampling and analysis of concrete
IS: 1791	General requirements for batch type concrete mixers
IS: 1838 (Part-I)	Specification for preformed fillers for expansion Joints in concrete pavements and structures (non- extruding and resilient type).
IS: 2438	Specification for roller pan mixer
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type
IS: 2506	General requirements for concrete vibrators, screed board type
IS: 2514	Specification for concrete vibrating tables
IS: 2645	Specification for Integral cement water proofing compounds
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)

IS: 2750	Specification for Steel scaffolding
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction
IS: 3025	Methods of sampling and test waste water
IS: 3366	Specification for Pan vibrators
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids
IS: 3414	Code of practice for design and installation of joints in buildings
IS: 3550	Methods of test for routine control for water used in industry
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete
IS:3935	Code of Practice for composite construction
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding
IS: 4326	Code of practice for earthquake resistant design and construction of buildings
IS: 4656	Specification for form vibrators for concrete
IS: 4925	Specification for batching and mixing plant
IS: 4990	Specification for plywood for concrete shuttering work
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work
IS: 5624	Specification for foundation bolts
IS: 6461	Glossary of terms relating to cement concrete
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools
IS: 6509	Code of practice for installation of joints in concrete pavements
IS: 7861	Code of practice for extreme weather concreting.(Parts I & II)
IS: 9012	Recommended practice for shot concreting
IS: 9103	Specification for admixtures for concrete
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction
IS: 10262	Recommended guidelines for concrete mix design
IS: 11384	Code of practice for composite construction in structural steel and concrete
IS: 12118	Specification for two-parts poly sulphide

IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams
IS: 13311	Method of non-destructive testing of concrete
Part-1	Ultrasonic pulse velocity
Part-2	Rebound hammer
SP:16	Design Aids for reinforced concrete to IS:456-1978
SP:22	Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
SP:23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP:25	Handbook on causes and prevention of cracks in buildings
SP:32	Handbook on functional requirements of industrial buildings
SP: 34	Handbook on concrete reinforcement and detailing
IS:13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
BS:4485	Structural design of cooling Towers(part 4)
o **Precast Concrete Works**	
SP: 7(Part VI/ Sec.7)	National Building Code- Structural design of prefabrication and systems building
IS: 10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units
IS: 10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete units
o **Masonry And Allied Works**	
IS: 1905	Code of Practice for Structural Safety of Buildings-Masonry walls
IS: 2212	Code of Practice for Brickwork
IS: 2250	Code of Practice for Preparation and use of Masonry Mortar
SP: 20	Explanatory hand book on masonry code
o **Sheeting Works**	
IS:277	Galvanised steel sheets (plain or corrugated).
IS: 513	Cold-rolled carbon steel sheets
IS: 730	Specification for fixing accessories for corrugated sheet roofing
IS: 2527	Code of practice for fixing rain water gutters and down pipe for roof drainage
IS: 7178	Technical supply conditions for tapping screw

IS: 8183	Bonded mineral wool
IS: 8869	Washers for corrugated sheet roofing
IS: 12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets
IS: 12866	Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).
IS: 14246	Specification for continuously pre-painted galvanised steel sheets and coils
o **Fabrication And Erection Of Structural Steel Work**	
IS: 2016	Specification for plain washers
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products
IS: 3502	Specifications for chequered plate
IS: 6911	Specification for stainless steel plate, sheet and strip
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts
IS: 6649	High Tensile friction grip washers
IS: 800	Code of practice for use of structural steel in general building construction.
IS:802	Code of Practice for use of structural steel in overhead transmission line towers: (All parts)
IS:806	Code of Practice for use of steel tubes in general building construction
IS:813	Scheme of symbols for welding
IS: 816	Code of practice for use of Metal Arc Welding for General Construction
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel
IS: 817	Code of practice for Training and Testing of Metal Arc Welders
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 7215	Tolerances for fabrication steel structures
IS: 12843	Tolerance for erection of structural steel

IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels
SP: 6	ISI Hand book for structural Engineers (Part 1 to 7)
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel
IS : 2595	Code of Practice for Radio graphic testing
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding
IS : 3658	Code of practice for Liquid penetrant Flaw Detection
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds
IS:1024	Code of Practice for use of welding in bridges and structures subjected to dynamic loading
IS:6533	Code of practice for design and construction of steel chimney-Part-1 &2
IS:8640	Recommendations for dimensional parameters for industrial building
IS:9595	Recommendation for Metal arc welding of carbon and carbon manganese steel
IS:12843	Tolerances for erection of steel structures
o **Plastering And Allied Works**	
IS : 1635	Code of practice for field slaking of Building lime and preparation of putty
IS : 1661	Application of cement and cement lime plaster finishes
IS : 2333	Plaster-of-paris
IS : 2402	Code of practice for external rendered finishes
IS : 2547	Gypsum building plaster
IS : 3150	Hexagonal wire netting for general purpose
o **Water Supply, Drainage And Sanitation**	
IS : 458	Specification for concrete pipes
IS : 774	Flushing cisterns for water closets and urinals

IS : 775	Cast iron brackets and supports for wash basins and sinks
IS : 778	Copper alloy gate, globe and check valves for water works purposes
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services
IS : 782	Caulking lead
IS : 783	Code of practice for laying of concrete pipes
IS : 1172	Basic requirements for water supply, drainage and sanitation
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes
IS : 1726	Cast iron manhole covers and frames
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories
IS : 1742	Code of practice for building drainage
IS : 1795	Pillar taps for water supply purposes
IS : 1879	Malleable cast iron pipe fittings
IS : 2064	Code of practice for selection, installation and maintenance of sanitary appliances
IS : 2065	Code of practice for water supply in building
IS : 2326	Automatic flushing cisterns for urinals
IS : 2470	Code of practice for installation of septic tanks (Part-I & II)
IS : 2501	Copper tubes for general Engineering purposes
IS : 2548	Plastic seat and cover for water-closets
IS : 2556	Vitreous sanitary appliances (vitreous china) (Part 1 to 15)
IS : 2963	Non-ferrous waste fittings for wash basins and sinks
IS : 3311	Waste plug and its accessories for sinks and wash basins
IS : 3438	Silvered glass mirrors for general purposes
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 4111	Code of practice for ancillary structure in sewerage system (Part I to IV)
IS : 4127	Code of practice for laying of glazed stone-ware pipes
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys

IS : 4984	High density polyethylene pipes for water supply
IS : 5329	Code of practice for sanitary pipe work above ground for buildings
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers
IS : 5822	Code of practice for laying of welded steel pipes for water supply
IS : 5961	Cast iron grating for drainage purpose
IS : 7740	Code of practice for road gullies
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services
IS : 8934	Cast copper alloy fancy pillar taps for water services
IS : 9762	Polyethylene floats for ball valves
IS : 10446	Glossary of terms for water supply and sanitation
IS : 10592	Industrial emergency showers, eye & face fountains and combination units
IS : 12592	Specification for precast concrete manhole covers and frames
IS : 12701	Rotational moulded polyethylene water storage tanks
SP: 35	Hand book on water supply and drainage - Manual on sewerage and sewage treatment (Published by CPH & EEO) as updated
o **Loading**	
IS 875	Code of practice for design loads other than earthquake) for buildings and structures (Part I to IV)
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
IS:11089	Code of Practice for design and construction of ring foundation
IS:13301	Guidelines for vibration isolation for machine foundations
IS:1911	Schedule of unit weights of building materials
o **Safety**	
IS:3696	Safety code for scaffolds and ladders (Part I & II)
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
o **Overhead Tank**	
IS:11682	Criteria for design of RCC staging for overhead water tanks
o **Doors, Windows And Allied Works**	
IS : 204	Tower Bolts
Part-I	Ferrous metals
Part-II	Nonferrous metals
IS : 208	Door Handles
IS : 281	Mild steel sliding door bolts for use with padlocks
IS : 362	Parliament Hinges
IS : 420	Specification for putty, for use on metal frames
IS : 1003 (Part-I)	Specification for timber panelled and glazed shutters-Part-I door shutters
IS : 1038	Steel doors, windows and ventilators
IS : 1081	Code of practice for fixing and glazing of metal (steel and Aluminium) doors, windows and ventilators
IS : 1341	Steel butt hinges
IS : 1361	Steel windows for industrial buildings
IS : 1823	Floor door stoppers
IS : 1868	Anodic coatings on Aluminium and its alloys
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortise 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
o **Roof Water Proofing And Allied Works**	
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
o **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 unbaked 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
o **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	Pre-treatment
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	Pre-treatment
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	Specification for plastic emulsion paint-for exterior use (Part-I)
IS:6278	Code of practices for white washing and colour washing
IS:10403	Glossary of terms relating to building finishes
o **Piling And Foundation**	
IS:1080	Code of practice for design and construction of Shallow foundations in Soils(Other than Raft, Ring & Shell)
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements
IS:2950	Code of practice for designs and construction of Raft (Part-I) 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
o **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:58	Guidelines for the Design of rigid pavements
IRC:86	Geometric Design standards for urban roads in plains
IRC:SP:13	Guidelines for the design of small bridges & culverts
IS:73	Specification for paving bitumen
o **Miscellaneous**	
IS:2210	Criteria for design of reinforced concrete shell structures and folded plates
IS:2470	Code of Practice for installation of septic tank:(part 1) Design criteria and construction (part 2) Secondary treatment and disposal of septic tank effluent

Codes in addition may be referred wherever required due to inadequacy of information in DBR. If details are not covered in Indian codes, international standards may be referred.

7.6. LOADS AND LOAD COMBINATIONS

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads and other piping loads, wind loads, seismic loads,

temperature load and any other loading condition which can occur during the design life of the facility. Structure shall also be checked for construction load during execution.

7.6.1 Dead Loads

Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including tanks, silos, partitions, roofing, piping, cable trays, bus-ducts etc. The contents of the tank shall be measured at full capacity for this purpose. The piping loads, cable tray loads and the contents of the tank shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing load for uplift. The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	**Unit Weight**
Plain Cement Concrete	2.40 t/cum
Reinforced Cement Concrete	2.50 t/cum
Brick work	1.90 t/cum
Cement Plaster	2.10 t/cum
Floor Finish	2.40 t/cum

7.6.2 Imposed Loads

Imposed loads shall include live loads, dust load, cable trays, hung loads, erection loads, operation / maintenance loads and loads produced by personnel, movable equipment, monorail hoist load and other items placed on the structure, but not permanently attached to it. For accessible roofs, a Roof load of 1.5kN/Sqm is considered.

- **Roofs** (Loading for sloped roof shall be as per-IS-875)

a)	Flat Roof	:	1.5kN/sqm for accessible roofs 0.75 kN/sqm for non-accessible roofs
		:	5.0 kN/sqm for accessible roofs with HVAC Equipment etc.
b)	Sloped Roof	:	As per IS 875 Part II

- **Main Control Room Building/Switch gear & control equipment building**

a)	Control Room Floor	:	10 kN /sqm
b)	M.C.C. Room	:	15 kN /sqm
c)	Cable Vault Room	:	5 kN /sqm
d)	Battery Rooms	:	10 kN /sqm
e)	A.H.U., A.C. & Ventilation Plant floors	:	10 kN /sqm
f)	Switchgear Room	:	15 kN /sqm
g)	PLCC, Relay Room	:	15 kN /sqm

- **Pump House**

a)	Operating Floor Slab	:	15kN/sqm or as required by equipment supplier whichever is higher. Maintenance area - 10kN/sqm.

- **Other Areas**

a)	R.C.C. Floors (offices, lab, conference room etc.)	:	5 kN /sqm
b)	Stairs & Balconies	:	5 kN /sqm
c)	Chequered Plate/Gratings	:	5 kN /sqm
d)	Walkways	:	3 kN /sqm
e)	Toilet Rooms	:	2 kN /sqm

Covers for trenches & channels which are not exposed to vehicular traffic shall be designed for Live load of adjoining area or 20 kN/sqm whichever is higher. In addition to the live loads/other loads a minimum load of 2.5 kN/sqm shall be considered as Hung loads for piping, electrical, ventilation & air conditioning and dust load of 0.5kN/Sqm. All above hung loads and equipment load shall be considered as dead load. The loads considered shall not be less than that specified in IS: 875 (Part II).

Culverts and allied structures shall be designed for Class "AA" loading and checked for Class "A" loading as per IRC standards for two lane road and above.

7.6.3 Earth Pressure Loads

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure underground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 20kN/sqm shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Effect of vehicular surcharge shall be considered, incase walls very close to the road.

7.6.4 Wind Load

Wind loading will be in accordance with Indian Standard Code IS - 875 for a basic wind speed of 33 m/ sec. Factors K1, K2 & K3 and subsequent wind pressure shall be as per IS -875 .
The various design parameters, as defined in IS: 875(Part-3), to be adopted for project site shall be as follows:

1. The basic wind speed "Vb" : 33 m/sec
2. The risk coefficient "K1" : 1.05
3. Category of terrain : Category-2
4. Topography factor "K3" : 1.0

7.6.5 Seismic Load

The lateral forces will be established in accordance with the recommendations of IS: 1893 (Part 1 & 4) of Indian Code of practice. The site falls in Zone II as identified in the map in IS: 1893. Analysis and design of structures shall be carried out accordingly taking into consideration the factors related to soil characteristics and importance of the structure together with following basic seismic co-efficient which are as per provisions of Indian code :-

Zone factor (Z) - 0.10
Importance factor (I) - As per Table-2, IS 1893-PART-4, 2005
Response Reduction Factor (R) - 5 for RCC Structures (as SMRF with ductile detailing as per IS 13920)

- 4 for Steel structures (for both moment connected and braced frames)
- for dynamic foundations I/R < 1.0 as per Cl 6.4.2 IS:1893 2002 part-I

7.6.6 Equipment Load

Static and dynamic loads of major equipment shall be based on the manufacturer's data of the specified equipment and shall be considered in design addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered. Eg. Switchgear & Control Rooms.

All equipment, tanks and piping design loading shall include hydraulic testing loading.

7.6.7 Crane and Monorail Loads

7.6.7.1 Crane loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

7.6.7.2 Monorail loads

All lifting beams, monorails shall have their design loads increased for impact factor as mentioned hereafter. Loads for cranes, hoists and elevators shall be taken as per IS: 875. The minimum impact factor to be used in design shall be as follows:

- Vertical loads - 10% of maximum wheel load for monorail end support design only.
- Vertical loads - 25% of maximum static load for monorail design only
- Horizontal force (transverse to rail) - 10% of the sum of lifted load and crab weight.
- Horizontal force (along the rail) – 5% of all static wheel loads

7.6.8 Temperature load

The effect of temperature loads shall be considered for design of structural frames. For temperature loading calculation the temperature variation shall be considered as 2/3rd of the difference in the mean of the daily maximum ambient temperature during the hottest month of the year (^{0}C) and mean of the daily minimum ambient temperature during the coldest month of the year (^{0}C). The structure shall be designed to withstand thermal stresses due to 50% of the total temperature variation. The structures shall also be analysed / checked for temperature effects in the areas where the temperature rise is expected to be high.

Mean Daily minimum ambient temperature during coldest month of the year = 11.50° C
Mean Daily maximum ambient temperature during hottest month of the year = 39.00°C

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per provisions of IS: 800 and IS: 456 for steel and concrete structures respectively. Coefficient of thermal expansion of steel shall be taken as per IS: 800 and Coefficient of thermal expansion for concrete shall be taken as per IS: 456.

7.6.9 Hydrostatic Pressure Load

Horizontal force acting on walls of sumps, tanks, drains and other water retaining structures, due to water column shall be considered in design. This would be a linearly varying load whose magnitude is equal to height of water column above the point of consideration.

7.6.10 Other Loads

Stresses imparted to structures due to variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.
All liquid retaining/storage structures are designed assuming liquid up to full height of wall irrespective of provision of any over flow arrangement.

7.6.11 Basic Load cases

The following basic load cases shall be considered for the analysis:

Load	**Notation**
Dead Load	DL
Equipment Load (permanent)	EQ
Live Load	LL
Crane trolley + Lifted load at A with Impact	CT/L/A(I)
Crane trolley + Lifted load at B with Impact	CT/L/B(I)
Crane Bridge	CB
Crane Bridge with Impact	CB(I)
Crane Trolley at Center	CT/C
Crane Trolley + 0.5 times Lifted load at Center with Impact	CT/0.5L/C(I)
Crane Surge due to Lifted load near A	CS/L/A
Crane Surge due to Lifted load near B	CS/L/B
Crane Surge due to 0.5 times Lifted load at Center	CS/0.5L/C
Crane Surge Longitudinal	CSL
Wind in +X direction (internal Pressure)	WL(+X)_PR

Load	Notation
Wind in -X direction (internal Pressure)	WL(-X)_PR
Wind in +Z direction (internal Pressure)	WL(+Z)_PR
Wind in -Z direction (internal Pressure)	WL(-Z)_PR
Wind in +X direction (internal Suction)	WL(+X)_SU
Wind in -X direction (internal Suction)	WL(-X)_SU
Wind in +Z direction (internal Suction)	WL(+Z)_SU
Wind in -Z direction (internal Suction)	WL(-Z)_SU
Seismic Load in X direction	SL(X)
Seismic Load in Z direction	SL(Z)
Load due to Soil Pressure	SP
Surcharge Load	SCL
Load due to Hydrostatic Pressure	HP
Temperature Load	TL
Special Load	SPL

7.6.12 Load Combinations

The following load combinations (summarized) as per IS: 875 Part 5 will be considered for finding out the critical forces on the structural elements.

- DL + LL + EQ
- DL + LL + EQ ± TL + CB(I) + CT/L/A(I) ± CS/L/A
- DL + LL + EQ ± TL + CB(I) + CT/L/B(I) ± CS/L/B
- DL + LL + EQ ± TL + CB(I) + CT/L/A(I) ± CSL
- DL + LL + EQ ± TL + CB(I) + CT/L/B(I) ± CSL
- DL + EQ ± TL + WL(+X)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(+X)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(-X)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(-X)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(+Z)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(+Z)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(-Z)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(-Z)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(+X)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(+X)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(-X)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(-X)_SU + CB(I) + CT/0.5L/C(I) ± CSL

- DL + EQ ± TL + WL(+Z)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(+Z)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL + WL(-Z)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + EQ ± TL + WL(-Z)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + EQ ± TL ± SL(X) + CB + CT/C
- DL + EQ ± TL ± SL(Z) + CB + CT/C
- DL + LL + EQ ± TL + WL(+X)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(+X)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(-X)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(-X)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(+Z)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(+Z)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(-Z)_PR + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(-Z)_PR + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(+X)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(+X)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(-X)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(-X)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(+Z)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(+Z)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + LL + EQ ± TL + WL(-Z)_SU + CB(I) + CT/0.5L/C(I) ± CS/0.5L/C
- DL + LL + EQ ± TL + WL(-Z)_SU + CB(I) + CT/0.5L/C(I) ± CSL
- DL + 0.5LL + EQ ± TL ± SL(X) + CB + CT/C
- DL + 0.5LL + EQ ± TL ± SL(Z) + CB + CT/C

Load combinations for overturning / uplift check

- 0.9DL + WL(+X)_PR ± TL
- 0.9DL + WL(-X)_PR ± TL
- 0.9DL + WL(+Z)_PR ± TL
- 0.9DL + WL(-Z)_PR ± TL
- 0.9DL + WL(+X)_SU ± TL
- 0.9DL + WL(-X)_SU ± TL
- 0.9DL + WL(+Z)_SU ± TL
- 0.9DL + WL(-Z)_SU ± TL
- 0.9DL ± SL(X) ± TL

- 0.9DL ± SL(Z) ± TL

Factors to these load combinations shall be taken as per IS: 456 for Concrete structures and as per IS: 800 2007 (WSD) for Steel structures. Lifted load of crane shall not be considered during seismic condition.

The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion.

The permissible stresses for different load combinations shall be as per IS: 875 (Part 5) and other relevant IS Codes. Wind and Seismic forces shall not be considered to act simultaneously.

An increase of 33.3% in permissible stresses will be made wherever wind or earthquake load has been considered with dead load and live load in the design of steel structures by Working Stress Method and Permissible stresses in bolts and welds shall be allowed to exceed up to 25% under wind or seismic conditions. However, members which are designed primarily to resist wind or seismic such as bracing members and shear keys, no increase in permissible stresses will be permitted. Permissible stresses shall not be increased for load combination with temperature load (other than wind and seismic load cases).

Bearing capacity of the soil shall be allowed to increase by 25% under seismic / wind load condition.

7.6.13 Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from superstructure for the design of sub structure of sumps and other underground structures.

- Only liquid pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside for liquid retaining structure.
- Earth pressure, surcharge pressure and ground water pressure (water level up to FGL) from outside and no water pressure from inside.

Buoyancy check for all underground structures, channels, sumps, trenches etc. shall be carried due to ground water level up to FGL. Minimum factor of safety as per IS: 3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

7.6.14 Loading Criteria for Pipe and Cable Rack Structures

Piping load shall be as per load plan drawings unless otherwise mentioned. Piping anchor and restraint forces of major piping shall be obtained from piping analysis results, and be considered as live load in the structure design.

7.7. ANALYSIS METHODOLOGY

Analysis of building / structure will be carried out by 3D (Space frame method) or by 2D depending on the type of structure and load details. For analysis of structure, STAAD Pro V8i will be used. For design of various structural elements like foundations, columns, beams, slab etc. in-house developed software or STAAD Pro V8i will be used wherever applicable.

7.8. DESCRIPTION OF FACILITIES

7.8.1 Centrifuge building

This building shall be steel framed structure, it has intermediate floor. Roof shall be truss with metal cladding. Colour coated single sheet metal cladding shall be provided from top of building to FGL. Roof/flooring/side cladding shall be as per mechanical requirement.

7.8.2 UF- RO building

This building shall be of RCC framed structure with RCC roof slab, RCC flooring and all-round brick cladding.

7.8.3 Crystallizer cum Evaporator building

The building shall be of structural steel frame with moment connection in the transverse direction and bracing in the longitudinal direction. It has intermediate grating/RCC floor. Roof shall be truss with metal cladding. Colour coated single sheet metal cladding shall be provided from top of building to FGL. Roof/flooring/side cladding shall be as per mechanical requirement.

7.8.4 Chemical House

This building shall be RCC framed structure with RCC roof slab, RCC flooring and all-round brick cladding.

7.8.5 Dyke area for UF & RO

Storage area shall be provided with an all-round dwarf wall of required height as per mechanical GA.

7.8.6 Miscellaneous

Roof access shall be provided for all the buildings with cage ladder. Finishing shall be as per vendor/ mechanical layout.

Each building shall house relevant equipments and other rooms required for functioning of ZLD plant system.

Floor where acid / alkali spillage are expected shall be isolated with RCC kerb and the flooring inside shall be of acid / alkali resistant brick. Drains from outside these building up to sludge sump/pit shall be provided with acid / alkali resistant brick lining. Acid / alkali unloading and storage area outside the building shall also be provided with kerb with a sump inside. This area shall also be provided with acid / alkali resistant brick lining. Tanks/Sumps/sludge pits shall be designed as a water retaining structure with water proofing compound.

Walls inside the Building area shall be provided with chlorinated rubber based painting. Main door shall be rolling shutter of adequate size to permit entry of the largest vessel/equipments. All doors and windows of the buildings shall be of powder coated aluminium glazed type. Windows shall be of sliding type.

7.8.7 Common Control room

Common control room shall be fully air conditioned area. Control room shall have luxalon false ceiling with minimum height of 3.0m. False ceiling shall be designed properly arranging supply air diffuser, return air grill, fire protection sprinklers and light fittings. Polished vitrified tile flooring shall be provided in control room. Main entrance of control room shall be provided with air locked lobby with automatic closing swing glass door. Lobby shall be formed of brick wall/ powder coated aluminium framing with hermetically sealed toughened glass (6mm, 12mm air gap & 6mm) as per detailed drawing. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. Doors shall be single leaf glazed aluminium door for all cabins in control room. No openings will be permitted on the roof of control room excepting possibly opening for A/C duct to exercise proper control on air conditioning.

Control room and laboratory shall be air-conditioned. False ceiling shall be provided in this area. Underdeck insulation shall be provided in the A/C area. Flooring in control room shall be of polished vitrified tiles. Toilets for ladies and gents along with the wash rooms shall be provided. In case a transformer yard is provided, the wall in front shall be fire barrier wall (i.e. 355 thk brick wall).

7.8.8 Condensate Storage Tank/Steel tanks

Condensate storage tank/steel tanks shall be supported on sand pad RCC ring wall footing.

7.8.9 Pipe and Cable Racks & Pipe sleepers

All cable and pipe routing in outlying areas shall be clubbed and shall run over ground on structural steel pipe / cable racks at a height not less than 3000 mm above graded level. In case

cable/pipe rack is not envisaged in the area, pipe shall be routed on the ground over RCC pedestals at a height not less than 500 mm above grade level. Where the cable/pipes cross the road, clear headroom of 7000 mm shall be maintained. Pipe/ Cable racks shall be two legged trestles with 750 mm walkway to cater maintenance requirements. Four legged trestles may also be provided as per design requirements.

The racks are generally designed as a rigid frame in the transverse direction and braced in the longitudinal direction. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 meters. Access ladder shall be provided at every 100m location. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundations with bottom of base plate about 300 mm above FGL.

7.8.10 Transformer Yard

Transformers may be located at suitable locations. Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through RCC pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as Fire barrier wall.

RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer.

Transformer yard area shall be paved with 100mm thk. plain cement concrete over rubble soling and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.

7.8.11 Fencing

Minimum 3 m high fencing above the toe wall shall be provided around transformer yard, wherever fencing is necessary due to security / safety / statutory requirements. Fencing shall comprise of 2.4 m high PVC coated galvanized chain link fence of minimum 8 gauge (including PVC coating) with mesh size 75 mm and galvanized barbed wire on inclined member to a height of 600 mm above the chain link fencing. 3 Lines of 12-gauge high tensile spring steel wire shall be provided for the entire length of fencing. Also 50 mm X 6 mm galvanized MS flats shall be provided at every fifth post sandwiching the fencing with post using GI nuts and bolts. Top of the toe wall shall be 200 mm above formation level. Toe wall shall be generally of RCC construction and shall extend 150 mm below the formation level and the fencing mesh shall be embedded inside toe wall by minimum 75 mm. Fencing post shall be

fabricated out of galvanized MS angle section of minimum 75x75x6 mm size and shall be spaced at a maximum spacing of 2.5 m with struts made up of galvanized MS angle at every fifth fencing post in addition to those at bends/ corners. Expansion joint shall be provided at every 60 m. Steel entry gates shall be provided for all fenced areas. Gates shall be formed out of tubular section conforming to IS: 1161. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

7.8.12 Pump foundations

All the pump foundations shall be of RCC type.

7.8.13 Roads, Drains and Culverts

All roads and vehicular parking areas shall be of rigid pavement type of concrete construction. All roads providing access to major buildings / structures / systems requiring maintenance by vehicles shall be 7 m wide. All other minor roads shall be 4 m wide. 1500 mm wide road shoulder shall be provided on either side of all two lane roads and 750mm wide shoulder on either side of 4.0m wide road. Longitudinal slope of pavement shall be limited to a maximum value of 1in 20. Top of road shall be 150mm above FGL of the area whereas top of rail shall be as per specific input drawings of the area concerned. On either side of the roads open drains shall be provided. Minimum clear width of the drain shall be 500 mm for main drains and 400 for garland drains. The drains shall be designed as rectangular open type and constructed of RCC. All service and utility lines crossing the roads shall be taken up through NP3 class RCC pipe designed for impact loading. Culverts shall also be generally using NP3 class pipe. In case the diameter of the pipe required is more than 600 mm, cast in situ RCC box culvert shall be provided.

7.8.14 Storm water drainage

The drainage system shall be designed for a maximum hourly rainfall intensity of 70mm. Run off coefficient for paved and unpaved areas shall be taken as 0.9 and 0.6 respectively. Exact terminal point location at plant boundary shall be as marked in plot plan as well as in separate drain layout. Storm water drainage system shall be designed in two parts.

(a) Main drains

(b) Auxiliary drains

Main drains shall be designed as a network covering total plant area and shall ultimately be led to nearest water body. Auxiliary / branch drains shall cover individual graded terraces to collect discharge from plant buildings and shall connect to main drain at suitable locations.

Drainage for plant effluent and storm water shall be carried by gravity. The drains shall generally be of open type and constructed with RCC. RCC box culverts shall carry drainage under roads.

At places where covered drainage system is required, channels with removable cover shall be preferred to piping system, as piped systems tend to get blocked. Underground storm water piping shall be restricted strictly to areas where surface drains are not desirable or practicable from functional point of view. Maximum allowable velocity of flow is 2.4 m/sec for pipe drainage and 1.8m/sec for open drains. However minimum self-cleansing velocity of 0.6m/sec shall be maintained. Minimum longitudinal slope of drain shall be limited to 1 in 1000. Manning's coefficient used in hydraulic design shall be 0.016

The storm water drainage for the contaminated area such as fuel oil areas and oil skids etc. shall be designed separately and the discharge shall be led separately for treatment and disposal through oil water separator. Where ever covered drains are required precast RC drain covers shall be provided.

7.9 GENERAL REQUIREMENTS FOR DESIGN

7.9.1 General

Design and construction of buildings, structure etc., shall take into account requirement for operation and maintenance of all equipment and its users. The buildings will have good architectural features. The surrounding area shall be properly micro levelled and graded.

7.9.2 Architectural concepts for Buildings

The architectural design concept of buildings structure shall be evolved considering the functional, technological and other requirements for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials, fittings and finishes.

7.9.3 Roof Access

All roofs shall be provided with access through a staircase/cage ladder. Minimum 1000 mm wide access path shall be provided to approach equipment on roof.

7.9.4 Stairs & Ladders

- **Steel Stairs**

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm. However, in case of space restriction, minimum clear width up to 750 mm may be provided. The vertical height between successive landings shall not exceed 5 m. Channels (min ISMC 200) shall be provided as stair stringers. Treads shall be minimum 250 mm wide of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm (200 mm in exceptional cases)

- **Steel Ladders**

Ladders shall be provided to platforms, walkways, instruments and equipment which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5 Degrees. Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum). Ladders shall be provided with a safety cage of minimum 750 mm dia. clear when the top of ladder is more than 4.5 m above the landing level. However, safety cages shall start at 2.5 m above the lower landing level. Same shall match with requirement of relevant BIS.

- **RCC Stairs**

All stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs wherever required.

7.9.5 Handrails

Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections /balconies, walkways, platforms, steel stairs etc. All handrails shall be of 32 mm nominal bore GI pipes (medium class) using 360 gm/sqm of zinc coating as per IS: 1161. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm center to center of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel.

7.9.6 Edge Protection

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. all around the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of RCC cable / pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

7.9.7 Anchor bolts & Insert plates

Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug

7.9.8 Vertical Headroom

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.

Finished floors to bottom of roof beams	3000 mm
Doors, Walkways, Platforms, Stairs etc	2100 mm
False ceiling of office areas	2400 mm
Walkway above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Main roads / Railway crossings & crane access	7000 mm
Cable & Pipe rack	3000mm except at Road / Rail crossings.

Above mentioned headroom clearance are applicable only if mechanical requirement is not given. In case mechanical requirements are given same shall be followed.

7.9.9 Expansion /Construction Joints

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC

ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. At other joints these shall be 150 mm wide.

Two part poly-sulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Pre-formed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

7.9.10 Brick / Stone Masonry & Parapet Wall

All masonry works shall be designed in accordance with IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of load bearing and non-load bearing walls constructed with solid or concrete blocks or Fly ash bricks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI.

All walls shall be non-load bearing in filled panels walls. External walls of all buildings shall be at least one brick thick. All internal walls shall be at least one brick thick except for internal partition walls for office area, change rooms and toilets which may be half brick thick. RCC bands shall be provided wherever necessary. RCC stub column of 230x230 shall be provided to avoid slenderness effect as specified in NBC.

50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work. Minimum 50 kg/ sq cm compressive strength brick shall be used for non-load bearing super structure brickwork. Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used.

All up stands and parapet walls on roof shall be of RCC constructions, minimum height of parapet walls shall be 900 mm and thickness 125 mm with aesthetics of architectural designs as approved by the owner.

7.9.11 Drainage

7.9.11.1 Floor drainage

For all buildings and areas, suitable arrangement for draining out water collected from equipment blow downs, leakage, floor washing, fire-fighting, etc., shall be provided on each floor. Gully traps, inspection pits, collecting pits etc., shall be located suitably and designed considering flow volume, easy access, maintenance and safety.

All drains inside the building shall have precast RCC covers where equipment loads would be coming or in open areas. These drains shall lead the water to drain sump. Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system. These garland drains would be of 500 width and shall be constructed in RCC.

7.9.11.2 Roof drainage

Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down corners and fixtures. System shall be designed to handle design rain fall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains though down comers. Rainwater down comers shall be of HDPE Pipe conforming to IS: 4984. Minimum pipe diameter of down comer pipe shall be 150mm.

7.9.11.3 Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

7.9.12 Water Proofing Of Underground Structures

All underground structures like basements, pump houses, water retaining structures etc., shall have plasticizer cum waterproofing cement additives confirming to IS: 9103. In addition, a limit on permeability as given in IS: 2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 9862 @ 1.7 kg/sqm (minimum) for water / damp proofing. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage.

7.9.13 Anti-Termite Treatment & Bituminous Coating for Foundations

Pre-constructional anti termite treatment shall be given to all buildings that have substantial wood work in it like service building etc., as per IS: 6313 and other relevant Indian Standards. Bituminous coating shall be provided to footing surfaces coming in contact with soil. Three coats of bitumen grade 85/25 as per IS 702 (@ 1.7kg/sqm) with 1% anti-stripping compound conforming to IS 6241 shall be applied.

7.9.14 Plinth Level

Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the FGL. Plinth protection should be min. 750 mm in length all around the periphery of building. Plinth protection shall be made in PCC M20 grade and thickness varying from 100mm near building to 75mm at end.

7.9.15 Backfilling of Over Excavated Area

Over excavated areas wherever foundations are coming shall be backfilled with PCC M10 grade. If depth of such backfilling exceeds 300mm nominal reinforcement shall be provided.

7.9.16 Statutory Requirements

All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (width as per mechanical drawing) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.

Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 355 thick and RCC firewall shall be minimum 200 mm thick

7.9.17 Specific design Requirements:

To account for revisions & additions of new loads likely to occur as the design work progress, the reduction of live load percentages for multiple floors as per IS:875 will not be considered. Further, the stress ratio / design margin for design of structural steel members shall be kept as 0.9. Minimum dia. of reinforcement provided shall be 12 mm for foundations. For foundations, the actual to allowable bearing ratio shall not exceed 0.9.

7.10 REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS

7.10.1 Design Methodology

All designs of RCC structures shall be carried out by limit state method as per IS:456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS:456. For reinforcement detailing IS 13920 IS: 5525 and SP: 34 shall be followed. RCC walls shall be provided with reinforcement on both faces or one face as per design requirement. Minimum depth of foundation shall be 1m below FGL for excavated area and 1.5m below NGL for filling area.

7.10.2 Foundation and Underground structures

The depth of all the foundations from design consideration shall be reckoned from the NGL (Natural Ground Level) or FGL (Finished Grade Level) whichever is lower. The minimum depth of foundation shall be 1.5m below FGL/NGL whichever is lower except for minor equipment foundations.

Foundation depth and safe bearing capacity etc. shall be considered as per Geotechnical Investigation report & Geotechnical Investigation layout.

For ease of construction and to achieve proper compaction /consolidation of concrete during construction of isolated footings, footing with uniform thickness shall be adopted. Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards. However, the settlement shall be restricted to 25 mm for isolated footing and 40mm for raft foundation.

All foundation including machine / equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant part of latest Indian standard IS: 2974 and IS: 456. Raft foundations shall be designed as per IS: 2950.

For design of underground structures, subsoil water level shall be considered up to FGL. Foundations shall be checked for safety against sliding and overturning. No foundation shall rest on backfilled soil. However minor foundation subjected to max bearing pressure of 5 T/m2 can be kept on backfilled soil.

The minimum depth of foundation shall be as per recommendations of geotechnical report. All underground pits, tunnels, basements, cable and pipe trenches, etc., shall be leak proof RCC structure where specified design depth of ground water table so warrants. Effects of uplift and reduction in bearing capacity due to underground water table shall also be considered where ever applicable.

7.10.3 Liquid Retaining Structures

RCC water retaining structure like storage tanks, water drain etc., shall be leak proof and designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses in accordance with IS:3370(part I & II) - 2009 for limit state method or as un-cracked section for working stress method. All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. Uplift force shall

be considered for water level up to FGL. No pressure relieving devices shall be permitted in underground structure.

In all liquid retaining structures, PVC water bar shall be provided at each construction /expansion joint. The sequence of construction shall also be specified on drawings showing construction joints. Fillet of size 200x200mm shall be provided at both the horizontal and vertical joints.

7.10.4 Machine Foundations

The design of equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations. All machine / equipment foundations and structures subject to vibrations shall suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.

All block foundations resting on soil shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than the two and a half (2.5) times mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. The Minimum reinforcement shall also be governed by IS: 2974 and IS: 456.

For the foundations supporting minor equipment weighing less than one ton or of the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on ground floor grade slab, suitable floor thickening shall be done.

Minimum reinforcement for raft shall be 0.12 % of the gross area in each face and in each direction. Minimum reinforcement for block foundations shall also be not less than 50 kg/cum.

7.10.5 Increase in Stresses

Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete, reinforcement steel and structural steel shall be increased by 33.33% in case of working stress design. However, when stresses due to wind (or seismic) loads are combined with dead load alone, no increase in allowable stress is permitted.

Bearing capacity of the soil shall be allowed to increase by 25% under seismic / wind load condition or as per applicable codal provisions whichever is lower.

Walls/slabs more than 150 mm thick and footings more than 300 mm thick shall be provided with reinforcement on each face /top & bottom, even if not required from design consideration. Minimum reinforcement for slabs shall be as per clause no 26.5.2.1 of IS 456. For walls, minimum reinforcement shall be as per clause no 32.5 of IS 456.And ductile detailing shall be as per IS 13920. Minimum reinforcement for pedestals shall be 0.15% of the gross cross sectional area.

7.10.6 Stability of Structures

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken in to consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed as per IS 456.

(a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

(b) Factor of safety against sliding shall be 1.5 minimum.

(c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

7.10.7 Minimum Thickness of Structural Elements

The following minimum thickness shall be followed:

- Suspended floor / slab / walkways /
  Canopy slabs, etc 125 mm

- Ground floor slab (non-suspended) 150 mm
- Water Retaining slabs / walls 200 mm
- Cable / pipe trenches / underground pits / Launder /drains
  - Walls & Base slab of drain 125 mm
  - Walls & Base slab(other than drains) 150mm
- All footings (except raft foundations) 250 mm
- Raft foundations 300mm
- Parapets 125 mm
- Sunshades 75 mm at edge
- Precast louvers / fins 50 mm
- Precast trench cover slabs / floor slabs / louvers 75 mm
- Paving 100 mm
- Basement walls and base slab 200 mm

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig 1 of table 16a of IS 456.

7.10.8 Minimum Heights for Pedestals of Steel Columns

Top or RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels for some columns shall be changed suitably to accommodate underground services, pits trenches, etc.

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

Pedestals to Steel Columns for Equipment structure:

- Equipment in open area as required (300mm min)
- Equipment in covered area as required (150 mm min)
- Structures and equipment supplied by vendor as per vendor's data subject to minimum as specified above.

7.10.9 Minimum Heights for Encasement to Steel Columns

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete with nominal reinforcement above FFL as per following.

- Open area : 300 mm above paved level

- Covered area : 150 mm above FFL

7.10.10 Concrete Mix

The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. Ordinary Portland Cement (OPC) shall generally be used. Pozzalona Portland Cement (PPC) shall also be used, if directed by the owner. Grade of OPC cement shall be 43 conforming to IS 8112.

Minimum cement content shall be governed by the requirement of IS: 456 or mix design whichever is stringent

Grade M10	:	Backfilling of over excavation.
Grade M15	:	Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 100 mm.
Grade M20	:	Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work, etc.
Grade M25	:	All RCC members except where other grades are specified e.g. substructure, Super structure, grade beams, pedestals, ground floor slabs, roof slabs, cable and pipe trenches, Precast concrete work, etc.
Grade M30		Water retaining structures below and above ground

7.10.11 Minimum cover to reinforcement

Minimum cover to the reinforcement (as defined in IS: 456) shall be as follows or bar diameter whichever greater unless stated otherwise.

Substructure Works:

Description	Top	Bottom	Sides	Ends
Foundation	50	50	50	-
Columns, pedestals	-	-	50	50
Tie beams/grade beams	40	40	40	-
Trenches	35	35	35	-

Liquid retaining structures/retaining walls	50	50	50	-
Slab on grade	30	30	30	-

Superstructure Works:

Description	**Top**	**Bottom**	**Sides**	**Ends**
Columns	-	-	40	50
Beams	35	35	35	35
Slabs	25	25	25	-
walls	30	30	30	-
Lintel, bands etc	30	30	30	-
Precast concrete	25	25	25	-
Chajja, Precast concrete for outdoor works	30	30	30	-

Equipment foundation:

Description	**Top**	**Bottom**	**Sides**	**Ends**
Equipment foundations	50	75	50	-

7.10.12 Reinforcements

Reinforcement bars shall be as per the following codes :

TMT of Grade Fe 500	:	IS 1786
Mild steel bars	:	Grade I of IS: 432
Welded wire fabric	:	IS: 1566

The minimum diameter of bar for main tensile reinforcement for foundation shall be 12 mm. Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed. Side face reinforcement (creep and shrinkage) reinforcement shall be provided for foundation depth more than 0.6m. Core reinforcement in all directions shall also be provided for foundation depth more than 1.0m for dynamic foundations.

7.10.13 Grouting

Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticizer admixture shall be added in the grout. For grouting of base of machine foundation high strength, flowable, ready mixed non-shrink grout shall be used.

Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.

Nominal thickness of grouting shall be 50 mm for building columns and major equipment supports. For secondary posts, stair and ladder base grouting shall not be less than 25 mm.

7.10.14 Minimum Cover to Foundation Bolts

Minimum distance from the center line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

- Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.
- Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.
- Clear distance from the edge of sleeve or anchor plate to the outer edge of pedestal shall be 75 mm.

7.10.15 Miscellaneous Requirement

Fillets at the junction of roof and vertical walls shall be provided with cast in situ cement concrete M15 grade followed by 12 mm thick 1:4 cement mortar.

A screed layer not less than 100 mm thick of cast in situ concrete of nominal mix grade M15 shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.

All underground structures shall be designed as per IS: 456 limiting the crack width to 0.1 mm. Check for crack width shall be in accordance with BS: 8007/IS: 456. In case of leakage in the above structure injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.

Plywood formwork shall be used for all water retaining / conveying structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.

Unless specified 20mm and downgraded aggregates shall be used for all structural concrete works. However 40mm and downgraded aggregates may also be used for levelling course/ PCC

under specific approval from the owner. Minimum thickness of levelling course/ PCC shall be 100mm.

Tolerance for formed and concrete dimension shall be as per IS:456

7.11 STRUCTURAL STEEL WORK

7.11.1 General

Design of structural steel work shall include generally but not be limited to the steel constructions listed below:

i) Steel building structure and open structures:
   This shall include beams, columns, bracings, supporting structures for floors, roof slabs, cladding etc.
ii) Crane gantry girder, monorails etc.
iii) Pipe and cable racks
iv) Platforms and walkways
v) Ladders, staircases, handrails etc.

7.11.2 Framing

All steel framed structures shall be either “rigid frame “or “simple space frames “or a combination of two.

Transverse direction forces shall be resisted by stiff jointed moment connections or pinned based on sway or non-sway condition in frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings shall be designed as simple space frame structures.

Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams, which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. Shear connectors of minimum ISMC 75 and width equal to width of flange (leaving tolerance for welding) shall be provided at a min spacing of 500c/c. However wherever large cut outs are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required. Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level. For axial compression concrete floor shall not be assumed to provide restraint unless bottom flange is also restrained. Suitable stays, secondary beams with stiffener connecting the bottom flange shall be provided to have lateral restraint.

Columns shall be designed to support the load combination, which produces the maximum interaction ratio. Exterior columns shall be designed to resist wind moments between braced elevations as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing or non-concentric bracing work points.

7.11.3 Materials

Structural steel shall conform to Grade A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness or welded construction, steel conforming to Grade B (Killed) of IS: 2062 shall be used except for crane girders where Grade C (IS: 2062) steel shall be used.

Chequered plates shall conform to IS: 3502. All gratings shall be pressure locked type (preferably electro-forged) manufactured in accordance with applicable Indian standard. Pipes for handrail shall be of medium grade as per IS: 1161. Crane rails shall conform to IS: 3443.

7.11.4 Connections

Welding shall be used for shop fabrication and joints. For site connections, welding or high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints may be adopted e.g. purlins, side girts etc. A minimum of two bolts per connection shall be used.

IS:816 and IS:9595 shall be followed for welding of structures.

For high strength friction grip bolt connections IS: 4000 shall be followed. High strength friction grip bolts shall be of property class 6.6 or 8.8 and shall conform to IS: 3757 and shall not

be less than 20 mm in diameter unless designated otherwise. High strength bolts shall be installed as bearing type joint except where loads are reversible.

All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and handrail shall be made with 20 mm diameter threaded fasteners conforming to IS: 1363. Erection bolts shall be black bolts of minimum 12 mm dia.

All bolts and nuts shall have property / class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS: 6755. The threaded portion of the bolt shall project through the nut at least by one thread.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Site Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

Horizontal bracings shall be angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at column locations.

For Major columns of main building, column splices shall be designed as per IS 800.

Minimum size of fillet weld shall be 6 mm. Main structural elements shall be welded continuously. Intermittent weld shall be used only on secondary members, which are not exposed to weather or other corrosive influence.

Efficiency of site welds to be considered shall be as following:-

Butt weld above 25m from ground

- Column Splicing – 50%

- In moment connection/ beam splicing – 80%
- Others – 80%

Shop connections will be all welded type and field connections will generally be bolted unless specified otherwise. Field bolts, wherever provided, will be high tensile friction grip bolt of 20 mm dia. or of higher diameter and of property class 8.8 (minimum) as per IS –1367 (latest) for all major connections. Minimum number of 2 bolts shall be provided. The bolted joints will be designed for friction type connection and the H.T. bolts will be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlin, stairs, wall beams will be done by means of M.S. black bolts (grade 4.6), conforming to IS-1363 unless specified otherwise. Welding will be done in accordance with the recommendation of IS : 816 – Code of Practice for use of metal arc welding for general construction in mild steel and I.S. 9595 Recommendation for Metal arc welding of Carbon and Carbon Manganese Steels. Submerged arc welding process shall be used for welding longitudinal fillet welds (connecting flanges with web) and longitudinal/transverse butt joints for fabrication of columns, framing beams, crane girders & and all other built up members unless manual arc welding is specifically required. All butt welds in beams, girders & columns will be of full penetration. All butt welds will be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding will conform to IS – 7280. The combination of wire and flux will satisfy requirement of IS – 3613. Following connections types will be provided during erection:

- **Welded Connections:**

  i. Connection of secondary beam to Main Beam.

  ii. Connection of Bracing to Column.

  iii. Connection of Bracing to longitudinal Tie Beam.

  iv. Connection of Longitudinal Tie Beam to column.

  v. Connection of Spandrel Beam to Column.

  vi. Connection of other secondary structures.

  vii. Connection of frame beam to column.

  viii. Connection of Brackets from column.

  ix. Column splices up to 50m height (shop splice).

  x. Beam splices.

- **HSFG connection (Grade 8.8 bolts)**

  i. Column splices above 50m height (field splice).

  ii. Connection of Crane Girder to column at fixed side, other side will be HT bolt Grade 8.8 in slotted holes.

  iii. Connection between Crane Girders.

  iv. Connection of members where tension will be in the fastener.

  v. Other major connections.

- **Bearing Type connection (H.T. bolts Grade 8.8)**

  i. All removable type connections.

  ii. Plan bracings at roof truss

- **M.S Bolts (Gr. 4.6)**
  i. Handrailing.
- **Low Hydrogen Electrodes as approved by the Engineer will invariably be used in the following cases:**

  i. For welding of all important joints such as Butt joints in Columns (flange or web), Butt joints in Main frame Beams (Flange or web) etc.

  ii For welding steel having thickness more than 20 mm.

In case of fillet weld between two components, the thickness of the thicker part will be considered as the limit for (ii)

7.11.5 Design Methodology

The Design of steel structures shall be done by working stress method in accordance with the provisions of IS: 800 2007 working stress method and other relevant IS Codes as applicable to specific structures.

All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings/moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.

Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting /

monorails and crane gantry (where ever feasible) beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced suitably if required.

Permissible stresses for different members shall be allowed to exceed up to 33.33% only under wind and seismic conditions, no increase in permissible stresses is permitted when wind and seismic loads are combined with dead loads alone. However, members which are designed primarily to resist wind such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25% only under wind and seismic conditions.

For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) following criteria shall be used in determining minimum load: Use 90% of the column dead load, No live load is used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.

Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself. No anchor pockets in foundation shall be allowed. Design of base plates shall be based on design pressure on foundation as per IS800/ IS456.

The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A coefficient of friction of 0.30 shall be used in conjunction with the minimum column load as defined above. If the horizontal shear force exceeds the frictional resistance force or if the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.

7.11.6 Design of Connections

Fabrication drawings shall be prepared according to the provisions of IS: 800, IS: 816, IS: 9595, IS: 1367 and IS: 9178. Connection of vertical bracings with connecting members and diagonals of truss members will be designed for full tensile capacity of the bracings. Size of fillet weld for flange to web connection for built up section will be as follows:

I. Full shear capacity or actual shear whichever is more for box section.
II. 80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more. For I –section, weld will be double fillet.

III. All welds will be continuous. The minimum size of the fillet weld will be as per relevant I.S. code.

Shear connections will be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Designed shear force shall be more than actual shear. Moment connections between beam and column will be designed for 100% of moment capacity of the beam section. All butt welds will be full penetration butt welds. The connection between top flange & web of crane girder will be full penetration butt weld & for bottom flange, connection may be fillet weld.

All splicing work will be full strength. Field splicing will be done with web /flange cover plates. For, exceptional cases the field splicing will be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing for all sections other than rolled will be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections will be carried out using web and flange cover plate.

7.11.7 Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

- **Vertical Deflection**
  - a) For beams supporting dynamic equipment : Span / 500
  - b) For beams supporting floors / masonry : Span / 325
  - c) For beams supporting pipes (pipe racks) : Span / 400
  - d) For roofing and cladding components : Span / 250
  - e) For gratings and chequered plates : Span / 200 subject to maximum of 6 mm

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

a) For manually operated cranes & monorails : Span / 500

b) For electric overhead cranes

i) up to 50 t capacity : Span / 750

ii) over 50 t capacity : Span / 1000

- **Horizontal deflections**

The permissible horizontal deflections shall be as per following unless specified otherwise:

a) Single storey building (without crane load) : Height / 325

b) Multistoried building (without crane load) : Height / 500

c) Pipe rack columns : Height / 200

d) Open Structures : Height / 200

e) Building main columns at crane rail level due to action of crane surge load only : Height/2500 limited to maximum of 10 mm

Provisions of IS:800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

7.11.8 Minimum Thickness and Sizes of Steel Elements

- **Minimum Thickness**

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a) Trusses, purlins, girts and bracing : 6 mm

b) Columns and beams : 8 mm

c) Gussets : 8 mm

d) Stiffeners : 8 mm

e) Base plates : 10 mm & above

f) Chequered plates : 6 mm o/p & above

g) Grating flats : 5 mm

h) Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

- **Minimum Sizes**

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width

of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 100 mm.

7.11.9 Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800. The following limiting ratios of depth to span shall be considered as a general guide.

a)	Truss	1 / 10
b)	Rolled beams and girders for Ordinary floors and rafters	1 / 24
c)	Supporting floor beams for vibrating Machinery / equipment	1 / 15
d)	Roof purlins and girts	1 / 45
e)	Gable columns	1 / 30

7.11.10 Fabrication and Erection

Detailed fabrication drawings and erection scheme shall be prepared based on the design drawings approved by OWNER. Fabrication shall commence only on the basis of the fabrication drawings approved by Tenderer Consultant. Detailed fabrication drawings are to be submitted to OWNER for reference before the commencement of fabrication.

Fabrication shall in general follow the provisions of IS:800, and good engineering practice where provisions of IS:800 are not clear. Tolerance in fabricated steel work shall be as per IS:7215. Erection of fabricated steel components shall be as per erection drawings prepared by tenderer and approved by its CONSULTANT. Tolerance for erected steel structures shall be as per IS:12843.

7.11.11 Inspection of Welding

The extent of quality control in respect of welds for structural elements shall be as follows.

- **Visual Examination**

All welds shall be 100% visually inspected to check the following:

a) Presence of undercuts
b) Surface cracks in both welds and base metals.
c) Unfilled craters
d) Improper weld profile and size
e) Excessive reinforcement in weld
f) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

- **Dye Penetration Test (DPT)**

This shall be carried out for all important fillet welds and groove welds to check the following:

a) Surface cracks
b) Surface porosities

Dye Penetration Test shall be carried out in accordance with American National Standard ASTME165.

- **Ultrasonic testing**

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by OWNER to detect the following:

a) Cracks
b) Lack of fusion
c) Slag inclusions
d) Gas porosity

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 Chapter 6 : Part C. Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

- **Radiographic Testing (X – ray and Gamma – ray Examination)**

This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by OWNER to detect the following defects:

a) Gas porosity
b) Slag inclusions
c) Lack of penetration
d) Lack of fusion
e) Cracks

Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWSD1.1-92. Any surface irregularity like undercuts, craters, pits etc shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75 x focal

distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

Tenderer shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the OWNER / consultant.

7.11.12 Acceptable Limits of defects of weld

Limits of Acceptability of welding defects shall be as follows.

- **Visual inspection & Dye Penetration Test**

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 8.15.1 & clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.

- **Ultrasonic Testing**

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 & clause 9.25.3 of American National Standard ANSI / AWS D1-92 respectively, for statically and dynamically loaded structures.

- **Radiographic Testing**

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clause 8.15.3 & 9.25.2 of American National Standard ANSI / AWS D1.1-92 respectively for statically and dynamically loaded structures.

7.11.13 Rectification of Defects in Welds

In case of detection of defects in welds, the rectification of the same shall be done as follows:

(i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld

(ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

(iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

7.11.14 Painting

All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface

preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be blast cleaned to grade SA-2 as per SIS 05-5900 or as per IS: 1477 (part -I). Primer paint shall be red oxide zinc chromate conforming to IS: 2074. Dry film thickness of each coat shall be 25 microns.

Finish paint shall be 2 coats synthetic enamel paint conforming to IS: 2932. Dry film thickness of each coat shall be 25 microns. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. All paints shall be of approved brand and shade as per the OWNER's requirement.

Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified. Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted. Only weldable primer, shall be applied on surfaces which required to be welded subsequently at site.

7.11.15 Requirements for Specific Structures

- In case chequered plates are used as floor covering the thickness of plate o/p shall be 6mm and additional support shall be provided if the span exceeds 1000mm. Suitable plan bracings shall be provided 75 mm from top of steel to transfer all the horizontal forces.
- Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.
- Bracing patterns and locations shall be so planned such that they do not hinder movement of personnel and movement of equipment during maintenance. When floor beam form part of vertical bracing system, additional loads from the floor beams transferred to the bracing shall be taken into account.
- Angle section shall not be used as flexural members except for purlins, side girts and walkway runners. Minimum angle size used shall be L50x50x6.
- End connection for rolled beams and channels shall be designed for a minimum of 60% of their shear capacity and built up beams for 80% of their shear capacity in addition to axial load.
- Dynamic analysis shall be carried out for beams supporting the vibrating / rotating equipment supporting beam floors in Buildings.

- All foundation bolts shall be provided with double nuts.

7.12 FINISHES

The minimum quality of finishes to be used for various building areas is furnished in this section. However, superior finishes may be used provided all specific requirements for the finish specified herein below are satisfied.

7.12.1 Flooring

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The under bed for floors shall consist of cement concrete M15 with stone chips 12.5 mm downgraded as coarse aggregates.

The flooring shall be laid on already matured concrete base. Floors on ground shall be made of minimum M25 reinforced concrete of 150 mm minimum thickness with reinforcement as per the design requirement. In case of toilets and offices, floor slab on ground shall be of plain cement concrete of Grade M25 with minimum thickness of floor slab of 100 mm.

For sub-base below the floor slab shall be min. 230 mm thick made of sand & rubble soling over compacted earth fill on top of which 100 mm thick PCC (M15) shall be provided.

- **PVC Flooring**

2mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.

- **Vitrified tile flooring**

Vitrified tile flooring shall be provided in the main control room area, other control rooms, electronic cubicle rooms, conference rooms etc. Polished vitrified tiles 600x600x10 thk. of approved shade, brand and colour laid in 1:3 shall be provided.

- **Granolithic Flooring**

Granolithic flooring (cement concrete flooring in M25) with non-metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance area, operating floor of pump house and other plant building areas where heavy duty flooring is required.

Granolithic flooring without floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned. Granolithic flooring shall also be provided in areas, which are not

provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.

- **Heavy Duty Ceramic Tiles**

Heavy duty anti-skid ceramic tiles with matt finish shall be used in toilets, pantry, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour.

- **Acid / Alkali Resisting Tiles**

Battery room and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, joined with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS: 4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm.

Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS: 4860 shall be provided for effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, kerbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.

- **Integral Floor Finish**

For cable vaults floor finish integral to the concrete base shall be provided as per IS:2571.

- **False /Removable Flooring System**

Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab shall be sunk to a depth as specified but not less than 800 mm which shall be height of the false floor system. The flooring shall consist of fire resistant phenol formaldehyde bonded particle board panels 600x600x35 mm size, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. 2 mm thick flexible anti-static PVC topping on top and PVC strip edging on sides of each panel shall be provided. Polished Granite shall be provided in entrance lobby floor, lift lobby floor and staircase riser and tread for service building only as per specification.

- **Miscellaneous**

Angles 50x50x6 mm (min) with lugs shall be provided for edge protection of cutouts / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected. Aluminium angle nosing with minimum size 50x25x3 mm shall be provided for edge protection of RCC stair tread for all staircases inside the building.

Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

7.12.2 Skirting / Dado

150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

Toilets & locker rooms shall be provided with dado of 2100 mm high with glazed tiles of minimum 5 mm thickness generally as per IS:777.

For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided up to false ceiling level.

For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.

Staircase wall shall be given dado of vitrified ceramic tiles to a height of 2100 mm.

7.12.3 Metal Cladding

- **Permanent Colour Coated Sandwiched Insulated Metal Cladding System**

Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm / sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

Galvanised M.S.sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanisation shall not be less than 150 gm / sq.m.

The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

Inner sheet shall fixed directly to side runners and Z spacers made of atleast 2 mm thick galvanised steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 0.750 m centre to centre to hold the insulation and external sheeting.

The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS: 8183 having a density of 32 kg / cum for glass wool & 48 kg / cum for rock wool.

- **Permanent Colour Coated (Non-Insulated) Metal Cladding System**

Trough type Zinc-aluminium alloy coated (both sides) high tensile sheet (Galvalume sheets) having 0.5mm total coated thickness with minimum yield strength of 550 Mpa shall be used on external face (outer face) of cladding system. Weight of Zinc and Aluminium coating shall not be less than 150 gms/sqm. The outer side (exposed face) shall be provided with fluoropolymer (PVF2) coating of DFT 20 microns over 5 microns primer. Inner face of the external sheet shall also be provided PVF2 coating of DFT 5 microns over 5 microns primer.

- **Flashings, Caps, Trim Closures etc.**

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

7.12.4 Plastering

Details furnished below do not include special types of plaster / plaster finishes which may be provided to enhance the architectural appeal.

External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 14 mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 shall be provided . For internal walls 18 mm thick plaster in CM 1:6 shall be provided on the uneven side of the wall and 13 mm thick plaster in CM 1:6 on the even side of the wall.

Inside surfaces of walls shall be provided with 2 mm thick plaster of paris / putty punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.

Ceiling of all buildings except in cable vaults and over false ceilings shall be given 6 mm thick cement sand plaster 1:4

All plastering work shall conform to IS: 1661. Plastering over steel structures like wall beams, shall be done using chicken wire mesh.

7.12.5 Painting

Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required to enhance overall appearance will be used if such finish meet with the technical requirements.

Acrylic exterior emulsion based paint as per IS: 5411 shall be provided on external faces of walls, sunshades, etc. Inside surfaces shall be provided with Acrylic emulsion paint as per IS: 5411 for Control room, Control equipment rooms, all air conditioned areas and all other areas and above dado in toilets, lift lobby etc.

Walls shall be provided with chlorinated rubber based paint as per IS: 9862. Walls above dado in battery rooms shall also be provided with similar painting.

Painting for structural steel has been specified elsewhere in this document.

Following general instruction for painting shall be followed.

a) For painting on concrete, masonry and plastered surfaces IS: 2395 parts I and II shall be followed.
b) For painting on wood work IS: 2338 part I & II shall be followed.
c) All paints shall be of brand and make to the approval of OWNER.
d) A minimum of two finishing coats of paint over a coat of primer shall be provided to give a smooth uniform finish for the painted surface.
e) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
f) Thinner shall not be used with textured paint (sandtex matt etc) finish.
g) All fire exits shall be painted in Post office red colour shade which shall not be used anywhere except to indicate emergency or safety measure.

7.13 ROOFING

All the buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS:14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised M.S.troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.

Roof of all other buildings having R.C.C. frame work shall have cast in situ R.C.C. slab with conventional shuttering.

7.13.1 Roof Drainage & Water Proofing

For efficient drainage of rain water, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provide by sloping the structural framing system itself.

Gradient may also be provided using screed concrete 1:2:4 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete may be restricted to about 50 mm. In the case of metal roofing system, using single length sheet, the roof slope shall be 1 vertical: 20 horizontal and with end laps the slope shall be 1 vertical: 10 horizontal.

All roofs shall be provided with polyurethane based liquid applied single component elastomeric water proofing membrane with separate wearing course as per ASTM C-836 and C-898. The Thickness of the membrane shall be a minimum overall DFT of 1.5 mm. The treatment includes application of a primer coat and polymerized mortar at the junction of parapet and roof slab over sloped roof to achieve a smooth surface. Wearing course shall be 40 mm screed of 1:2:4 concrete (Down Graded Aggregate of 12.5 mm) as above cast in panels of 1.2mx1.2m and reinforced with 0.56 mm dia galvanized chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered cement tiles as above.

Number and size of rain water down comer pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipes shall be UPVC/HDPE pipe conforming to IS: 4985. It is recommended that the minimum diameter of the pipe be kept as 100 mm for UPVC pipes and 150mm for HDPE pipes. Number of rain water pipes required for drainage shall be as per design requirements and/or space availability. Down comer pipe shall be suitably concealed with masonry work, cement concrete work or sheeting work to match with the exterior finish.

7.13.2 False Ceiling & Under Deck Insulation

All air conditioned areas in plant building shall be provided with suspended false ceiling system. Under deck insulation system shall be provided on the underside of the roof / floor slab of the air conditioned areas based on the functional requirement.

Aluminium false ceiling shall be of approved colour and Luxalon 84 C or approved equivalent with corrosion resistant aluminium alloy panels of minimum thickness 0.5mm including 50mm thick mineral wool insulation(density 48 kg/cum) conforming to IS:8183 bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc all complete.

Gypsum board false ceiling system shall consist of 600x600x12.5 mm gypsum board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.

Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.

A layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. shall be prepared such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.

Under deck insulation shall comprise of 50 thick resin bonded mineral wool (density 48 kg/cum) insulation mat conforming to IS: 8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.

Trap doors shall be provided for maintenance of light fixtures, AC ducts etc. in false ceiling of AC areas.

7.14 DOORS & WINDOWS

Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have powder coated aluminium framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.

Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium frame work with glazing. Doors shall be of double swing type or sliding type.

For common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non-air-conditioned areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.

Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by

filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc. Steel windows and ventilators shall be as per IS 1038.

Based on functional requirements rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.

Fire proof doors with panic devices and vision panel shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS: 3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation and of approved manufacturer.

Hollow extruded section of minimum 1.5 mm wall thickness as manufactured by Hindalco, Jindal or equivalent shall be used for all windows and ventilators. Hollow extruded section of minimum 3 mm wall thickness as manufactured by Hindalco, Jindal or equivalent shall be used for partitions/ doors.

All windows and ventilators on exterior walls of ZLD buildings shall be provided with suitable anodised aluminium grill.

7.15 GLAZING

All ventilators and windows on external face of buildings shall be provided with wired glass of minimum 6 mm thickness conforming IS: 5437. Where specified, double glazing shall consist of two 6 mm thick clear toughened safety glass conforming to IS: 2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation. For single glazed aluminium partitions and doors, Float glass or flat transparent sheet glass of minimum 5.5 mm thickness shall be used.

Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets. Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm. Float glass or flat transparent sheet glass shall conform to IS:2835. All glazing work shall conform to IS:1083 and IS:3548.

7.16 WATER SUPPLY AND SANITATION

Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank

conforming to IS: 12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.

For plant area sanitary sewage disposal, common septic tanks shall be provided at suitable locations for all buildings. The over flow from the septic tank shall be led to dispersion trenches or soak pits.

Waste water generated from the plant shall be treated in a full scale effluent treatment system. The treated effluent shall be used for watering the trees and maintenance of green belt area. Provision shall also be made for collection and disposal of solid waste. HDPE or DI pipes shall be used to carry sewage / waste water. The pipes shall be encased in concrete at road crossings. Manholes shall be at junctions and change of direction. In straight stretches manhole shall be provided at a maximum spacing of 30 m

The facilities provided in the toilet block shall depend on the number of users. IS: 1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS: 2064 and IS: 2065 shall also be followed. Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).

a) WC (Indian type) Orissa pattern (580x440mm) as per IS: 2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type-1 no.
b) WC western type 390 mm high as per IS: 2556 (part 2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type – 1 no.
c) Urinal with all fittings with photo voltic control flushing system as per IS: 2556 (Part-6, Sec.1) – 2 nos.
d) Wash basin (oval shape) with all fittings as per IS:2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos.
e) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings.
f) Stainless steel towel rail (600 x 20mm) - 2 nos.
g) Stainless steel liquid soap holder cum dispenser – 2 nos.
h) Janitor room.
i) Provision for installation of water cooler.
j) Provision of ventilation shaft.

An eye & face fountain (combined unit with receptacle) conforming to IS: 10592 shall be provided in battery room, chemical house and Chlorination plant. Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS: 2556(Part-5) in laboratories.

7.17 MISCELLANEOUS REQUIREMENTS

Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 450 mm over window openings, and 750 mm over door openings and 1200mm over rolling shutters.

Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.

No cable trenches shall be provided in TG hall, fuel oil pump house etc.

All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.

Fans shall be provided in general office area as per standard norms.

Area of windows shall be a minimum of 15% of the floor area to ensure adequate natural lighting.

Sewerage system shall be provided with adequate ventilation for pipe work as well as manhole.

Adequate natural lighting and ventilation shall be ensured for all buildings.

Duct banks consisting of MS / PVC conducts for cables shall be properly sealed with fire retardant sealing compound after laying of cables.

All floor openings for cables below electrical panel shall be sealed with fire sealing compound after the cables are laid

All openings in the external wall provided for pipes, cable ducts etc shall be effectively sealed to prevent water seepage after the routing of the services are completed.

7.18 ANNEXURE – A – FINISHING SCHEDULE

Buildings – RCC Framed buildings with RCC roof & brick cladding all-round.

Plastering -20mm thk (ex) (1:6 14mm + 1:4 6mm)
-13mm thk (in.) (1:6)
-6mm thk (ceiling) (1:4)

External painting - Water proof cement based paint

Sl. no	Area name	Flooring	Internal Wall finish	Ceiling finish
1	UF & RO Building	38mm thick Granolithic flooring with non-metallic floor hardner	Chlorinated rubber based paint as per IS:9862	Water bound distemper.
2	Chemical house	Acid/ alkali resistant tiling + similar dado and/or granolithic flooring with non-metallic hardener	-do-	-do-
3	Centrifuge/ Evaporator Building	38mm thick Granolithic flooring with non-metallic hardner	-do-	-do-
4	Switchgear/ MCC room	38mm thick Granolithic flooring with non-metallic hardner	Acrylic emulsion paint as per IS:5411	-do-
5	Control room	Polished Vitrified tiles polished type + same skirting	-do-	Aluminium false ceiling with under deck insulation
6	Battery room	38mm thick Acid/ alkali resistant tiling + similar dado	Chlorinated rubber based paint as per IS:9862	Water bound distemper.

Sl. no	Area name	Flooring	Internal Wall finish	Ceiling finish
7	Chemical Store room	38mm thick Acid/ alkali resistant tiling + similar skirting	Chlorinated rubber based paint as per IS:9862	-do-
8	Toilet	Heavy duty Ceramic tiles with matt finish and dado with glazed ceramic tiles Up to 2.1 M	Acrylic emulsion paint as per IS:5411	-do-
9	Office	Polished Vitrified tiles polished type + same skirting	Acrylic emulsion paint as per IS:5411	Aluminium false ceiling with under deck insulation
10	Laboratory	Polished Vitrified tiles polished type + same skirting	Acrylic emulsion paint as per IS:5411	Aluminium false ceiling with under deck insulation
11	Store Room	38mm thick Granolithic flooring with non-metallic hardner	Oil bound distemper	Water bound distemper.
12	RCC Staircase	Heavy duty Ceramic tiles	Acrylic emulsion paint as per IS:5411	Water bound distemper.